# B.E. (Electronics and Instrumentation Engineering)

## 2022 Regulations, Curriculum & Syllabi

Stay Ahead

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

An Autonomous Institution Affiliated to Anna University - Chennai • Approved by AICTE • Accredited by NAAC with "A+" Grade

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## VISION OF THE DEPARTMENT

To empower graduates with future-ready engineering skills and transform them into intellectually competent and responsible professionals who excel in automation and allied domains, contributing meaningfully to societal and industrial advancement at both national and international reputes.

## MISSION OF THE DEPARTMENT

- To empower the students with balanced technical education to confront multidisciplinary engineering problems.
- To strengthen the relation between academia and industry for their mutual benefits.
- To update the existing infrastructure along with establishing a new one to encourage research and start-up related activities.

## PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

- Perform effectively in interdisciplinary fields related to Instrumentation engineering, including associated industries, software firms, and academic institutions.
- Pursue higher studies and research at prestigious institutions in India or abroad.
- Exhibit social responsibility, teamwork, leadership, and entrepreneurial skills in their professional endeavors.

## PROGRAMME OUTCOMES (POs)

1. **Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.
3. **Design / Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.
4. **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.
5. **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.
6. **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.
7. **Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.
8. **Individual and Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

9. **Communication**: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
10. **Project Management and Finance**: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
11. **Life-Long Learning**: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

## PROGRAMME SPECIFIC OUTCOMES (PSOs)

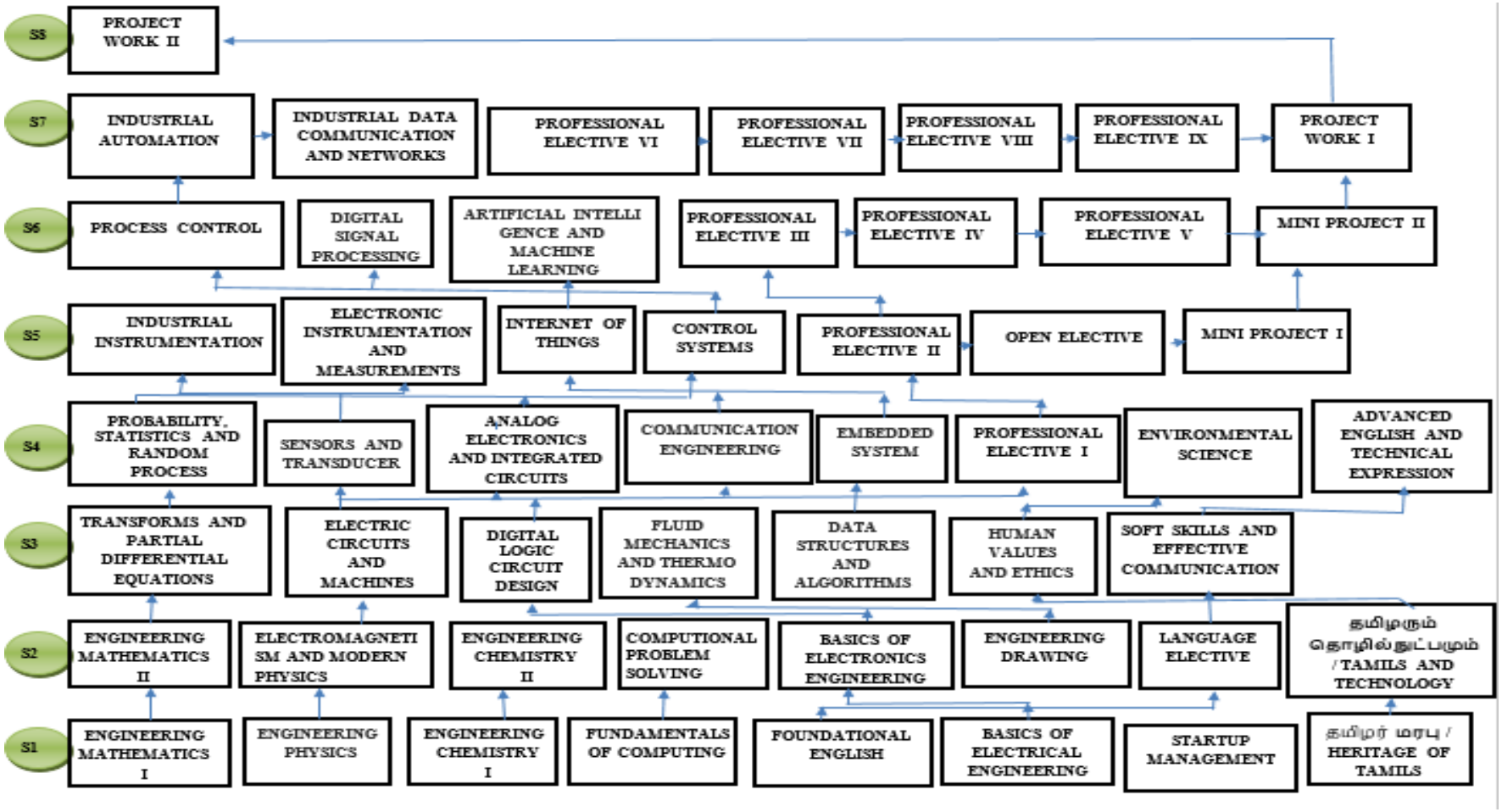
- Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications.
- Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

## MAPPING OF PEOs WITH POs & PSOs

| PEO(s) | POs & PSOs | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **PSO1** | **PSO2** |
| I | X | X | X | X | X | X | | | X | | X | X | X |
| II | X | X | | X | X | X | X | X | X | X | X | | X |
| III | | | | X | X | X | X | X | X | X | | X | X |

BANNARI AMMAN INSTITUTE OF TECHNOLOGY
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# DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING



| **DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING – R 2022**<br>**Minimum Credits to be Earned : 163** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **I SEMESTER** | | | | | | | | | | |
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours/ Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CIA** | **SEE** | **Total** | |
| 22MA101 | ENGINEERING MATHEMATICS I | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | BS |
| 22PH102 | ENGINEERING PHYSICS | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | BS |
| 22CH103 | ENGINEERING CHEMISTRY I | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | BS |
| 22GE001 | FUNDAMENTALS OF COMPUTING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | ES |
| 22HS001 | FOUNDATIONAL ENGLISH | 1 | 0 | 2 | 2 | 3 | 50 | 50 | 100 | HSS |
| 22GE003 | BASICS OF ELECTRICAL ENGINEERING | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | ES |
| 22HS002 | STARTUP MANAGEMENT | 1 | 0 | 2 | 2 | 3 | 50 | 50 | 100 | EEC |
| 22HS003 | தமிழர் மரபு<br>HERITAGE OF TAMILS#* | 1 | 0 | 0 | 1 | 1 | 40 | 60 | 100 | HSS |
| 22EI108 | COMPREHENSIVE WORK$ | 0 | 0 | 2 | 1$ | 2 | 100 | 0 | 100 | EEC |
| **Total** | | **15** | **1** | **10** | **21** | **26** | **-** | **-** | **-** | **-** |
| **II SEMESTER** | | | | | | | | | | |
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours/ Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CIA** | **SEE** | **Total** | |
| 22MA201 | ENGINEERING MATHEMATICS II | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | BS |
| 22PH202 | ELECTROMAGNETISM AND MODERN PHYSICS | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | BS |
| 22CH203 | ENGINEERING CHEMISTRY II | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | BS |
| 22GE002 | COMPUTATIONAL PROBLEM SOLVING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | ES |
| 22GE004 | BASICS OF ELECTRONICS ENGINEERING | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | ES |
| 22GE005 | ENGINEERING DRAWING | 1 | 0 | 2 | 2 | 3 | 50 | 50 | 100 | ES |
| | LANGUAGE ELECTIVE | 1 | 0 | 2 | 2 | 3 | 50 | 50 | 100 | HSS |
| 22HS006 | தமிழரும் தொழில்நுட்பமும்<br>TAMILS AND TECHNOLOGY^* | 1 | 0 | 0 | 1 | 1 | 40 | 60 | 100 | HSS |
| 22HS009 | COCURRICULAR OR EXTRACURRICULAR ACTIVITY* | - | - | - | NC | - | 100 | - | 100 | HSS |
| **Total** | | **15** | **1** | **10** | **21** | **26** | **-** | **-** | **-** | **-** |

* Applicable for the students admitted during academic year 2024-2025. The lateral entry students have to complete these courses during III and IV semesters.

# Students admitted during academic year 2022-2023 studied this course in semester II.

^ Students admitted during academic year 2022-2023 studied this course in semester III.

$ Applicable only for the students admitted during academic year 2022-2023.

| **III SEMESTER** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours/ Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CIA** | **SEE** | **Total** | |
| 22EI301 | TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | BS |
| 22EI302 | ELECTRICAL CIRCUITS AND MACHINES | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | ES |
| 22EI303 | DIGITAL LOGIC CIRCUIT DESIGN | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22EI304 | FLUID MECHANICS AND THERMODYNAMICS | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22EI305 | DATA STRUCTURES AND ALGORITHMS | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | PC |
| 22HS004 | HUMAN VALUES AND ETHICS | 2 | 0 | 0 | 2 | 2 | 40 | 60 | 100 | HSS |
| 22HS005 | SOFT SKILLS AND EFFECTIVE COMMUNICATION | 0 | 0 | 2 | 1 | 2 | 60 | 40 | 100 | EEC |
| **Total** | | **16** | **2** | **8** | **22** | **26** | **-** | **-** | **-** | **-** |
| **IV SEMESTER** | | | | | | | | | | |
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours/ Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CIA** | **SEE** | **Total** | |
| 22EI401 | PROBABILITY, STATISTICS AND RANDOM PROCESS | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | BS |
| 22EI402 | SENSORS AND TRANSDUCER | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22EI403 | ANALOG ELECTRONICS AND INTEGRATED CIRCUITS | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22EI404 | COMMUNICATION ENGINEERING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PC |
| 22EI405 | EMBEDDED SYSTEMS | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| | PROFESSIONAL ELECTIVE I | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22HS007 | ENVIRONMENTAL SCIENCE | 2 | 0 | 0 | NC | 2 | 100 | 0 | 100 | HSS |
| 22HS008 | ADVANCED ENGLISH AND TECHNICAL EXPRESSION | 0 | 0 | 2 | 1 | 2 | 60 | 40 | 100 | HSS |
| 22HS010 | SOCIALLY RELEVANT PROJECT* | - | - | - | NC | - | 100 | 0 | 100 | HSS |
| **Total** | | **20** | **1** | **8** | **23** | **29** | **-** | **-** | **-** | **-** |

* Applicable for the students admitted during academic year 2024-2025.

| **V SEMESTER** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours/ Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CIA** | **SEE** | **Total** | |
| 22EI501 | INDUSTRIAL INSTRUMENTATION | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22EI502 | ELECTRONIC INSTRUMENTATION AND MEASUREMENTS | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | PC |
| 22EI503 | INTERNET OF THINGS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PC |
| 22EI504 | CONTROL SYSTEMS | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | PC |
| | PROFESSIONAL ELECTIVE II | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | OPEN ELECTIVE | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI507 | MINI PROJECT I | 0 | 0 | 2 | 1 | 2 | 60 | 40 | 100 | EEC |
| **Total** | | **18** | **2** | **4** | **22** | **24** | **-** | **-** | **-** | **-** |
| **VI SEMESTER** | | | | | | | | | | |
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours/ Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CIA** | **SEE** | **Total** | |
| 22EI601 | PROCESS CONTROL | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22EI602 | DIGITAL SIGNAL PROCESSING | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | PC |
| 22EI603 | ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| | PROFESSIONAL ELECTIVE III | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | PROFESSIONAL ELECTIVE IV | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | PROFESSIONAL ELECTIVE V | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI607 | MINI PROJECT II | 0 | 0 | 2 | 1 | 2 | 60 | 40 | 100 | EEC |
| **Total** | | **18** | **1** | **6** | **22** | **25** | **-** | **-** | **-** | **-** |

| VII SEMESTER | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours/ Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CIA** | **SEE** | **Total** | |
| 22EI701 | INDUSTRIAL AUTOMATION | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22EI702 | INDUSTRIAL DATA COMMUNICATION AND NETWORKS* | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | PC |
| | PROFESSIONAL ELECTIVE VI | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | PROFESSIONAL ELECTIVE VII | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | PROFESSIONAL ELECTIVE VIII | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | PROFESSIONAL ELECTIVE IX | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI707 | PROJECT WORK I | 0 | 0 | 4 | 2 | 4 | 60 | 40 | 100 | EEC |
| **Total** | | **18** | **1** | **6** | **22** | **25** | **-** | **-** | **-** | **-** |
| **VIII SEMESTER** | | | | | | | | | | |
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours/ Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CIA** | **SEE** | **Total** | |
| 22EI801 | PROJECT WORK II | 0 | 0 | 20 | 10 | 20 | 60 | 40 | 100 | EEC |
| **Total** | | **0** | **0** | **20** | **10** | **20** | **-** | **-** | **-** | **-** |

* LTPC for this course is 3 0 0 3 for the students admitted during academic year 2022-2023.

| ELECTIVES | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **LANGUAGE ELECTIVES** | | | | | | | | | | |
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours/ Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CIA** | **SEE** | **Total** | |
| 22HS201 | COMMUNICATIVE ENGLISH II | 1 | 0 | 2 | 2 | 3 | 50 | 50 | 100 | HSS |
| 22HSH01 | HINDI | 1 | 0 | 2 | 2 | 3 | 50 | 50 | 100 | HSS |
| 22HSG01 | GERMAN | 1 | 0 | 2 | 2 | 3 | 50 | 50 | 100 | HSS |
| 22HSJ01 | JAPANESE | 1 | 0 | 2 | 2 | 3 | 50 | 50 | 100 | HSS |
| 22HSF01 | FRENCH | 1 | 0 | 2 | 2 | 3 | 50 | 50 | 100 | HSS |

| ELECTIVES | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **PROFESSIONAL ELECTIVES** | | | | | | | | | | |
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours/ Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CIA** | **SEE** | **Total** | |
| **VERTICAL I - SENSOR TECHNOLOGIES AND IOT** | | | | | | | | | | |
| 22EI001 | SMART SENSORS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI002 | IoT PROTOCOLS AND INDUSTRIAL SENSORS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI003 | IoT PROCESSORS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI004 | IoT SYSTEM DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI005 | WIRELESS SENSOR NETWORK DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI006 | INDUSTRIAL IoT AND INDUSTRY 4.0 | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI007 | DATA ANALYTICS FOR IoT | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **VERTICAL II - AUTOMATION** | | | | | | | | | | |
| 22EI008 | ROBOTICS AND AUTOMATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI009 | BUILDING AUTOMATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI010 | INTELLIGENT AUTOMATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI011 | SMART MANUFACTURING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI012 | AI AND EXPERT SYSTEM FOR AUTOMATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI013 | INTELLIGENT CONTROL | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI044 | HYDRAULICS AND PNEUMATICS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **VERTICAL III - APPLIED INSTRUMENTATION** | | | | | | | | | | |
| 22EI014 | ANALYTICAL INSTRUMENTS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI015 | VIRTUAL INSTRUMENTATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI016 | INSTRUMENTATION IN PETROCHEMICAL INDUSTRIES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI017 | FIBER OPTICS AND LASER INSTRUMENTATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI018 | POWER PLANT INSTRUMENTATION AND CONTROL | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI019 | INSTRUMENTATION IN FOOD PROCESSING INDUSTRIES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI045 | SMART AND WIRELESS INSTRUMENTATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI049 | INSTRUMENTATION AND CONTROL FOR PROCESS INDUSTRIES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI050 | PRODUCT DESIGN AND DEVELOPMENT | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **VERTICAL IV - SEMICONDUCTOR / EMBEDDED** | | | | | | | | | | |
| 22EI020 | SEMICONDUCTOR MANUFACTURING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI021 | AUTOMOTIVE ELECTRONICS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI022 | GREEN ELECTRONICS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI023 | DIGITAL VLSI | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI024 | REAL TIME EMBEDDED SYSTEMS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI025 | SOLAR PV FUNDAMENTAL AND APPLICATIONS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI046 | MICRO ELECTRO MECHANICAL SYSTEM | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI051 | SYSTEM VERILOG PROGRAMMING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI052 | FUNDAMENTALS OF VLSI VERIFICATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI053 | BARE METAL EMBEDDED SYSTEMS APPLICATION DEVELOPMENT | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI054 | EMBEDDED LINUX | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **VERTICAL V - ADVANCED CONTROL SYSTEMS** | | | | | | | | | | |
| 22EI026 | PROCESS MODELING AND SIMULATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI027 | SYSTEM IDENTIFICATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI028 | NON LINEAR CONTROL | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI029 | ADAPTIVE CONTROL | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI030 | DIGITAL CONTROL SYSTEM | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI031 | OPTIMIZATION TECHNIQUES FOR CONTROLLER DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI047 | POWER ELECTRONICS AND DRIVES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI048 | CHEMICAL PROCESS SYSTEMS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **VERTICAL VI - ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING** | | | | | | | | | | |
| 22EI032 | APPLIED SOFT COMPUTING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI033 | MACHINE LEARNING TECHNIQUES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI034 | DEEP LEARNING TECHNIQUES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI035 | PYTHON PROGRAMMING FOR AI AND ML | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI036 | OPTIMIZATION TECHNIQUES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI037 | NATURAL LANGUAGE PROCESSING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **VERTICAL VII - HEALTHCARE INSTRUMENTATION** | | | | | | | | | | |
| 22EI038 | BIOMEDICAL INSTRUMENTATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI039 | DIGITAL IMAGE PROCESSING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 22EI040 | BIO SIGNAL PROCESSING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI041 | HUMAN ASSISTIVE DEVICES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI042 | MEDICAL IMAGING SYSTEMS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EI043 | BRAIN COMPUTER INTERFACE | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |

| **HONOURS VERTICAL COURSES - SENSOR TECHNOLOGIES AND IOT** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 22EIH01 | SMART SENSORS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EIH02 | IoT PROTOCOLS AND INDUSTRIAL SENSORS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EIH03 | IoT PROCESSORS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EIH04 | IoT SYSTEM DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EIH05 | WIRELESS SENSOR NETWORK DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EIH06 | INDUSTRIAL IoT AND INDUSTRY 4.0 | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EIH07 | DATA ANALYTICS FOR IoT | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |

| **MINOR VERTICAL COURSES - SENSOR TECHNOLOGIES AND IOT** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 22EIM01 | SMART SENSORS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EIM02 | IoT PROTOCOLS AND INDUSTRIAL SENSORS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EIM03 | IoT PROCESSORS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EIM04 | IoT SYSTEM DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EIM05 | WIRELESS SENSOR NETWORK DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EIM06 | INDUSTRIAL IoT AND INDUSTRY 4.0 | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EIM07 | DATA ANALYTICS FOR IoT | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |

* Honor and Minor vertical courses offered for the students admitted during academic year 2022-2023 and 2023-2024.

| **OPEN ELECTIVES** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours/ Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CIA** | **SEE** | **Total** | |
| 22OCE01 | ENERGY CONSERVATION AND MANAGEMENT | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OCS01 | OBJECT ORIENTED PROGRAMMING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OCS02 | JAVA FUNDAMENTALS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OCS04 | E-LEARNING TECHNIQUES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OEC04 | PRINCIPLES OF COMPUTER COMMUNICATION AND NETWORKS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OME01 | DIGITAL MANUFACTURING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OME02 | INDUSTRIAL PROCESS ENGINEERING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OME03 | MAINTENANCE ENGINEERING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OME04 | SAFETY ENGINEERING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OBT01 | BIOFUELS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OFD01 | TRADITIONAL FOODS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OFD02 | FOOD LAWS AND REGULATIONS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OFD03 | POST HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OFD04 | CEREAL, PULSES AND OILSEED TECHNOLOGY | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OFT01 | FASHION CRAFTSMANSHIP | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OFT02 | INTERIOR DESIGN IN FASHION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OFT03 | SURFACE ORNAMENTATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OPH01 | NANOMATERIALS SCIENCE | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OPH04 | BIOPHOTONICS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OPH05 | PHYSICS OF SOFT MATTER | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OCH01 | CORROSION SCIENCE AND ENGINEERING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OCH02 | POLYMER SCIENCE | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 22OCH03 | ENERGY STORING DEVICES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OMA01 | GRAPH THEORY AND COMBINATORICS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OGE01 | PRINCIPLES OF MANAGEMENT | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OGE02 | ENTREPRENEURSHIP DEVELOPMENT I | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OGE03 | ENTREPRENEURSHIP DEVELOPMENT II | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OGE04 | NATION BUILDING, LEADERSHIP AND SOCIAL RESPONSIBILITY | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OBM01 | OCCUPATIONAL SAFETY AND HEALTH IN PUBLIC HEALTH EMERGENCIES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OBM02 | AMBULANCE AND EMERGENCY MEDICAL SERVICE MANAGEMENT | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OBM03 | HOSPITAL AUTOMATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OAG01 | RAINWATER HARVESTING TECHNIQUES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OEE01 | VALUE ENGINEERING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OEE02 | ELECTRICAL SAFETY | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OCB01 | INTERNATIONAL BUSINESS MANAGEMENT | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OCE02 | COST MANAGEMENT OF ENGINEERING PROJECTS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |

| **ONE CREDIT COURSES** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 22EI0XA | ELEMENTS OF INDUSTRIAL AUTOMATION | 1 | 0 | 0 | 1 | - | 100 | 0 | 100 | EEC |
| 22EI0XB | SMART VISUALISATION OF INDUSTRIAL PARAMETERS | 1 | 0 | 0 | 1 | - | 100 | 0 | 100 | EEC |
| 22EI0XC | AUTOMOTIVE EMBEDDED SYSTEM | 1 | 0 | 0 | 1 | - | 100 | 0 | 100 | EEC |
| 22EI0XD | DATA ANALYTICS AND VISUALIZATION | 1 | 0 | 0 | 1 | - | 100 | 0 | 100 | EEC |
| 22EI0XE | AUTOMOTIVE COMMUNICATION PROTOCOLS | 1 | 0 | 0 | 1 | - | 100 | 0 | 100 | EEC |
| 22EI0XF | ADVANCED STM32 ARM PROGRAMMING TECHNIQUES | 1 | 0 | 0 | 1 | - | 100 | 0 | 100 | EEC |
| 22EI0XG | INTELLIGENT SENSOR DESIGN | 1 | 0 | 0 | 1 | - | 100 | 0 | 100 | EEC |

## SUMMARY OF CREDIT DISTRIBUTION

| S.No | CATEGORY | CREDITS PER SEMESTER | | | | | | | | TOTAL CREDIT | CREDITS in % | Range of Total Credits | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI | VII | VIII | | | Min | Max |
| 1 | BS | 10 | 10 | 4 | 4 | | | | | 28 | 17.18 | 15% | 20% |
| 2 | ES | 7 | 8 | 4 | | | | | | 19 | 11.66 | 15% | 20% |
| 3 | HSS | 3 | 3 | 2 | 1 | | | | | 9 | 5.52 | 5% | 10% |
| 4 | PC | | | 11 | 15 | 15 | 12 | 8 | | 61 | 37.42 | 30% | 40% |
| 5 | PE | | | | 3 | 6 | 9 | 12 | | 30 | 18.40 | 10% | 15% |
| 6 | EEC | 1 | | 1 | | 1 | 1 | 2 | 10 | 16 | 9.82 | 10% | 15% |
| Total | | 21 | 21 | 22 | 23 | 22 | 22 | 22 | 10 | 163 | 100% | - | - |

BS - Basic Sciences
ES - Engineering Sciences
HSS - Humanities and Social Sciences
PC - Professional Core
PE - Professional Elective
EEC - Employability Enhancement Course
CA - Continuous Assessment
ES - End Semester Examination

## 22MA101 ENGINEERING MATHEMATICS I 3 1 0 4

**Course Objectives**

- To impart mathematical modeling to describe and explore real-world phenomena and data.
- To provide basic understanding on linear, quadratic, power and polynomial, exponential, and multi variable models.
- Summarize and apply the methodologies involved in framing the real world problems related to fundamental principles of polynomial equations.

**Programme Outcomes (POs)**

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

**Course Outcomes (COs)**

1. Implement the concepts of mathematical modeling based on linear functions in Engineering.
2. Formulate the real-world problems as a quadratic function model
3. Demonstrate the real-world phenomena and data into power and polynomial functions
4. Apply the concept of mathematical modeling of exponential functions in Engineering
5. Develop the identification of multivariable functions in the physical dynamical problems

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | - | - | - | - | - | - | - | - | - | 1 | 1 |
| 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | - | 1 |
| 3 | 2 | 1 | - | - | - | - | - | - | - | - | - | - | 1 |
| 4 | 2 | 2 | - | - | - | - | - | - | - | - | - | - | 1 |
| 5 | 1 | 2 | - | - | - | - | - | - | - | - | - | 1 | 1 |

**UNIT I** **9 Hours**

**MATHEMATICS MODELING OF LINEAR FUNCTIONS**

The geometry of linear equations - Formation of linear equations: Method of least squares and method of regression - Vector spaces: Basic concepts with examples - Linear combination - Eigen values and vectors

**UNIT II** **9 Hours**

**MATHEMATICAL MODELING OF QUADRATIC FUNCTIONS**

General form of a quadratic function - Basic relationships between the equation and graph of a quadratic function - Sum of squares error and the quadratic function of best fit - Quadratic forms: Matrix form - Orthogonality - Canonical form and its nature

**UNIT III** **9 Hours**

**MATHEMATICAL MODELING OF POWER AND POLYNOMIAL FUNCTIONS**

Characteristics of the graphs of power and polynomial functions - Fitting of power and polynomial functions using the method of least squares - Local maxima and local minima of power and polynomial functions - Power series of functions with real variables, Taylor's series, radius and interval of convergence - Tests of convergence for series of positive terms - Comparison test, Ratio test

**UNIT IV** **9 Hours**

**MATHEMATICAL MODELING OF EXPONENTIAL FUNCTIONS**

Concept of exponential growth - Graphs of exponential functions - Relationship between the growth factor and exponential growth or decay - Exponential equations have a variable as an exponent and take the form $y = ab^x$ through least square approximation - Calculus of exponential functions - Exponential series - Characteristics

**UNIT V** **9 Hours**

**MATHEMATICAL MODELING OF MULTIVARIABLE FUNCTIONS**

Graphing of functions of two variables - Partial derivatives - Total derivatives - Jacobians - Optimization of multivariable functions with constraints - Optimization of multivariable functions without constraints

**Tutorial: 15 Hours**
**Total: 60 Hours**

**Reference(s)**

1. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2016.
2. B. S. Grewal, Numerical Methods in Engineering & Science: with Programs in C, C++ & MATLAB, Khanna Publishers, 2014.
3. S. C. Gupta, V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2020.
4. Thomas and Finney, Calculus and Analytic Geometry, Fourteenth Edition, By Pearson Paperback, 2018.

## 22PH102 ENGINEERING PHYSICS 2 0 2 3

**Course Objectives**

- Understand the concept and principle of energy possessed by mechanical system
- Exemplify the propagation and exchange of energy
- Identify the properties of materials based on the energy possession

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Micro controller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Apply the work-energy theorem to analyze and optimize mechanical system performance
2. Analyze free and forced mechanical oscillations in vibrational energy systems
3. Analyze the propagation of energy in mechanical systems through transverse and longitudinal waves
4. Analyze the exchange of energy and work between the systems using thermodynamic principles
5. Apply the concept of energy and entropy to understand the mechanical properties of materials

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 1 | 1 | - | - | - | - | 2 | - | 1 | 1 | 1 |
| 2 | 3 | 2 | 1 | 2 | - | - | - | - | 2 | - | 1 | - | 1 |
| 3 | 3 | 2 | 2 | 1 | - | - | - | - | 2 | - | 1 | 1 | - |
| 4 | 3 | 2 | 2 | 1 | - | - | - | - | 2 | - | 1 | 1 | 1 |
| 5 | 3 | 2 | 2 | 1 | - | - | - | - | 2 | - | 1 | 1 | - |

**UNIT I** **6 Hours**

**CONSERVATION OF ENERGY**

Concept of energy - types of energy - conservation of energy Mechanical energy: - translation - rotation - vibration - Kinetic and potential energies - conservation - work and energy - laws of motion - minimization of potential energy - equilibrium - dissipative systems - friction

**5 Hours**

**UNIT II**

**VIBRATIONAL ENERGY**

Periodic Motion - Simple Harmonic Motion - Energy of the SHM - Pendulum types - Damped oscillations - forced oscillations - natural frequency - resonance

**UNIT III** **6 Hours**

**PROPAGATION OF ENERGY**

Transfer of energy - material medium - Transverse wave - Longitudinal wave - standing wave - interference - Doppler effect. Sound waves and its types - characteristics - human voice - reflection - refraction - beats

**UNIT IV** **7 Hours**

**EXCHANGE OF ENERGY**

Energy in transit - heat - Temperature - measurement - specific heat capacity and water - thermal expansion - Heat transfer processes. Thermodynamics: Thermodynamic systems and processes - Laws of thermodynamics - Entropy - entropy on a microscopic scale - maximization of entropy

**UNIT V** **6 Hours**

**ENERGY IN MATERIALS**

Elastic energy - Structure and bonding - Stress - strain - Tension and compression - elastic limit - Elastic Modulus - Stress - strain diagram - ductility - brittleness - rubber elasticity and entropy

**EXPERIMENT 1** **5 Hours**

Assess the physical parameters of different materials for engineering applications like radius, thickness and diameter to design the electrical wires, bridges and clothes

**EXPERIMENT 2** **5 Hours**

Evaluate the elastic nature of different solid materials for modern industrial applications like shock absorbers of vehicles

**EXPERIMENT 3** **5 Hours**

Analyze the photonic behavior of thin materials for advanced optoelectronic applications like adjusting a patients head, chest and neck positions as a medical tool

**EXPERIMENT 4** **5 Hours**

Investigate the phonon behavior of poor conductors for thermionic applications like polymer materials and textile materials

**EXPERIMENT 5** **5 Hours**

Assess the elongation of different solid materials for industrial applications like buildings, bridges and vehicles

**EXPERIMENT 6** **5 Hours**

Measure the compressibility of different liquids for modern industrial applications like navigation, medicine and imaging

**Total: 60 Hours**

**Reference(s)**

1. C J Fischer, The energy of Physics Part I: Classical Mechanics and Thermodynamics, Cognella Academic Publishing, 2019.
2. P G Hewitt, Conceptual Physics, Pearson education, 2017.
3. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2019.
4. J Walker, D Halliday and R Resnick, Principles of Physics, John Wiley and Sons, Inc, 2018.
5. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, New Delhi, 2017.

## 22CH103 ENGINEERING CHEMISTRY I 2 0 2 3

**Course Objectives**

- Understand the origin of elements from the universe
- Outline the properties of elements in the periodic table
- Analyse the different types of bond formed during chemical reactions and its reaction thermodynamics
- Summarize different states of matter based on atomic arrangement

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Apply the principles of nuclear fusion and stellar evolution to explain the processes of hydrogen fusion in stars and the creation of elements
2. Apply the concept of atomic structure of elements in the periodic table to interpret the periodic trends in properties of elements with its anomaly
3. Apply the conditions for the formation of different types of chemical bonds and predict the minimum energy required for a reaction to occur
4. Analyse endothermic and exothermic processes and exchange of energy during chemical reactions
5. Analyse whether the given matter is a solid, liquid, gas, or plasma and interpret the arrangement of atoms

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | - |
| 2 | 1 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | - |
| 3 | 1 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | - |
| 4 | 1 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | - |
| 5 | 1 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | - |

**UNIT I** **6 Hours**

**ORIGIN OF ELEMENTS**

Hydrogen - Elements and Sun - fusion - hypernova - supernova - dying stars - man-made elements

**UNIT II** **6 Hours**

**ATOMIC STRUCTURE AND PERIODICITY**

Atomic Structure - Electronic configuration - Periodic Table - Periodic trends in properties of elements - Anomalous behaviour in periodicity

**UNIT III** **6 Hours**

**CHEMICAL BONDING**

Octet rule & its limitations - types of chemical bonds - bond energy - bond cleavage - activation energy of reactions

**UNIT IV** **6 Hours**

**REACTION THERMODYNAMICS**

Conservation of energy - Endothermic reactions & exothermic reactions - Exchange of energy involved in chemical reactions

**UNIT V** **6 Hours**

**STATES OF MATTER**

Solid - liquid - gas - plasma - quantum dots - arrangement of atoms/ions/molecules in different phases

**EXPERIMENT 1** **5 Hours**

Evaluate the dissolved oxygen (DO) levels in effluent samples collected from sewage treatment plants in BIT. Ensure the suitability of outlet water for the growth of aquatic animals (fishes).

**EXPERIMENT 2** **5 Hours**

Investigate the amount of Iron ($Fe^{2+}$) in a mild steel alloy sample using a spectrophotometer.

**EXPERIMENT 3** **4 Hours**

Estimate the amount of chromium present in industry effluent samples and bottled beverages.

**EXPERIMENT 4** **5 Hours**

Ensure the suitability of drinking water in the RO water supply in BIT based on the presence of chloride ions.

**EXPERIMENT 5** **3 Hours**

Assess the acidic nature of effluent water from industries using the conductometric titration method.

**EXPERIMENT 6** **4 Hours**

Measure the stain removal efficiency of the prepared soaps from stained clothes.

**EXPERIMENT 7** **4 Hours**

Assess the purity of commercially available active pharmaceutical ingredients (aspirin) as per the government-prescribed standards.

**Total: 60 Hours**

**Reference(s)**

1. Rose Marie Gallagher and Author Paul Ingram, Complete Chemistry Cambridge IGCSE, 2nd Edition, Oxford university press, 2020.
2. Peter Atkins, Julio D Paula and James Keeler, Atkins' Physical Chemistry, 12th Edition, Oxford university press, 2019.
3. Gareth Price, Thermodynamics of chemical processes, 2nd Edition, Oxford university press, 2019.

4. D Tabor, Gases, liquids and solids and other states of matter, 3rd Edition, Oxford University press, 2018.
5. P L Soni, Text book of inorganic chemistry, Chand publishers, New Delhi, 2017.
6. J.D. Lee, Concise inorganic chemistry, 5th edition (Reprint), Blackman Science Ltd, France, Wiley-India, 2016.

## 22GE001 FUNDAMENTALS OF COMPUTING 3 0 0 3

**Course Objectives**

- Understand the fundamental digital logics behind computations of computer systems.
- Develop simple assembly language programs with respect to arithmetic operations.
- Understand the program execution process and basics of software development methodologies.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Micro controller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Infer the hidden languages and inner structures of computer hardware and software through codes and combinations.
2. Interpret the organizational and architectural issues of a digital computer with concepts of various data transfer techniques in digital computers and the I/O interfaces.
3. Analyze programming problems and apply assembly instructions to solve simple problems.
4. Infer the fundamentals of operating system and System programs basics.
5. Apply the software development methodologies to various real life scenarios.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | 1 | 1 | - | - | - | - | - | - | - | - | 1 |
| 2 | 3 | 3 | 3 | 1 | - | - | - | - | - | - | - | - | 1 |
| 3 | 2 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | 1 |
| 4 | 2 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | 1 |
| 5 | 2 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | 1 |

**UNIT I** **8 Hours**

**CODES AND COMBINATIONS**

Communication using Mores and Braille binary codes - Digitizing letters, numbers and objects using binary codes - Performing simple operations: addition through binary codes.

**UNIT II** **9 Hours**

**COMPUTATION USING COMPUTER**

Communication to computing devices through various input sources - Computational operation - flow, functions and controls - communication to output devices - Basic communication protocol.

**UNIT III** **11 Hours**

**ASSEMBLY LANGUAGE PROGRAMMING**

Little Man Computing (LMC) Model - Instruction Set - Labels - Calculation -Branching - Input - Output - Loops - Simple programs.

**UNIT IV** **9 Hours**

**OPERATING SYSTEM AND APPLICATION GENERATION**

BIOS - Device Drivers - Resources - Scheduler - Applications Generation and Creation - Stages of Compilation - Linkers, Loaders and Libraries.

**UNIT V** **8 Hours**

**SOFTWARE DEVELOPMENT**

Phases of application life cycle management - Software Development Methodologies - Web Page development.

**Total: 45 Hours**

**Reference(s)**

1. Charles Petzold, "Code: The Hidden Language of Computer Hardware and Software", Microsoft Press books, 2009.
2. David D. Riley, Kennya. Hunt, "Computational thinking for the modern problem Solver", CRC Press Taylor & Francis Group, 2014.
3. Andrew Eliaz, "Little Man Computer Programming: For The Perplexed From The Ground Up", The Internet Technical Bookshop; 1st Edition, 2016.
4. Abraham Silberschatz, "Peter Baer Galvin and Greg Gagne, Operating System Concepts", 9th Edition, John Wiley & Sons Pvt. Ltd, 2015.
5. Roger S. Pressman, "Software Engineering: A Practitioner"s Approach", McGraw Hill International edition, Seventh Edition, 2010.

## 22HS001 FOUNDATIONAL ENGLISH 1 0 2 2

**Course Objectives**

- Heighten awareness of grammar in oral and written expression
- Improve speaking potential in formal and informal contexts
- Improve reading fluency and increased vocabulary
- Prowess in interpreting complex texts
- Fluency and comprehensibility in self-expression
- Develop abilities as critical readers and writers
- Improve ability to summarize information from longer text, and distinguish between primary and supporting ideas

**Programme Outcomes (POs)**

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

**Course Outcomes (COs)**

1. Express themselves in a professional manner using error-free language
2. Express in both descriptive and narrative formats
3. Interpret and make effective use of the English Language in Business contexts
4. Actively read and comprehend authentic text
5. Express opinions and communicate experiences.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | 2 | 3 | - | 2 | - | - |
| 2 | - | - | - | - | - | - | - | 2 | 3 | - | 2 | - | - |
| 3 | - | - | - | - | - | - | - | 2 | 3 | - | 2 | - | - |
| 4 | - | - | - | - | - | - | - | 2 | 3 | - | 2 | - | - |
| 5 | - | - | - | - | - | - | - | 2 | 3 | - | 2 | - | - |

**UNIT I** **15 Hours**

**SELF-EXPRESSION**

Self-Introduction - Recreating Interview Scenarios (with a focus on verbal communication) - Subject Verb Concord - Tenses - Common Errors in verbal communication Be-verbs - Self-Introduction - Recreating interview scenarios - Haptics - Gestures - Proxemics - Facial expressions - Paralinguistics / Vocalics - Body Language - Appearance - Eye Contact – Artefacts Self-Introduction - Powerful openings and closings at the interview - Effective stock phrases - Modified for spontaneity and individuality-Question tags, framing

questions including WH - questions - Prepositions - Listening to Ted talks-Listening for specific information

**UNIT II** **15 Hours**

**CREATIVE EXPRESSION**

Descriptive Expression - Picture Description and Blog Writing - Vocabulary - One word substitution - Adjectives - Similes, Metaphors, Imagery & Idioms - Link words - Inclusive language Narrative Expression - Travelogue and Minutes of Meeting -Verbal Analogy -Sequence & Time order words - Jumbled paragraph, sentences, Sequencing - Text & Paragraph completion - Past tense - Using quotation marks

**UNIT III** **15 Hours**

**FORMAL EXPRESSION**

Formal Letters and Emails - Writing: E-mails and Letters of apology, Requisition and Explanation, and Letters to newspapers - Speaking: Tendering verbal apologies, and explanations, persuading a listener/ audience-Hierarchy in Business correspondence- Subject of a mail, Header, Body (Salutation) and Footer of a mail, Conjunctional clause Punctuation - Formal Idioms - Phrases - Articles - Definite & Indefinite - Types of sentences - Modal verbs Precision in comprehension, Summary writing, Selective summary - Reading: Active reading - short paragraphs, excerpts, articles and editorials - Skimming and Scanning Reading comprehension & analysis - Tenses, QP/ PQ approach. Identifying the central themes/ crux- Interpreting tone - formal/informal/semi-formal - Note-taking-Listening: Listening for data, for specific information, for opinion -Active and passive Listening - Transcription - Paraphrasing and summarizing information-Agreeing & disagreeing - Note-taking-Writing: Summary writing, selective summary, paraphrasing, note-making, opinion pieces - Finding synonyms in the context. Paraphrasing - Sentence Transformation - simple, compound, complex. Sentence substitution - Sentence completion - Interpreting paragraphs

**Total: 45 Hours**

**Reference(s)**

1. Sasikumar, V, et.al. A Course in Listening & Speaking Foundation Books, 2005.
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Prasad, Hari Mohan. A Handbook of Spotting Errors. Mcgraw Hill Education, 2010.
4. Reynolds, John. Cambridge IGCSEÃ‚Â® First Language English. 2018th ed., Hodder Education, 2018.
5. Wiggins, Grant P., and Jay McTighe. Understanding by Design. Association for Supervision and Curriculum Development, 2008.

## 22GE003 BASICS OF ELECTRICAL ENGINEERING 2 0 2 3

**Course Objectives**

- To understand the basic concepts of electrical charge and its properties
- To interpret the formation of electric field due to electric charges
- To illustrate the concept of magnetic fields due to revolving electron
- To illustrate the force on moving charges in electric and magnetic field
- To understand the energy, transfer in electro mechanical conversion

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

**Course Outcomes (COs)**

1. Analyze the behavior of electric charges in different medium using coulombs law.
2. Analyse the electric field due to different charge distributions.
3. Analyse the magnetic field intensity due to long conductor, solenoid, toroid and magnetic dipoles.
4. Analyze the force on conductors due to the moving charges.
5. Apply the energy conversion concepts in electromagnetic fields.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 2 | - | - | - | - | - | 2 | 2 | - | - | - |
| 2 | 2 | 2 | 2 | 3 | - | - | - | - | 2 | 2 | - | 1 | - |
| 3 | 2 | 2 | 1 | 3 | - | - | - | - | 2 | 2 | - | 1 | - |
| 4 | 3 | 2 | 1 | 2 | - | - | - | - | 2 | 2 | - | - | - |
| 5 | 2 | 2 | - | - | - | 3 | - | - | 2 | 2 | - | 2 | - |

**UNIT I** **5 Hours**

**ELECTRIC CHARGE**

Properties of charge, additivity of charges, quantization of charge, conservation of charge, Forces between multiple charges, Electric charge in conductors, Drift of Electrons, Charges in Clouds.

**UNIT II** **7 Hours**

**ELECTRIC FIELD**

Electric field due to system of charges, Significance of Electric field line. Electric Dipole and its significance, Continuous charge distribution, Field in infinite long uniform straight conductors, field in uniform charged uniform infinite plane sheet, field due to uniform thin spherical sheet.

**UNIT III** **7 Hours**

**MAGNETIC FIELDS**

Concept of magnetic field, magnetic fields in infinitely long straight wire, straight and toroidal solenoids, Magnetic dipole moment of a revolving electron, Magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to axis, Induced Electric field due to changing Magnetic Field.

**UNIT IV** **6 Hours**

**FORCE ON CHARGES**

Force on a moving charge in uniform magnetic and electric fields, Force on a current carrying conductor in a uniform magnetic field, Force between two parallel current carrying conductors.

**UNIT V** **5 Hours**

**ELECTRO MECHANICAL ENERGY CONVERSION**

Energy transfer in electromagnetic fields, Energy storage in magnetic field, Electromagnetic induction, induced emf, Eddy currents. Self and mutual inductance Linear Momentum and Angular Momentum carried by Electromagnetic Fields.

**EXPERIMENT 1** **7 Hours**

Analysis the behaviour of a Fixed Resistor in an Electric Heater

**EXPERIMENT 2** **7 Hours**

Construct an Electrical Wiring Layout for a Basic Household Applications

**EXPERIMENT 3** **8 Hours**

Analysis the Self and Mutual Induction in a Domestic Fan

**EXPERIMENT 4** **8 Hours**

Design a Transistor-Based Electronic Switch

**Total: 60 Hours**

**Reference(s)**

1. Mathew N. O. Sadiku, Principles of Electromagnetics, 6th Edition, Oxford University, 2020.
2. William H. Hayt and John A. Buck, Engineering Electromagnetics, McGraw Hill, 2020.
3. Kraus and Fleisch, Electromagnetics with Applications, McGraw Hill International Editions, 2017.
4. S.P.Ghosh, Lipika Datta, Electromagnetic Field Theory, First Edition, McGraw Hill Education(India) Private Limited, 2017.

## 22HS002 STARTUP MANAGEMENT 1 0 2 2

**Course Objectives**

- Promote entrepreneurial spirit and motivate to build startups
- Provide insights on markets and the dynamics of buyer behaviour
- Train to develop prototypes and refine them to a viable market offering
- Support in developing marketing strategies and financial outlay
- Enable to scale up the porotypes to commercial market offering

**Programme Outcomes (POs)**

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

**Course Outcomes (COs)**

1. Generate valid and feasible business ideas
2. Create Business Model Canvas and formulate positioning statement
3. Invent prototypes that fulfills an unmet market need
4. Formulate business strategies and create pitch decks
5. Choose appropriate strategies for commercialization.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | 1 | 2 | 1 | - | 1 | | - | - |
| 2 | - | - | - | - | - | 2 | 2 | 1 | 1 | 2 | | - | - |
| 3 | - | - | - | - | - | 3 | 3 | 1 | 2 | 2 | | - | - |
| 4 | - | - | - | - | - | 1 | 3 | 1 | 2 | 2 | | - | - |
| 5 | - | - | - | - | - | 2 | 3 | 2 | 2 | 2 | | - | - |

**UNIT I** **3 Hours**

**BUSINESS MODELS AND IDEATION**

Startups: Introduction, Types of Business Modes for Startups. Ideation: Sources of Ideas, Assessing Ideas, Validating Ideas, Tools for validating ideas, Role of Innovation and Design Thinking

**UNIT II** **3 Hours**

**UNDERSTANDING CUSTOMERS**

Buyer Decision Process, Buyer Behaviour, Building Buyer Personas, Segmenting, Targeting and Positioning, Value Proposition (Business Model Canvas), Information Sourcing on Markets, Customer Validation

**UNIT III** **3 Hours**

**DEVELOPING PROTOTYPES**

Prototyping: Methods - Paper and Digital, Customer Involvement in Prototyping, Product Design Sprints, Refining Prototypes

**UNIT IV** **3 Hours**

**BUSINESS STRATEGIES AND PITCHING**

Design of Marketing Strategies and Campaigns, Go-To-Market Strategy, Financial KPIs Financial Planning and Budgeting, Assessing Funding Alternatives, Pitching, Preparing Pitch Decks

**UNIT V** **3 Hours**

**COMMERCIALIZATION**

Implementation: Prototype to Commercialization, Test Markets, Institutional Support, Registration Process, IP Laws and Protection, Legal Requirements, Type of Ownership, Building and Managing Teams, Defining role of investors

**EXPERIMENT 1** **1 Hours**

Analysis of various business sectors

**EXPERIMENT 2** **2 Hours**

Developing a Design Thinking Output Chart

**EXPERIMENT 3** **1 Hours**

Creating Buyer Personas

**EXPERIMENT 4** **3 Hours**

Undertake Market Study to understand market needs and assess market potential

**EXPERIMENT 5** **2 Hours**

Preparation of Business Model Canvas

**EXPERIMENT 6** **15 Hours**

Developing Prototypes

**EXPERIMENT 7** **2 Hours**

Organizing Product Design Sprints

**EXPERIMENT 8** **2 Hours**

Preparation of Business Plans

**EXPERIMENT 9** **2 Hours**

Preparation of Pitch Decks

**Total: 45 Hours**

**Reference(s)**

1. Rashmi Bansal, Connect the Dots, Westland and Tranquebar Press, 2012.
2. Pavan Soni, Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solving, Penguin Random House India, 2020.
3. Ronnie Screwvala, Dream with Your Eyes Open: An Entrepreneurial Journey, Rupa Publications, 2015.
4. Stephen Carter, The Seed Tree: Money Management and Wealth Building Lessons for Teens, Seed Tree Group, 2021.
5. Kotler Philip, Marketing Management, Pearson Education India, 15th Edition
6. Elizabeth Verkey and Jithin Saji Isaac, Intellectual Property, Eastern Book Company, 2nd Edition, 2021.

## 22HS003 HERITAGE OF TAMILS 1 0 0 1

**Course Objectives**

- Describe the linguistic diversity in India, highlighting Dravidian languages and their features
- Summarize the evolution of art, highlighting key transitions from rock art to modern sculptures
- Examine the role of sports and games in promoting cultural values and community bonding
- Discuss the education and literacy systems during the Sangam Age and their impact.
- Outline the importance of inscriptions, manuscripts, and the print history of Tamil books in preserving knowledge and culture

**Programme Outcomes (POs)**

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

**Course Outcomes (COs)**

1. Understand the concept of language families in India, with a focus on Dravidian languages.
2. Trace the evolution of art from ancient rock art to modern sculptures in Tamil heritage.
3. Identify and differentiate various forms of folk and martial arts in Tamil heritage.
4. Understand the concepts of Flora and Fauna in Tamil culture and literature.
5. Evaluate the contributions of Tamils to the Indian Freedom Struggle.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | 2 | 3 | - | - | - |
| 2 | - | - | - | - | - | - | - | - | 2 | 3 | - | - | - |
| 3 | - | - | - | - | - | - | - | - | 2 | 3 | - | - | - |
| 4 | - | - | - | - | - | - | - | - | 2 | 3 | - | - | - |
| 5 | - | - | - | - | - | - | - | - | 2 | 3 | - | - | - |

**UNIT I** **3 Hours**

**LANGUAGE AND LITERATURE**

Language Families in India - Dravidian Languages - Tamil as a Classical Language- Classical Literature in Tamil- Secular Nature of Sangam Literature- Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

**UNIT II** **3 Hours**

**HERITAGE - ROCK ART PAINTINGS TO MODERN ART- SCULPTURE**

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

**UNIT III** **3 Hours**

**FOLK AND MARTIAL ARTS**

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

**UNIT IV** **3 Hours**

**THINAI CONCEPT OF TAMILS**

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

**UNIT V** **3 Hours**

**CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE**

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India - Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine - Inscriptions & Manuscripts - Print History of Tamil Books.

**Total: 15 Hours**

**Reference(s)**

1. Dr. K. K. Pillay, Social Life of Tamils, A joint publication of TNTB & ESC and RMRL.
2. Dr. S. Singaravelu, Social Life of the Tamils - The Classical Period, International Institute of Tamil Studies.
3. Dr. S. V. Subatamanian, Dr. K. D. Thirunavukkarasu, Historical Heritage of the Tamils, International Institute of Tamil Studies.
4. Dr. M. Valarmathi, The Contributions of the Tamils to Indian Culture, International Institute of Tamil Studies.
5. Keeladi, Sangam City Civilization on the banks of river Vaigai, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
6. Dr. K. K. Pillay, Studies in the History of India with Special Reference to Tamil Nadu.
7. Porunai Civilization, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
8. R.Balakrishnan, Journey of Civilization Indus to Vaigai, RMRL.

**22HS003 - தமிழர் மரபு** **1 0 0 1**

**பாடத்திட்டத்தின் நாக்கம்**

1. இந்திய தமொழிக்குடும்பத்Fள் திரொவிட தமொழிகள் தனித்F இயங்கும் தன்மமமய அதன் சிறப்புகள் வழி அறிதல்.
2. ததொன்றுததொட்டு தமிழர், கமலயில் அமடந்த வளர்ச்சிமய இயம்புதல்.
3. சங்ககொல தமிழரின் கற்றல் திறத்மத இலக்கியங்கள் வழி ஆரொய்தல்.

**கற்றலின் விளைவு**

1. இந்திய தமொழிக்குடும்பத்Fள் திரொவிட தமொழிகள் தனித்F இயங்கும் தன்மமமய அதன் சிறப்புகள் வழி அறிதல்.
2. ததொன்றுததொட்டு தமிழர், கமலயில் அமடந்த வளர்ச்சிமய இயம்புதல்.
3. சங்ககொல தமிழரின் கற்றல் திறத்மத இலக்கியங்கள் வழி ஆரொய்தல்.
4. தமிழ் தமொழியின் சிறப்புகமள அதன் பமடப்பிலக்கியங்கள் மூலம் அறிந்F தகொள்ளுதல்.
5. கற்கொலம் ததொடங்கி, இக்கொலம் வமர சிற்பக்கமல அமடந்த வளர்ச்சிமய கண்டுதகொள்ளல் .
6. தமிழர் தம் வொழ்வில் எங்கனம் இயற்மகமய வணங்கி பபொற்றினர் என்பமத திமண பகொட்பொட்டின் வழி ததளிதல்.
7. இந்திய விடுதமல பபொரில் தமிழர் ஆற்றிய பங்கிமன ததரிந்F தகொள்ளுதல்.

**அலகு I மொழி மற்றும் இலக்கியம்:** **3**

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

**அலகு II மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை:** **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

**அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்:** **3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

**அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்:** **3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

**அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு:** **3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**


1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

## 22MA201 ENGINEERING MATHEMATICS II 3 1 0 4

**Course Objectives**

- To impart and analyze the concepts of differential equations to describe in real-world phenomena.
- To provide basic understanding on differential equation models and vector field models.
- Summarize and apply the methodologies involved in framing the real world problems related to fundamental principles of complex functions.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.
PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.
PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.
PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

**Course Outcomes (COs)**

1. Interpret the concept of differential equations through mathematical modeling and analyze its applications in engineering
2. Formulate the real world problems as second order linear differential equations and give solutions for the same
3. Demonstrate the real-world phenomena with magnitude and direction in the form of vector functions
4. Apply the concept of vector fields and line integrals through mathematical modeling in engineering
5. Determine complex functions and apply them to formulate problems arising in engineering

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | | - | - | - | - | - | - | - | - | 1 | 1 |
| 2 | 2 | 2 | | - | - | - | - | - | - | - | - | 1 | 1 |
| 3 | 2 | 2 | | - | - | - | - | - | - | - | - | - | 1 |
| 4 | 2 | 1 | | - | - | - | - | - | - | - | - | - | 1 |
| 5 | 1 | 2 | | - | - | - | - | - | - | - | - | 1 | 1 |

**UNIT I** **9 Hours**

**FIRST ORDER LINEAR DIFFERENTIAL EQUATIONS**

Formation of differential equations- Solutions of first order linear ODE: Leibnitz's and method of separation of variables - Cooling/Heating of an object - A falling object - Modeling of electric circuits: RL and RC circuits - Modeling of population dynamics: Exponential growth and decay - Logistic growth model

**UNIT II** **9 Hours**

**SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS**

Methods of solving second order linear ordinary differential equations - Models for linear oscillators: Simple harmonic motion - Mechanical vibrations with and without damping - Electric circuit system: RLC circuits

**UNIT III** **9 Hours**

**VECTOR DIFFERENTIAL CALCULUS**

Vector and scalar functions - Fields - Derivative of a vector function and geometrical interpretation - Velocity and acceleration - Gradient and its properties - Tangent and normal vectors - Directional derivative - Divergence of a vector field - Curl of a vector field - Projectile motion

**UNIT IV** **9 Hours**

**VECTOR INTEGRAL CALCULUS**

Line integrals of vector point functions - Surface integral of vector point functions - Applications of line and surface integrals - Greens theorem in a plane - Stokes theorem - Gauss divergence theorem

**UNIT V** **9 Hours**

**COMPLEX FUNCTIONS**

Basic concepts of Complex numbers - Geometrical representation of complex number - Analytic functions and its properties - Construction of Analytic functions: Fluid flow and Electric flow - Mapping of complex functions

**Tutorial: 15 Hours**
**Total: 60 Hours**

**Reference(s)**

1. Richard E. Williamson, Introduction to Differential Equations and Dynamical Systems, McGraw Hill Companies. Inc, 1997.
2. Michael Greenberg, Advanced Engineering Mathematics, Second Edition, Pearson Education, 2018.
3. George B. Thomas, Maurice D. Weir and Joel Hass Thomas Calculus, Thirteenth Edition, Pearson Education, 2013.
4. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley, 2015.
5. J. Stewart, Essential Calculus, Cengage, 2nd Edition, 2017.

## 22PH202 ELECTROMAGNETISM AND MODERN PHYSICS

**2 0 2 3**

**Course Objectives**

- Understand the principles and mechanisms of electricity and magnetism
- Infer the classification of electromagnetic waves
- Analyze the theory of relativity and energy bands

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

**Course Outcomes (COs)**

1. Analyze the mechanisms of Coulomb's law and electric potential in various charge system
2. Analyze the magnetic properties of materials and their effects on external magnetic fields
3. Analyze the classification of electromagnetic waves based on frequency and wavelength
4. Outline the importance of theory of relativity and analyze the wave nature of particles
5. Apply the principles of electron and hole transport to study p-type and n-type semiconductors

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 1 | 1 | - | - | - | - | 2 | - | 1 | 1 | 1 |
| 2 | 3 | 2 | 1 | 2 | - | - | - | - | 2 | - | 1 | 1 | 1 |
| 3 | 3 | 2 | 2 | 1 | - | - | - | - | 2 | - | 1 | 1 | - |
| 4 | 3 | 2 | 2 | 1 | - | - | - | - | 2 | - | 1 | 1 | - |
| 5 | 3 | 2 | 2 | 1 | - | - | - | - | 2 | - | 1 | 1 | 1 |

**UNIT I** **6 Hours**

**ELECTRICITY**

Electric monopoles - Electric field - Electric flux - Electric potential - Electrical energy- Capacitor- Conductors and Insulators - Electric dipole and polarization - Electric current - Voltage sources - Resistance

**UNIT II** **6 Hours**

**MAGNETISM**

Sources of magnetism - Monopoles - Magnetic field and force - magnetic field and current distribution - Magnetic dipole - Magnetic potential energy - Inductor - Electric and magnetic field comparison

**UNIT III** **6 Hours**

**ELECTROMAGNETIC WAVES AND LIGHT**

Electromagnetism: Basic laws - Electromagnetic energy - radiation. Electromagnetic waves: Origin, nature and spectrum - Visible light. Principle of least time - Geometrical optics-Human eye - Diffraction - Interference - Polarization - LASER

**UNIT IV** **6 Hours**

**MODERN PHYSICS**

Special theory of relativity - Simultaneity and time dilation - Length contraction - Relativistic mass variation. Matter waves - De-Broglie hypothesis - Wave nature of particles

**UNIT V** **6 Hours**

**ENERGY BANDS IN SOLIDS**

Band theory of solids - Classification of materials - Semiconductors - Direct and indirect semiconductor - Fermi energy - Intrinsic and extrinsic semiconductor - Carrier concentration - Electrical conductivity

**EXPERIMENT 1** **5 Hours**

Analysis a I-V characteristics of a solar cell for domestic applications

**EXPERIMENT 2** **5 Hours**

Determine the carrier concentration of charge carriers in semiconductors for automotive applications

**EXPERIMENT 3** **5 Hours**

Investigate the photonic behavior of laser source for photo copier device

**EXPERIMENT 4** **5 Hours**

Implement the principle of stimulated emission of laser for grain size distribution in sediment samples

**EXPERIMENT 5** **5 Hours**

Assess the variation of refractive index of glass and water for optical communication

**EXPERIMENT 6** **5 Hours**

Evaluate the band gap energy of semiconducting materials for display device applications

**Total: 60 Hours**

**Reference(s)**

1. C J Fischer, The energy of Physics Part II: Electricity and Magnetism, Cognella Academic Publishing, 2019.
2. P G Hewitt, Conceptual Physics, Pearson Education, 2017.
3. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2019.
4. J Walker, D Halliday and R Resnick, Principles of Physics, John Wiley and Sons, Inc, 2018.
5. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, New Delhi, 2017.

## 22CH203 ENGINEERING CHEMISTRY II 2 0 2 3

**Course Objectives**

- Understand the concept of electrochemistry for determination of electrode potential, pH and applications as energy storage devices
- Outline the chemistry of metal corrosion and analyze the methods of corrosion control
- Understand the role of catalyst in the rate of reaction
- Summarize the variation in properties and reactivity of isotopes.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.
PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.
PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.
PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Apply the electrochemical concepts to determine the electrode potential of a metal
2. Analyze the working of batteries for the energy storage devices
3. Analyze the specific operating conditions under which corrosion occurs and suggest a method to control corrosion
4. Analyze reaction mechanisms and assess the role of catalyst in a chemical reaction
5. Analyze various types of nuclear transmutation including decay reactions

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | - | - | - | - | - | - | - | - | - | 1 | - |
| 2 | 2 | 1 | - | - | - | - | - | - | - | - | - | 1 | - |
| 3 | 2 | 1 | - | - | - | - | - | - | - | - | - | 1 | - |
| 4 | 2 | 1 | - | - | - | - | - | - | - | - | - | 1 | - |
| 5 | 2 | 1 | - | - | - | - | - | - | - | - | - | 1 | - |

**UNIT I** **6 Hours**

**ELECTROCHEMISTRY**

Origin of potential - Electromotive force - Electrical double layer - Transport of charge within the cell - Cell description - Prediction of cell potentials

**UNIT II** **6 Hours**

**ENERGY STORING DEVICES**

Relation between electrical energy and energy content of a cell - Reversible and irreversible cell - Charging and discharging reactions in a reversible cell - Current challenges in energy storage technologies

**UNIT III** **6 Hours**

**METAL CORROSION AND ITS PREVENTION**

Oxidation of metals: Electrochemical origin of corrosion - Electromigration - Electron transfer in the presence and absence of moisture - Galvanic series. Strategies for corrosion control: Galvanic anode and impressed current.

**UNIT IV** **6 Hours**

**CATALYSIS**

Energy profile diagram for a chemical reaction - activation energy - role of catalyst - homogeneous and heterogeneous catalysis - types

**UNIT V** **6 Hours**

**NUCLEAR REACTIONS**

Radioactive and stable isotopes - Variation in properties between isotopes - Radioactive decay (alpha, beta and gamma) - Half-life period - Nuclear reactions - recent applications of radioactive isotopes.

**EXPERIMENT 1** **4 Hours**

Measure industrial effluent water pH and assess water quality against allowed standards

**EXPERIMENT 2** **4 Hours**

Iron ($Fe^{2+}$) in Bhavani River water: Potentiometric Analysis & Pollution Assessment (CPCB Standards)

**EXPERIMENT 3** **4 Hours**

Construct a Zn-Cu electrochemical cell and validate the output by connecting the LED light

**EXPERIMENT 4** **5 Hours**

Evaluate the corrosion percentage in concrete TMT bars

**EXPERIMENT 5** **4 Hours**

Determination of the percentage of corrosion inhibition in plain-carbon steel using natural inhibitors

**EXPERIMENT 6** **4 Hours**

Electroplating of copper metal on iron vessels for domestic application

**EXPERIMENT 7** **5 Hours**

Determination of acid-catalyzed hydrolysis kinetics in locally sourced fruit extracts

**Total: 60 Hours**

**Reference(s)**

1. U. Hanefeld, L. Lefferts, Catalysis: An Integrated Textbook for Students, 2nd Edition, Wiley- VCH, 2017.
2. S. Vairam, Engineering Chemistry, 1st Edition, John Wiley & Sons, 2014.
3. Jain and Jain, Engineering Chemistry, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2013.
4. P.H. Rieger, Electrochemistry, Second Edition (Reprint), Springer, Netherland, 2012.
5. H.J. Arnikar, Essentials of Nuclear Chemistry, 4th Edition (revised), New Age International Publishers, 2011.
6. E. McCafferty, Introduction to Corrosion Science, 1st Edition, Springer, 2010.

## 22GE002 COMPUTATIONAL PROBLEM SOLVING 3 0 0 3

**Course Objectives**

- Analyze the algorithm design techniques and development principles in solving the real life problems.
- Illustrate the different ways of organizing and storing the data in computing systems.
- Understand the basic network configuration and setup connections among different device systems.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.
PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.
PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.
PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.
PSO2. Design, develop and realize advanced control schemes in different platforms such as Micro controller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Analyze a problem and formulate algorithms, pseudocodes and flowcharts.
2. Develop algorithmic solutions to simple computational problems and explore algorithmic approaches to problem solving.
3. Design and apply appropriate data structures for solving computing problems.
4. Compare the various storage devices used in a computer system.
5. Analyze the requirements for a given organizational structure and establish the connection between two or more computers to form a network.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | 1 | 2 | - | - | - | - | - | - | - | - | 1 |
| 2 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | - | - | 1 |
| 3 | 2 | 2 | 2 | 3 | - | - | - | - | - | - | - | - | 1 |
| 4 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 1 |
| 5 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 1 |

**UNIT I** **6 Hours**

**VISUAL PROCESS MODELING**

Scenario decomposition - Logical sequencing - Drawing flowchart - Preparation of visual process model.

**UNIT II** **12 Hours**

**ALGORITHMIC DESIGN THINKING**

Analysis - Verification - Brute force - Divide and conquer - Greedy - Backtracking.

**UNIT III** **12 Hours**

**DATA ORGANIZATION**

Elementary Data Organization - Abstract Data Types - Fundamentals of Linear and Non Linear Data Structures.

**UNIT IV** **7 Hours**

**DATA STORAGE**

Flat File and Relational database - Data Read & Write in Local Storage, Server Storage and Cloud storage - Database Query Methods.

**UNIT V** **8 Hours**

**NETWORKING ESSENTIALS**

Networking Components and Services - IP Addressing - Configuring and Managing the Campus Network - Network Security - Firewalls.

**Total: 45 Hours**

**Reference(s)**

1. David D. Riley, Kennya. Hunt, "Computational thinking for the modern problem Solver", CRC Press Taylor & Francis Group, 2014.
2. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", Third Edition, Pearson Education Asia, 2011.
3. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education, 2016.
4. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, "Database System Concepts", McGraw Hill, 2015.
5. Behrouz A.Forouzan, "Data Communication and Networking", 5th Edition, Tata McGraw-Hill, 2014.

## 22GE004 BASICS OF ELECTRONICS ENGINEERING 2 0 2 3

**Course Objectives**

- To Understand the concept of energy transmission through mechanical, electrical and electromagnetic form.
- To Analyze the use of PN Junction Diode and BJT for signal conditioning.
- To apply the working principle of PN Junction Diode and BJT for the design of basic Digital Logic.
- To analyze the working and characteristics of Special Purpose Semiconductor Electronic Devices.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Micro controller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Attribute the need for electrical and electromagnetic signal transmission.
2. Analyze the working principle and characteristics of PN junction diode.
3. Analyze the working principle and characteristics of Bipolar Junction Transistor.
4. Apply the working principle of PN Junction diode and BJT for designing basic Digital Logic functions.
5. Analyze the energy conversion needs and working principle of Special purpose electronic devices.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 3 | 1 | - | - | - | - | - | - | - | 1 | 1 |
| 2 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | 1 | 1 |
| 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | 1 | 1 |
| 4 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | 1 | 2 |
| 5 | 3 | 3 | 3 | 1 | - | - | - | - | - | - | - | 1 | 2 |

**UNIT I** **6 Hours**

**ENERGY TRANSFER AND SIGNALS**

Energy Transmission through Mechanical, Electrical and Electromagnetic means, Signal as Energy Transmission, Complexity in signal transmission (Volume of Information, Distance and Time taken), Limitations of Mechanical Energy Transmission, Electrical and Electromagnetic Signal Transmission, Need for Conversion between Electrical and Mechanical Signals.

**UNIT II** **8 Hours**

**SIGNAL CONDITIONING USING DIODE**

Need for Vacuum Tubes in the Evolution of Electronics, Overview of Vacuum Tubes, Diode and Triode, Limitations of Vacuum Tubes. Semiconductor Group in Periodic Table, Overview of Semiconductor Materials, Flow of electrical energy through PN Junction Diode, Signal Clipping, Signal Clamping and Signal Multiplication using PN Junction Diode, Limitations of PN Junction Diode.

**UNIT III** **6 Hours**

**SIGNAL CONDITIONING USING TRANSISTOR**

Need for controlling electrical signals, Principle of Bipolar Junction Transistor operation, Signal Switching and Amplification using BJT, Limitations of BJT, Principle of Field Effect Transistor operation.

**UNIT IV** **6 Hours**

**LOGIC SYNTHESIS USING DIODE AND TRANSISTORS**

Overview of Logic Gates, PN Junction and BJT as electronic switches, Digital Logic Synthesis using Diode and Transistor: Diode Logic, Resistor Transistor Logic, Diode Transistor Logic, Transistor Logic.

**UNIT V** **4 Hours**

**DEVICES FOR SPECIAL REQUIREMENTS**

Voltage Regulation using Zener Diode, Variable Capacitance using Varactor Diode, Electrical Energy to Light Energy conversion using Light Emitting Diode, Light to Energy to Electrical Energy conversion using Solar Cell.

**EXPERIMENT 1** **6 Hours**

Design a voltage multiplier to convert the low voltage from the mains power supply to the high voltage to operate the microwave oven.

**EXPERIMENT 2** **6 Hours**

Design and construct regulated DC power supply for Mobile phone charger

**EXPERIMENT 3** **6 Hours**

Design and construct an audio amplifier circuit to play the mobile music in a huge speaker.

**EXPERIMENT 4** **6 Hours**

Design and construct Switching circuit for the Pump to control over flow and drain condition for overhead tank using PN junction diode.

**EXPERIMENT 5** **6 Hours**

Design and construct BJT based circuit to implement two way connection for stair case light application.

**Total: 60 Hours**

**Reference(s)**

1. Thomas L. Floyd, Electronic Devices: Electron Flow Version, Ninth Edition, Prentice Hall, 2012.
2. J Millman, C. Halkias & Satyabrata JIT, Electronic Devices and Circuits, Tata McGraw-Hill, 2007.

3. L Robert Boylestead, Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education 2006.
4. David A. Bell, Electronic Devices and Circuits, Prentice Hall of India, 2003.
5. Adel S. Sedra & Kenneth C. Smith, Micro Electronic Circuits Theory and Applications, Sixth Edition, Oxford University Press, 2013.
6. Behzad Razavi, Microelectronics, Wiley India Pvt. Ltd.; 2nd Edition, 2018.

## 22GE005 ENGINEERING DRAWING 1 0 2 2

**Course Objectives**

- To provide knowledge on fundamentals of engineering drawings and conic sections.
- To impart skill on orthographic projections of points and lines.
- To familiarize on projection of planes and simple solids.
- To provide knowledge on section of solids and development of surfaces of simple solids.
- To impart skill on conversion of isometric view to orthographic projection and vice versa.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

**Course Outcomes (COs)**

1. Understand the engineering drawing concepts as per industrial standards.
2. Construct orthographic projections of points and lines.
3. Draw the projection of planes and simple solids.
4. Draw the section of solids and development of surfaces.
5. Draw the orthographic projection from isometric view and vice versa.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | - | - | - | - | - | 2 | - | 2 | - | - | - | - |
| 2 | 2 | - | - | - | - | - | 2 | - | 2 | - | - | - | - |
| 3 | 1 | - | - | - | - | - | 2 | - | 2 | - | - | - | - |
| 4 | 1 | - | - | - | - | - | 2 | - | 2 | - | - | - | - |
| 5 | 1 | - | - | - | - | - | 2 | - | 2 | - | - | - | - |

**UNIT I** **7 Hours**

**FUNDAMENTALS OF ENGINEERING DRAWING**

Definition - standards - drawing tools - drawing sheets - scales - line and its types. Practices on lettering - numbering - dimension of drawings. Construction of conic sections - ellipse - parabola and hyperbola using eccentricity method.

**UNIT II** **9 Hours**

**PROJECTION OF POINTS AND LINES**

Principles of projection - projection of points in four quadrants - first angle projection of straight lines - perpendicular to one plane - parallel and inclined to both planes.

**UNIT III** **9 Hours**

**PROJECTION OF PLANES AND SOLIDS**

Projection of simple planes and projection of simple solids - parallel - perpendicular and inclined to one plane using change of position method - inclined to both the planes

**UNIT IV** **9 Hours**

**SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES**

Section of Solids - simple position with cutting plane parallel - perpendicular and inclined to one plane with true shape of section. Development of surfaces - simple and truncated solids.

**UNIT V** **11 Hours**

**ORTHOGRAPHIC PROJECTIONS AND ISOMETRIC VIEW**

Orthographic projections and isometric view of components used in engineering applications.

**Total: 45 Hours**

**Reference(s)**

1. N. D. Bhatt and V. M. Panchal, Engineering Drawing, Charotar Publishing House Pvt. Limited, 2019.
2. K.V. Natarajan, A Text Book of Engineering Graphics, Dhanalakshmi Publishers, 2013.
3. K Venugopal, Engineering Drawing and Graphics, Sixth edition, New Age International, 2013.
4. Basant Agarwal, Mechanical drawing, Tata McGraw-Hill Education, 2013.
5. Engineering Drawing Practice for Schools & Colleges, Bureau of Indian Standards - Sp46, 2013.

## 22HS006 TAMILS AND TECHNOLOGY 1 0 0 1

**Course Objectives**

- Analyse graffiti on potteries as a form of historical and cultural documentation during the Sangam Age.
- Investigate the building materials and the historical context of Hero stones during the Sangam Age by Analysing the details of stage constructions in Silappathikaram and their cultural significance.
- Examine ancient knowledge of oceans and its impact on Tamil society.

**Programme Outcomes (POs)**

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

**Course Outcomes (COs)**

1. Understand the significance of the weaving industry during the Sangam Age and its cultural importance.
2. Understand the significance of dams, tanks, ponds, and sluices in the agricultural and irrigation practices of the Chola Period.
3. Explore the architectural designs and structural construction methods used in household materials during the Sangam Age.
4. Explore the art of shipbuilding in ancient Tamil culture and its role in maritime trade and transportation.
5. Trace the development of scientific terminology and vocabulary in Tamil language.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | 2 | 3 | - | - | - | - |
| 2 | - | - | - | - | - | - | - | 2 | 3 | - | - | - | - |
| 3 | - | - | - | - | - | - | - | 2 | 3 | - | - | - | - |
| 4 | - | - | - | - | - | - | - | 2 | 3 | - | - | - | - |
| 5 | - | - | - | - | - | - | - | 2 | 3 | - | - | - | - |

**UNIT I** **3 Hours**

**WEAVING AND CERAMIC TECHNOLOGY**

Weaving Industry during Sangam Age - Ceramic technology - Black and Red Ware Potteries (BRW) - Graffiti on Potteries.

**UNIT II** **3 Hours**

**DESIGN AND CONSTRUCTION TECHNOLOGY**

Designing and Structural construction House and designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age - Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple) - Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period

**UNIT III** **3 Hours**

**MANUFACTURING TECHNOLOGY**

Art of Ship Building-Metallurgical studies-Iron industry-Iron smelting,steel-Copper and gold-Coins as source of history-Minting of Coins-Beads making-industries Stone beads -Glass beads-Terracotta beads- Shell beads-bone beats-Archeological evidences-Gem stone types described in Silappathikaram.

**UNIT IV** **3 Hours**

**AGRICULTURE AND IRRIGATION TECHNOLOGY**

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry-Wells designed for cattle use- Agriculture and Agro Processing-Knowledge of Sea-Fisheries-Pearl-Conche diving-Ancient Knowledge of Ocean-Knowledge Specific Society.

**UNIT V** **3 Hours**

**SCIENTIFIC TAMIL**

Development of Scientific Tamil-Tamil computing-Digitalization of Tamil Books-Development of Tamil Software-Tamil Virtual Academy-Tamil Digital Library-Online Tamil Dictionaries-Sorkuvai Project.

**Total: 15 Hours**

**Reference(s)**

1. Dr. K. K. Pillay , Social Life of Tamils, A joint publication of TNTB & ESC and RMRL
2. Dr. S. Singaravelu, Social Life of the Tamils - The Classical Period, International Institute of Tamil Studies.
3. Dr. S. V. Subatamanian , Dr.K.D. Thirunavukkarasu, Historical Heritage of the Tamils, International Institute of Tamil Studies.
4. Dr. M. Valarmathi, The Contributions of the Tamils to Indian Culture, International Institute of Tamil Studies
5. Keeladi - Sangam City Civilization on the banks of river Vaigai, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
6. Dr. K. K. Pillay, Studies in the History of India with Special Reference to Tamil Nadu.
7. Porunai Civilization, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
8. R.Balakrishnan , Journey of Civilization Indus to Vaigai, RMRL

## 22HS006 - தமிழரும் ததாழில்நுட்பமும் 1 0 0 1

### பாடத்திட்டத்தின் ந ாக்கம்

1. சங்க கொலத்தில் வரலொறு மற்றும் கலொச்சொர ஆவணங்களின் ஒரு வடிவமொக, மட்பொண்டங்கள் மீதொன கிரொஃபிட்டிமய பகுப்பொய்வு தசய்தல்.
2. சிலப்பதிகொரத்தில் கட்டப்பட்ட பமமட கட்டுமொனங்களின் விவரங்கமளயும் அவற்றின் கலொச்சொர முக்கியத்Fவத்மதயும் பகுப்பொய்வு தசய்வதன் மூலம், சங்க கொலத்தில் மொவீரர் கற்களின் கட்டுமொனப் தபொருட்கள் மற்றும் வரலொற்று சூழமல ஆரொய்தல்.
3. சமுத்திரங்கள் பற்றிய பண்மடய அறிமவயும், தமிழ் சமூகத்தில் அதன் தொக்கத்மதயும் ஆரொய்வF ஆகியமவ இப்பொடத்திட்டத்தின் பநொக்கம் ஆகும்.

### கற்றலின் விளைவு

1. சங்க கொலத்தில் தநசவுத் ததொழிலின் முக்கியத்Fவத்மதயும் அதன் கலொச்சொர முக்கியத்Fவத்மதயும் புரிந்F தகொள்ளல்.
2. பசொழர் கொல விவசொய மற்றும் நீர்ப்பொசன நமடமுமறகளில் அமணகள், குளங்கள் மற்றும் மதகுகளின் முக்கியத்Fவத்மதப் புரிந்F தகொள்ளல்.
3. சங்க கொலத்தில் வீட்டுப் தபொருட்களில் பயன்படுத்தப்பட்ட கட்டடக்கமல வடிவமமப்புகள் மற்றும் கட்டமமப்பு கட்டுமொன முமறகமள ஆரொய்தல்.
4. பண்மடய தமிழ் கலொச்சொரத்தில், கப்பல் கட்டும் கமல, கடல் வர்த்தகம் மற்றும் பபொக்குவரத்தில் அதன் பங்மக ஆரொய்தல்.
5. தமிழ் தமொழியில் அறிவியல் தசொற்களஞ்சியம் மற்றும் தசொல்லகரொதியின் வளர்ச்சிமயக் கண்டறிதல்.

**அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம்:** **3**

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

**அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்:** **3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

**அலகு III உற்பத்தித் தொழில் நுட்பம்:** 3

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

**அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்:** 3

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

**அலகு V அறிவியல் தமிழ் மற்றும் கணித்தமிழ்:** 3

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

**TOTAL : 15 PERIODS**

**Reference(s)**


1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

## 22HS009 COCURRICULAR OR EXTRACURRICULAR ACTIVITY

**Course Objectives**

- To develop Interpersonal and Leadership Skills
- To Foster Personal Growth and Time Management
- To enhance Community Engagement and Social Responsibility

**Programme Outcomes (POs)**

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change

**Course Outcomes (COs)**

1. Build leadership skills and teamwork capabilities by engaging in group activities through organization and participation of events
2. Demonstrate the technical, creative, and interpersonal skills through active participation in technical events.
3. Exhibit balanced academics with diverse cultural, sports, and literary activities, showcasing improved time management and organizational skills.
4. Enhance the social responsibility and community engagement by participating in outreach and extension activities.
5. Gain practical experience and industry insights through field visits, industrial training, and internships.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | 3 | 3 | 3 | 2 | - | - |
| 2 | - | - | - | - | - | - | - | 3 | 3 | 3 | 2 | - | - |
| 3 | - | - | - | - | - | - | - | 3 | 3 | 2 | 2 | - | - |
| 4 | - | - | - | - | - | - | - | 2 | 2 | 2 | 2 | - | - |
| 5 | - | - | - | - | - | - | - | 3 | 3 | 3 | 2 | - | - |

Every student shall be required to undergo a minimum of 40 hours of Co-curricular / Extracurricular activities organized through society chapters, technical and non-technical Club activities during the II semester, failing which he/she shall not be permitted to appear for the VIII Semester examination. Such students are permitted to appear for the Semester End examinations only after completing the requirements. The attendance of the

courses / events shall be maintained on the regular basis by the concerned Co-coordinators and made available in the Office of the Controller of Examinations before the commencement of Semester end examinations of Semester II.

The following co-curricular and extra-curricular activities are conducted on a regular basis and is compulsory for all students. The students' performances are assessed on the basis of their participation and organization of events in voluntary services, performance in technical and nontechnical events, games and sports, performance in literary activities, performance in cultural activities and their participation in District/Regional/State/National and International level events.

**Co-Curricular activity**

Technical events organized through departments, Special labs, Clubs, Society and Chapters etc. includes but not limited to Workshop, Seminar, Conference, Symposium Technical Contest Competition, Field visit, Industrial Training, and Internships.

**Extracurricular activity**

Non-Technical Events Organized through departments, Special labs, Clubs, Society and Chapters etc. includes but not limited to NSS Camp, NCC Camp, YRC activity, Yoga, Sports and games, Cultural events, Outreach activity and Extension activity

**Total: 40 Hours**

## 22EI301 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

**3 1 0 4**

### Course Objectives

- Understand the concepts of Fourier series, Transforms and formation of partial differential equations, which will enable them to model and analyze the physical phenomena
- Implement the Fourier analysis, an elegant method in the study of heat flow, fluid mechanics and electromagnetic fields
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment

### Programme Outcomes (POs)

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.
PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.
PSO1.Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.
PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

### Course Outcomes (COs)

1. Analyze the periodicity of a function and formulate the same as a combination of sine and cosine using Fourier series.
2. Apply Fourier transform to convert the function in time domain into a sum of sine waves of different frequencies, each of which represents a frequency component.
3. Demonstrate the function in frequency domain whenever the function is defined in time domain through Laplace transforms.
4. Apply the Z-transform to convert a discrete-time signal, which is a sequence of real or complex numbers, into a complex frequency domain representation.
5. Exemplify the concepts of partial differential equations and able to apply them to solve real scenarios.

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 |
| 2 | 1 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 |
| 3 | 1 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 |
| 4 | 1 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 |
| 5 | 1 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 |

**UNIT I** **9 Hours**

**FOURIER SERIES**

Introduction - Periodic functions - Dirichlet's conditions - General Fourier series - Odd and even functions – Parseval's identity - Root mean square value - Harmonic analysis.

**UNIT II** **9 Hours**

**FOURIER TRANSFORM**

Fourier integral theorem - Fourier transform and inverse Fourier transform - Sine and cosine transforms - Properties - Transforms of simple functions - Convolution theorem - Parseval's identity.

**UNIT III** **9 Hours**

**LAPLACE TRANSFORM**

Laplace transform: Existence of Laplace transform - Properties of Laplace transform - Laplace transform of periodic function - Inverse Laplace transform: Properties of inverse Laplace transform - Partial fraction method – Convolution - Application of Laplace transform to solve ordinary differential equations with constant coefficients.

**UNIT IV** **9 Hours**

**Z TRANSFORM**

Z-Transform - Properties - Inverse Z-transform - Convolution method- Partial fraction method - Solution of difference equations using Z-transform.

**UNIT V** **9 Hours**

**APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Solution of standard types of first order partial differential equations (Clairaut's form, Lagrange linear equation) - Linear partial differential equations of second order with constant coefficients.

**Tutorial: 15 Hours**
**Total: 60 Hours**

**Reference(s)**

1. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi, 2016.
2. Peter V O Neil, Advanced Engineering Mathematics, Seventh Edition, TBH Publishers, 2013.
3. James Glyn, Advanced Modern Engineering Mathematics, Third Edition, Pearson Education, 2014.
4. Michael D Greenberg, Advanced Engineering Mathematics, Second Edition, Pearson Education, 2002.
5. B. S. Grewal, Higher Engineering Mathematics, Forty third Edition, Khanna Publications, New Delhi, 2015.

## 22EI302 ELECTRICAL CIRCUITS AND MACHINES 3 1 0 4

**Course Objectives**

- To understand the basic circuits theorems and its simplification techniques
- To determine the operation, characteristics and performance parameters of electrical machines
- To understand operation, characteristics and performance parameters of special machines

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Apply the fundamental laws in electric circuits to compute the electric parameters of direct and alternating quantities.
2. Analyze the resonance frequency, bandwidth, Q factor and RL, RC response time constants for the step and ramp inputs.
3. Select suitable DC Machines by analyzing its characteristics.
4. Analyze the characteristics of three phase induction motor, synchronous motor and transformers.
5. Select suitable special electrical machines for specified applications.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 3 | - | - | - | - | - | - | - | 2 | 1 | 2 |
| 2 | 3 | 2 | 2 | - | - | - | - | - | - | - | 2 | 1 | 2 |
| 3 | 3 | 2 | 2 | - | - | 1 | - | - | - | - | 2 | - | 2 |
| 4 | 3 | 2 | 2 | - | - | - | - | - | - | - | 2 | - | 2 |
| 5 | 3 | 2 | 2 | - | - | 1 | - | - | - | - | 2 | - | 2 |

**UNIT I** **10 Hours**

**BASIC CIRCUITS AND SIMPLIFICATION TECHNIQUES**

Kirchhoffs Current and Voltage Laws, Independent and dependent sources and their interconnection, power calculations. Mesh, Super mesh, Node and Supernode analysis. Source transformation and source shifting Network Theorems: Superposition, Thevenins, Nortons and Maximum Power Transfer Theorems.
(AC circuit analysis for all the topics of this unit)

**UNIT II** **8 Hours**

**RESONANCE CIRCUITS**

Series resonant circuits - Bandwidth of an RLC circuit - Q factor and its effect on bandwidth - Parallel resonance -Simple problems on resonance - Applications of resonance - Introduction - Transient response of RL & RC series circuits with step and ramp inputs - Time Constant - Rise and fall times

**UNIT III** **9 Hours**

**DC MACHINES**

Construction of DC Machine, Motoring and generation action, types, EMF equation, Torque equation (Torque-armature current characteristics, Torque-speed characteristics, speed-armature current characteristics), Power flow diagram. Problems on speed, torque & losses. Different methods of speed control, different types of starters for DC shunt motors. Permanent Magnet DC motors, Applications of DC Motors

**UNIT IV** **10 Hours**

**AC MACHINES**

Types, Construction, Transformer on No-load (Transformation ratio, EMF equation). Three phase Induction motors, construction and principle of operation, types, slip and torque equation, Torque-slip characteristics, condition for maximum torque & ratios, types of starters. Synchronous motors: Construction, principle of operation, characteristics (V curves) and applications

**UNIT V** **8 Hours**

**SPECIAL MACHINES**

Special machines - reluctance motor, repulsion motor, hysteresis motor, stepper motor, servo motor, BLDC, PMSM, Dynamic, regenerative and plugging

**Tutorial: 15 Hours**
**Total: 60 Hours**

**Reference(s)**

1. Smarjith Ghosh, Fundamentals of Electrical and Electronics Engineering, Prentice Hall (India) Pvt. Ltd., 2010.
2. R. Muthusubramanian, S. Salivahanan, Basic Electrical and Electronics Engineering, Tata McGraw-Hill Education, Reprint 2012.
3. William H. Hayt, Jack E. Kemmerly, and Steven M. Durbin, Engineering Circuit Analysis, Eighth Edition, Tata McGraw Hill, 2013.
4. D.P.Kothari and J.J.Nagrath, Electric Machines, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2017.
5. A.E.Fitzgerald, Charles Kingsley and Stephen D. Umans, Electric Machinery, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2014.
6. Stephen J. Chapman, Electric Machinery Fundamentals, Tata McGraw Hill Publishing Company Limited, New Delhi, 2017.

## 22EI303 DIGITAL LOGIC CIRCUIT DESIGN 3 0 2 4

**Course Objectives**

- To acquire the basic knowledge of digital logic levels and digital electronic circuits
- To design and analyze the combinational logic circuits
- To design and analyze the sequential logic circuits

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Analyze the weighted, non-weighted number systems and Codes
2. Analyze the boolean laws and K-Map for minimization of logic circuits
3. Design and analyze the combinational logic circuits
4. Design and analyze the sequential logic circuits
5. Design and analyze the synchronous & asynchronous counters, logic families and Programmable Logic Devices (PLDs)

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | 2 | - | - | - | - | - | - | - | - | - | 1 |
| 2 | 1 | 2 | 3 | 2 | - | - | - | - | - | - | - | - | 2 |
| 3 | 1 | 3 | 2 | 3 | - | - | - | - | - | - | - | 1 | 2 |
| 4 | 1 | 2 | 3 | 3 | 3 | - | - | - | - | - | - | 1 | 2 |
| 5 | 1 | 2 | 2 | 3 | - | - | - | - | - | - | - | 1 | 2 |

**UNIT I** **6 Hours**

**NUMBER SYSTEMS AND CODES**

Introduction to Digital Systems, Review of Number Systems, Representation of signed numbers, Binary Arithmetic using 1"s and 2"s Complements, Codes and their types

**UNIT II** **10 Hours**

**BOOLEAN THEOREMS AND LOGIC REDUCTION**

Logic gates, Basic Theorems and Properties of Boolean Algebra, Boolean Functions, AOI, NAND and NOR Implementation - Canonical and Standard Forms of representation, Karnaugh-Map Method

**UNIT III** **10 Hours**

**COMBINATIONAL LOGIC CIRCUITS**

Binary adders, Binary Subtractor, Parallel Binary Adders, BCD Adders, Encoder, Decoder, Comparator, Code Convertor, Multiplexers, Demultiplexers, Parity Generator and Checker

**UNIT IV** **10 Hours**

**SEQUENTIAL LOGIC CIRCUITS**

Gated Latches & Flip Flops- Level and Edge triggered flip-flops, Flip Flop Conversion. Shift registers, General model of sequential circuits- Mealy/Moore models -Excitation table- State table- State diagram

**UNIT V** **9 Hours**

**COUNTERS, LOGIC FAMILIES AND PLDS**

Design of Synchronous & Asynchronous Counters, shift register counters, Hazards in logic circuits, Logic Families, Programmable Logic Devices (PLDs)

**EXPERIMENT 1** **2 Hours**

Design and construct combinational circuit to implement two-way connection for staircase light application.

**EXPERIMENT 2** **3 Hours**

Design a circuit for Conveyor belt transporting bottled products to packaging, where a deflector plate is activated to deflect bottles into a reject bin if either the weight is not within certain tolerances or there is no cap on the bottle.

**EXPERIMENT 3** **5 Hours**

Design a calculator circuit with a seven segment display using encoder, decoder & logic gates.

**EXPERIMENT 4** **5 Hours**

Design a Logic Gate-Based Data Routing System: Multiplexer & Demultiplexer Circuit Design

**EXPERIMENT 5** **5 Hours**

Design the comparator circuit to compare the number of products/boxes/objects for packaging industries using magnitude comparator

**EXPERIMENT 6** **5 Hours**

Design circuit based on direction of data movement and the way data is loaded and unloaded for shopping complex.

**EXPERIMENT 7** **5 Hours**

Design and implement automated car parking system using flip fop-counters

**Total: 75 Hours**

**Reference(s)**

1. M. Morris Mano and Michael D. Ciletti, "Digital Design", Pearson, 5th Edition, 2013.
2. Thomas L.Floyd, Digital Fundamentals, Prentice Hall, 11th Edition, 2015.
3. A.Anand Kumar, Fundamentals of Digital Circuits, 4th Edition PHI Learning Private Limited, 2016.
4. Charles H. Roth, Jr., Fundamentals of Logic Design, 2014, 7th Edition Reprint, Brooks/Cole, Pacific Grove, US.
5. Ronald J. Tocci, Digital System Principles and Applications, 10th ed., Pearson Education, 2009.

## 22EI304 FLUID MECHANICS AND THERMODYNAMICS

**3 0 2 4**

### Course Objectives

- To enhance the students knowledge on fluid statics, kinematics, dynamics and hydraulic pumps
- To study the fundamentals and laws of thermodynamics
- To understand the basic concepts of various thermal applications like Internal Combustion Engines
- To study the working principle and applications of refrigeration and air conditioning systems

### Programme Outcomes (POs)

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

### Course Outcomes (COs)

1. Interpret the fundamentals properties of fluid systems
2. Classify pumps and explain their working principles
3. Exemplify the basic concepts and laws of thermodynamics
4. Understand the concept of air standard cycles and the working of internal combustion engine
5. Interpret the concept of refrigeration and air conditioning system

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 1 | 1 | 1 | - | - | - | - | - | - | 1 | - |
| 2 | 2 | 3 | 1 | 1 | 2 | - | - | - | - | - | - | 1 | 1 |
| 3 | 2 | 3 | 1 | 1 | 1 | - | - | - | - | - | - | - | 1 |
| 4 | 2 | 3 | 1 | 1 | 2 | - | - | - | - | - | - | - | 1 |
| 5 | 2 | 3 | 1 | 1 | 1 | - | - | - | - | - | - | - | 1 |

**UNIT I** **9 Hours**

**FLUID PROPERTIES AND KINEMATICS**

Fundamental units - mass density - specific weight - viscosity - surface tension- capillarity - compressibility. Streamline - streak line - path line - continuity equation.

**UNIT II** **9 Hours**

**FLUID DYNAMICS AND HYDRAULIC PUMPS**

Stream and potential functions - Laminar flow, Turbulent flow - Bernoullis equation - Darcys equation - Pipes in series and parallel - major and minor losses - hydraulic grade line - Classification of pumps - Centrifugal pumps - Reciprocating pumps - Multistage pumps - Specific speed and characteristic curves.

**UNIT III** **9 Hours**

**BASIC CONCEPTS AND LAWS OF THERMODYNAMICS**

Thermodynamic systems - Boundary - Control volume - System and surroundings - Universe - Properties: State - Process - Cycle - Equilibrium - Work and heat transfer - Point and path functions. First law of thermodynamics for open and closed systems - steady flow energy equations. Second law of thermodynamics - Carnot cycle - Heat engines - Refrigerators and heat pumps.

**UNIT IV** **9 Hours**

**INTERNAL COMBUSTION ENGINES AND AIR STANDARD CYCLES**

Internal combustion engines - Classification and Working Principle of four stroke and two stroke engines - spark and compression ignition engines - Applications of Internal Combustion engines. Air standard cycles: Otto, diesel and dual cycles - comparison of efficiency.

**UNIT V** **9 Hours**

**REFRIGERATION AND AIR CONDITIONING**

Refrigeration - Basic functional difference between refrigeration and air conditioning - Terminologies of refrigeration - refrigerants - Vapour compression cycle: Pressure - Enthalpy and Temperature- Entropy diagram -Saturation cycles. Vapour absorption. Air-conditioning systems - Terminologies of psychrometry - Simple psychometric processes - summer, winter, window and central air conditioning systems - concept of effective temperature, infiltration, internal heat gains, Human comfort charts.

**EXPERIMENT 1** **6 Hours**

Select and propose suitable lubricating oils (2T oil, SAE2040 oil, coconut oil, and neem oil) for two-stroke and four-stroke engine applications.

**EXPERIMENT 2** **6 Hours**

Identify and propose a suitable bio oil (coconut oil, sunflower oil, and neem oil) for petrol and diesel engines based on its flash and fire points.

**EXPERIMENT 3** **12 Hours**

Measure and display (digitally) the values of water exit velocity, flow rate, volume of water, and pressure in the DAM.

**EXPERIMENT 4** **6 Hours**

Analyze the friction factor of various pipes in a distribution of a water supply for domestic applications.

**Total: 75 Hours**

**Reference(s)**

1. R.K. Bansal, Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 2011.
2. R. K. Rajput, A Text book of Fluid Mechanics and Hydraulic Machines, S. Chand and Co. Ltd.
3. B. C. Punmia, Ashok K. Jain and Arun K. Jain, Mechanics of Materials, Laxmi Publications, 2010.

4. Mahesh M Rathore , Thermal Engineering ,Tata McGraw Hill, New Delhi, 2011.
5. Stephen R. Turns, Thermodynamics Concepts and Applications, Cambridge University Press, 2006.
6. Eastop and McConkey, Applied Thermodynamics and Engineering, Pearson Education Ltd., 2009.

## 22EI305 DATA STRUCTURES AND ALGORITHMS 2 0 2 3

**Course Objectives**

- To understand the concept of computer programming
- To develop problem solving skills and troubleshooting techniques in electronics
- To develop critical reasoning and problem solving abilities including the use of simulation software for designing and troubleshooting

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

**Course Outcomes (COs)**

1. Develop abstract data type models and design recursive algorithms.
2. Develop applications by using the concept of Stack, Queues and List.
3. Analyze various sorting and searching algorithms.
4. Apply the Binary Search tree, AVL search tree and Heap tree in writing C++ programs.
5. Apply minimum spanning tree and shortest path algorithms for real time problems.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | 1 | 3 | 3 | - | - | - | - | - | - | - | 1 |
| 2 | 2 | - | - | 2 | 2 | - | - | - | - | - | - | - | 1 |
| 3 | 1 | 2 | - | 3 | 2 | - | - | - | - | - | - | - | 1 |
| 4 | 1 | - | - | 3 | 2 | - | - | - | - | - | - | - | 1 |
| 5 | 1 | 3 | 1 | 3 | 3 | - | - | - | - | - | - | - | 1 |

**6 Hours**

**UNIT I**

**INTRODUCTION**

Pseudo code-Abstract Data types-Model for an ADT-ADT Implementations-Algorithm Efficiency-Designing Recursive Algorithms-Recursive Examples.

**UNIT II** **7 Hours**

**LINEAR LIST: STACKS, QUEUES AND LISTS**

Arrays : Basic Stack Operation-Stack ADT - Applications of Stack : Queues Operations- Queue ADT -Queue Applications-Linked List-Operations- Basic concepts of Circular and Doubly Linked List.

**UNIT III** **6 Hours**

**SORTING AND SEARCHING**

Sorting: Insertion Sort-Selection Sort-Bubble Sort - Quick sort-Heap sort-shell sort-External Sorts-Merge sort-Searching: Sequential search- Binary Search - Hashing-General Idea - Hash Function - Separate Chaining - Open Addressing - Linear Probing.

**UNIT IV** **5 Hours**

**NON LINEAR LIST: TREES**

Basic Tree concepts - Binary Trees-Tree Traversals -Expression Trees-Binary Search Trees - AVL Search Trees-Heap concepts-Implementation-Heap Applications: Priority Queue.

**UNIT V** **6 Hours**

**GRAPHS**

Definitions - Graph Representations - Adjacency matrix- Adjacency List-Traverse Graph: Depth first Traversal-Breadth first Traversal-Shortest Path Algorithms: Dijkstra's Algorithm. Minimum Spanning Tree: Prim's Algorithm- Kruskal's Algorithm.

**EXPERIMENT 1** **4 Hours**

Design an MP3 player using singly linked list and its operations

**EXPERIMENT 2** **3 Hours**

Design a shopping cart using stack and generate the history of the customer purchase details using queue.

**EXPERIMENT 3** **4 Hours**

Implementation of storing a web browser's history

**EXPERIMENT 4** **4 Hours**

Interrupt handling in real-time systems

**EXPERIMENT 5** **3 Hours**

Design a program to implement a phonebook using sorting

**EXPERIMENT 6** **4 Hours**

Design a program to store the possible moves in a chess game using tree data structure.

**EXPERIMENT 7** **4 Hours**

Design a postfix calculator (1 3 2 4 * - should calculate 1 - (3 * (2 4))) using stack

**EXPERIMENT 8** **4 Hours**

Scanning a hierarchical file system directory structure

**Total: 60 Hours**

**Reference(s)**

1. F.RichardGilberg, A.Behrouz. Forouzan, Data Structures, A Pseudocode Approach with C, Thomson, 2007.
2. M. A. Weiss, Data Structures and Algorithm Analysis in C, Pearson Education, 2009.
3. Y.Langsam, M. J.Augenstein and A. M.Tenenbaum, Data Structures using C, Pearson Education, 2004.
4. A. M.AhoHopcroft and J.D. Ullman, Data Structures and Algorithms, Pearson education, 2000.

## 22HS004 HUMAN VALUES AND ETHICS 2 0 0 2

**Course Objectives**

- Understand the concept of good values and comprehend the importance of value-based living.
- Recognize the culture of peace through education.
- Identify and apply the practices for value development and clarification.

**Programme Outcomes (POs)**

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change

**Course Outcomes (COs)**

1. Understand the importance of human values and ethics in life.
2. Execute the importance of harmonious living in a diverse society.
3. Analyze the sensitivity to the crying needs of society such as ungodliness, corruption, poverty, and suffering, and play a vital role in eradicating them.
4. Plan intellectually mature, morally upright, ethically correct, and spiritually inspired decisions.
5. Execute a correct balance between professional excellence and social commitment.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | 3 | 2 | 1 | 1 | - | - |
| 2 | - | - | - | - | - | - | - | 3 | 2 | 1 | 1 | - | - |
| 3 | - | - | - | - | - | - | - | 3 | 2 | 1 | 1 | - | - |
| 4 | - | - | - | - | - | - | - | 3 | 2 | 1 | 1 | - | - |
| 5 | - | - | - | - | - | - | - | 3 | 2 | 1 | 1 | - | - |

**UNIT I** **6 Hours**

**COURSE INTRODUCTION - NEED, BASIC GUIDELINES AND ANALYSIS**

Importance of Human Values & Ethics in 21st Century - Understanding the theory of basic human values and ethics - Openness to change - Self enhancement - Conservation - Self transcendence - Schwartz Value Survey: Self-Assessment

**UNIT II** **6 Hours**

**EMBRACING THE COMMON ETIQUETTE**

Altruism- Integrity - Freedom - Justice - Honesty - Truthfulness - Responsibility - Compassion

**UNIT III** **6 Hours**

**CONTINUOUS HAPPINESS AND PROSPERITY**

An overview on basic Human Aspirations - Understanding and living in harmony at various levels of life - Embracing self-love and wellness - Understanding harmony in the family and society

**UNIT IV** **6 Hours**

**UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS**

Reflection on growing global multifold problems: poverty, pollution, hunger, disease, unemployment, caste system, child labour, gender equality, politics and violence. Understanding the challenges in cultural, personal, social, political, and economic environment

**UNIT V** **6 Hours**

**UNDERSTANDING HARMONY IN THE NATURE AND EXISTENCE - WHOLE EXISTENCE AS CO-EXISTENCE**

Understanding the harmony in Nature - Holistic perception of harmony at all levels of existence - Practice Exercises and Case Studies will be taken up in Practice Sessions

**Total: 30 Hours**

**Reference(s)**

1. Martin, G. The Little Book of Ethics: A Human Values Approach. Australia: G.P. Martin, 2011.
2. Gupta, N. L. Human Values for The 21St Century. India: Anmol Publications Pvt. Limited, 2002.
3. Mishra, A. Happiness Is All We Want. India: Bloomsbury Publishing, 2017.
4. Universal Human Values. (n.p.): Booksclinic Publishing, 2023.
5. A Textbook on Professional Ethics and Human Values. India: New Age International (P) Limited, 2007.

## 22HS005 SOFT SKILLS AND EFFECTIVE COMMUNICATION

**0 0 2 1**

### Course Objectives

- Communicate proficiently in formal discussions at the workplace.
- Describe experiences and events, and briefly give reasons and explanations for opinions and plans.
- Interact with a degree of fluency and spontaneity that results in efficacious communication
- Convey agreement and disagreement in a polite but firm manner
- Communicate with coherence and imagination in both written and spoken formats.

### Programme Outcomes (POs)

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change

### Course Outcomes (COs)

1. Enhance confidence in expressing thoughts in grammatically proper language and etiquette in waiting for the opportunity to provide input
2. Effectively communicate in English on formal occasions and proficiency in the use of link words and other discourse markers
3. Provide constructive feedback and file logical complaints
4. Analyse the understanding of oral and written communication in real-world situations.
5. Apply the improved spelling and punctuation in writing and heightened understanding of tone, pitch and stress in oral formats.

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | 2 | 3 | 1 | - | - |
| 2 | - | - | - | - | - | - | - | - | 2 | 3 | 1 | - | - |
| 3 | - | - | - | - | - | - | - | - | 2 | 3 | 1 | - | - |
| 4 | - | - | - | - | - | - | - | - | 2 | 3 | 1 | - | - |
| 5 | - | - | - | - | - | - | - | - | 2 | 3 | 1 | - | - |

### UNIT I — 10 Hours

**SELF-EXPRESSION**

Group discussion/ Peer discussion - Communicating decisions and opinions - Tone, Pitch, Stress - Agreeing, Disagreeing, Suggesting, Speculating - Comparing and Contrasting - Comparatives and Superlatives - Discourse markers – Interjections - Decision making - Synthesis - Higher order thinking Group discussion/Peer discussion - Effective Communication Types of communication - Written vs Spoken -

Contractions Intonation Stress Active voice - Question tags - Confidence and body language Guided writing- Outlining Main Points - Group discussion/Peer discussion - Avoiding common errors Reduction of MTI - Common errors - Barriers to communication Accent

**UNIT II** **10 Hours**

**CREATIVE EXPRESSION**

JAM, Debate, Review writing, Social media posts Synonyms - Antonyms Cloze test Phrasal verbs Spotting errors Collocation - Commonly mispronounced

**UNIT III** **10 Hours**

**FORMAL EXPRESSION**

Writing: Giving written feedback, Review writing, and Letter of complaint. Speaking: Giving constructive feedback and offering suggestions, asking for inputs, commenting politely on appropriate phrases - Giving written feedback, Review writing, and Letter of complaint. Critical reasoning - Modal verbs - Polite ways to express negatives

**Total: 30 Hours**

**Reference(s)**

1. Word Power Made Easy by Norman Lewis, W. R. Goyal Pub. & Distributors, 2009.
2. Sasikumar, V, et al., A Course in Listening & Speaking Foundation Books, 2005.
3. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
4. Prasad, Hari Mohan. A Handbook of Spotting Errors, Mcgraw Hill Education, 2010.
5. Personality Development & Soft Skills, Barun K. Mitra, Oxford University Press, 2012.
6. Business English by Ken Taylor, Orient Blackswan, 2011.

## 22EI401 PROBABILITY, STATISTICS AND RANDOM PROCESS

**3 1 0 4**

### Course Objectives

- Understand the basic concepts of probability and the distributions with characteristics and also random variables.
- Summarize and apply the design of experimental methodologies of probability for the data analysis using statistical notions.
- The random process represents the mathematical model of the random signals.

### Programme Outcomes (POs)

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development

### Course Outcomes (COs)

1. Demonstrate and apply the basic probability axioms and concepts in their core areas of random phenomena.
2. Apply the concepts of probability distributions in an appropriate place of science and Engineering.
3. Apply the basic statistical inference techniques, including confidence intervals, hypothesis testing to science/engineering problems.
4. Design an experiment for an appropriate situation using ANOVA technique.
5. Apply Random Process techniques to the problem of random input signals.

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| 2 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| 4 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |

**UNIT I** **9 Hours**

**PROBABILITY AND RANDOM VARIABLES**

Axioms of probability - Conditional probability - Total probability - Bayes theorem - Random variables - Probability mass function - Probability density functions - Properties.

**UNIT II** **9 Hours**

**STANDARD DISTRIBUTIONS**

Binomial distribution - Poisson distribution - Negative binomial distribution - Exponential distribution - Gamma distribution - Normal distribution and their properties.

**UNIT III** **9 Hours**

**TESTING OF HYPOTHESIS**

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample test based on normal distribution for single mean and difference of means - Small sample tests: t-test for mean - F-test - Chi-square test for Goodness of fit and Independence of attributes.

**UNIT IV** **9 Hours**

**DESIGN OF EXPERIMENTS AND CONTROL CHART**

One way and two way classifications - Completely Randomized Design - Randomized Block Design Latin Square Design. Control charts for measurements (X and R charts) - Control charts for attributes (p, c and np charts).

**UNIT V** **9 Hours**

**RANDOM PROCESSES**

Definition and examples - first order, second order, strictly stationary, wide sense stationary and Ergodic processes - Markov process - Poisson and Normal processes.

**Tutorial: 15 Hours**
**Total: 60 Hours**

**Reference(s)**

1. Peyton Z Peebles, Probability, Random Variables and Random Signal Principles, Fourth Edition, Tata McGraw Hill Publications, New Delhi, 2010.
2. Richard A Johnson and John Freund, Miller and Freunds Probability Statistics for Engineers, Eighth Edition, Pearson Education, 2015.
3. Henry Stark and John W. Woods, Probability and Random Processes with Applications to Signal Processing, Third Edition, Pearson Education, Delhi, 2002.
4. Athanasios Papoulis, S. UnniKrishna Pillai, Probability, Random Variables and Stochastic Processes, Tata McGraw Hill Publications, Fourth Edition, New Delhi, 2010.

## 22EI402 SENSORS AND TRANSDUCER 3 0 2 4

**Course Objectives**

- To understand the concepts of calibration, characteristics and response of transducers
- To impart knowledge in the construction and characteristics of various electrical transducers
- To familiarize about different transducers and sensors

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO9.Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10.Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments

PSO1 Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Analyze the errors in measurement and instrumentation systems using static and dynamic characteristics
2. Apply the characteristics of resistive transducer for a given application
3. Analyze the variable inductive transducers for the measurement of displacement and pressure
4. Analyze the capacitive transducers for the given applications
5. Apply the various transduction methods used for field applications

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | 2 | - |
| 2 | 3 | 2 | - | 3 | - | - | - | - | 2 | 1 | - | 3 | 1 |
| 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | - |
| 4 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | - |
| 5 | 2 | 2 | 1 | 3 | - | - | - | - | 2 | 1 | - | 2 | 1 |

**UNIT I** **9 Hours**

**CHARACTERISTICS OF INSTRUMENTS**

Units and Standards - Static calibration- Classification of errors -Error analysis -Limiting error -Probable error -Static Characteristics-Accuracy, Precision, Resolution, Sensitivity, Linearity, Hysteresis, Range and Span, Drift, Dead Zone- Dynamic characteristics and order of the systems - Transducers classification

**UNIT II** **9 Hours**

**VARIABLE RESISTANCE TRANSDUCERS**

Principles of operation - Construction details -Characteristics of resistance transducers -Resistance potentiometers -Strain gauges -Resistance thermometers - Thermistors- Hot wire anemometer -Piezo resistive sensor

**UNIT III** **9 Hours**

**VARIABLE INDUCTANCE TRANSDUCERS**

Induction potentiometer -Variable reluctance transducers -Linear Variable Differential Transformer- LVDT Pressure transducer- Rotary Variable Differential Transformer-Eddy current transducers, synchro's and resolvers

**UNIT IV** **9 Hours**

**VARIABLE CAPACITIVE TRANSDUCERS**

Variable air gap type - Variable area type - Variable permittivity type - Feedback type capacitance proximity pickup - Capacitor microphone

**UNIT V** **9 Hours**

**OTHER TRANSDUCERS**

Piezoelectric transducer- Ultrasonic transducer, magnetostrictive transducer, fiber optic transducers, hall effect transducers, photoelectric transducers, and humidity sensor, Digital transducer.

**EXPERIMENT 1** **6 Hours**

Design and construct an electronic pressure gauge with 7 segment LED display for a compressor system

**EXPERIMENT 2** **6 Hours**

Design and construct a thermometer to measure the temperature in the water geyser

**EXPERIMENT 3** **6 Hours**

Speedometer for two-wheeler application using Hall Effect Transducer

**EXPERIMENT 4** **6 Hours**

Design and construct a weighing machine for the kitchen using strain gauge and load cell

**EXPERIMENT 5** **6 Hours**

Design and construct a light intensity meter in a closed room using optical transducers

**Total: 75 Hours**

**Reference(s)**

1. A. K. Sawhney, Puneet Sawhney, A course in Electrical and Electronic Measurements and Instrumentation, Nineteenth edition Dhanpat Rai & Co (P) Ltd, 2012.
2. H.S.Kalsi, Electronic Instrumentation, Third Edition, Tata McGraw Hill Education Private Limited, 2012.
3. D. Patranabis, Sensors and Transducers, 2nd Edition, Prentice Hall India Pvt. Ltd, 2009.

4. E.O.Doeblin, Measurement Systems: Applications and Design , 6th Edition, Tata McGraw-Hill Book Co., 2012.
5. D. V. S. Murthy,Transducers and Instrumentation, 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.
6. J. P. Bentley, Principles of Measurement Systems, 4th Edition, Addison Wesley Longman Ltd., UK, 2015.

## 22EI403 ANALOG ELECTRONICS AND INTEGRATED CIRCUITS

**3 0 2 4**

**Course Objectives**

- To learn the fundamental concepts behind transistor biasing and to differentiate small signal and large signal circuit models
- To understand the performance metrics of Multistage and Power amplifiers and the working of signal generating and wave shaping circuits
- To analyze the linear and non-linear applications of operational amplifiers.
- To illustrate the operating principle of comparators, Data Converters and various special function ICs.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PSO1 Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Analyze different biasing methods for Bipolar Junction Transistors and model different Transistor configurations for BJT
2. Design feedback and power amplifier circuits using Bipolar Junction Transistors
3. Analyze the internal structure of operational amplifiers, its characteristics and applications
4. Design Oscillator and Multivibrator circuits using Bipolar Junction Transistors and operational amplifiers.
5. Design comparator, Data converters and analyze the special function ICs and its application in modern electronic equipment.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | 3 | - |
| 2 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 3 | 2 |
| 3 | 3 | 3 | 3 | - | - | - | - | - | - | - | - | 3 | 2 |
| 4 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 3 | 2 |
| 5 | 2 | 2 | 2 | 2 | - | 2 | 2 | - | - | - | - | 3 | 2 |

**UNIT I** **9 Hours**

**BIASING**

Review of Transistor Biasing- Bias Stability, Bias Compensation - Small Signal CB, CE and CC - Hybrid pi model (High Frequency) - Simplified T Model

**UNIT II** **9 Hours**

**FEEDBACK AMPLIFIERS AND POWER AMPLIFIERS**

Cascade and Cascode Amplifier, Difference Amplifier - Feedback amplifiers - Current Series, Voltage Shunt, Current shunt and Voltage Series. Power Amplifiers: Class A, Class B, Class C and Class AB Power Amplifiers, Distortion in Power Amplifiers.

**UNIT III** **9 Hours**

**OP-AMP CHARACTERISTICS**

Ideal Op Amp, Operational Amplifier Internal Circuit, DC Characteristics, AC Characteristics, Slew Rate, Inverting and Non inverting Amplifiers, Voltage Follower, Summing Amplifier, Subtractor, Differentiator, Integrator, Instrumentation amplifier, 1st Order LPF, HPF and all-pass filters.

**UNIT IV** **9 Hours**

**WAVEFORM GENERATORS**

Barkhausencriterion, Oscillators using BJT: LC, Hartley, Colpitts and Crystal Oscillators, Principles of Op-Amp based Sine Wave Oscillator, RC Phase Shift, Wien Bridge Oscillator, Multivibrators (Op-Amp & 555) - Astable, Monostable

**UNIT V** **9 Hours**

**COMPARATORS, DATA CONVERTERS AND SPECIAL FUNCTION ICS**

Open Loop Op Amp Configuration, Comparator, Schmitt trigger, Sample and Hold circuits, Flash ADC, Dual Slope ADC - Binary Weighted Resistor DAC - R-2R Ladder DAC,VCO, Voltage regulator: Fixed and Adjustable

**EXPERIMENT 1** **8 Hours**

Design and implementation of an audio amplifier in home theaters.
Design and implementation of audio volume control using differential amplifiers.

**EXPERIMENT 2** **8 Hours**

Design and implementation of light detector using Operational amplifier.
Design and implementation of Analog arithmetic circuits (Summer/ Subtractor/ Comparator/ Differentiator/ Integrator).

**EXPERIMENT 3** **8 Hours**

Design and implementation of ambulance siren circuit using Timer IC.
Design and implementation of Op-Amp based clocks for digital circuits.

**EXPERIMENT 4** **6 Hours**

Design and implementation of Analog Temperature Monitor with ADC

**Total: 75 Hours**

**Reference(s)**

1. Adel. S. Sedra, Kenneth C. Smith, Microelectronic Circuits Theory and Applications, 7th Edition, Oxford University, 2017.
2. Donald.A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill, 3rd Edition, 2010.
3. David A. Bell, Electronic Devices and Circuits, Oxford Higher Education press, 5th Edition, 2010.
4. D.Roy Choudhry, Shail Jain, Linear Integrated Circuits, New Age International Pvt. Ltd, 5th Edition, 2018.
5. Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, 4th Edition, Tata Mc Graw-Hill, 2016.
6. William D.Stanely, Operational Amplifiers with Linear Integrated Circuits. Pearson Education, 4th Edition, 2009.

## 22EI404 COMMUNICATION ENGINEERING 3 0 0 3

**Course Objectives**

- To understand the fundamental concepts of communication systems
- To analyze different analog and digital modulation schemes
- To familiarize the basic concept of Optical Fiber Communications

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PSO1.Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Analyze the concept of amplitude modulation in time and frequency domain
2. Apply angle and phase modulation technique to design FM transmitter and receiver
3. Analyze different types of modulation techniques in digital communication system using time and frequency division multiplexing
4. Apply the appropriate data transmission method for error free transmission
5. Apply wavelength division multiplexing concept to develop fiber optic communication system for telephone and television applications.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 1 | - |
| 2 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 1 | - |
| 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 2 | - |
| 4 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 1 | - |
| 5 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 1 | - |

**UNIT I** **9 Hours**

**AMPLITUDE MODULATION**

Elements of communication systems - Time and frequency domain - Noise and communications - Amplitude modulation - AM Transmitters - AM Receivers.

**UNIT II** **9 Hours**

**ANGLE MODULATION**

Angle modulation - Phase modulation - Angle modulation spectrum - FM and Noise - FM stereo - FM measurements - FM Transmitters- FM Receivers - Receiver topologies - FM Demodulators.

**UNIT III** **9 Hours**

**DIGITAL MODULATION**

Introduction - Pulse Modulation - Pulse code modulation - Delta Modulation - Line codes - Time division multiplexing.

**UNIT IV** **9 Hours**

**DATA TRANSMISSION**

Data coding - Asynchronous Transmission - Synchronous Transmission - Error detection and Correction - Data compression and encryption.

**UNIT V** **9 Hours**

**FIBER OPTIC SYSTEMS**

Basic fiber optic systems - repeaters and optical amplifiers - wavelength division multiplexing - submarine cables - SONET - Fiber in local area networks.

**Total: 45 Hours**

**Reference(s)**

1. Roy Blake, Electronic Communication Systems, Thomson Delmar Ltd, New York, 2013.
2. Wayne Tomasi, Electronic Communication Systems, Pearson Education Asia Ltd, New Delhi, 2012.
3. Louis Frenzel ,Principles of Electronic Communication Systems by 3rd Edition,TMH publications, 2010.
4. Miller, Modern Electronic Communication, Prentice Hall of India, New Delhi, 2010.
5. William Schweber, Electronic Communication System, Prentice Hall of India Ltd, India, New York, 2010.

## 22EI405 EMBEDDED SYSTEMS 3 0 2 4

**Course Objectives**

- To understand the overview of Embedded System Architecture.
- To apply the Embedded C programming concepts in Microcontroller
- To analyse embedded communication protocols

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PSO1.Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Apply 8086 instruction set to implement ALP for performing arithmetic and logic operations.
2. Apply the concept of hardware architecture to select appropriate micro controllers and peripherals for embedded applications.
3. Analyse the special features and architecture of TIVA C series microcontroller.
4. Analyse and program different communication protocols used for Embedded Networking.
5. Design embedded applications by interfacing the OFF-chip peripherals with the microcontroller.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 2 | - | - | - | - | - | - | - | - | 1 | - |
| 2 | 1 | 2 | 3 | - | - | - | - | - | - | - | - | 2 | - |
| 3 | 2 | 3 | 2 | - | - | - | - | - | - | - | - | 3 | 2 |
| 4 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | | 1 |
| 5 | 1 | 3 | 2 | - | - | - | - | - | - | - | - | | 2 |

**UNIT I** **9 Hours**

**8086 MICROPROCESSOR**

8086 Architecture-8086 Instruction set-8086 Addressing modes- 8086 ALP-Interrupts

**UNIT II** **9 Hours**

**INTRODUCTION TO EMBEDDED SYSTEM**

Categories of embedded systems, Specialties of embedded systems, Recent trends in embedded systems, Hardware architecture, Software architecture, Communication software, Process of generation of executable image, Development/testing tools.

**UNIT III** **9 Hours**

**TIVA-C MICROCONTROLLER**

TIVA-C Microcontroller Architecture and Its memory map, GPIO Programming, WDT Programming, Interrupt Programming, LPM Programming

**UNIT IV** **9 Hours**

**COMMUNICATION PROTOCOLS**

UART, ADC, PWM, Timer, I2C, SPI

**UNIT V** **9 Hours**

**OFF-CHIP PERIPHERAL INTERFACING AND PROGRAMMING**

RTC Interfacing, Bluetooth module interfacing, Analog Sensor interfacing, Motor Interfacing.

**EXPERIMENT 1** **4 Hours**

Design a car parking system using 16-bit, 32-bit 8086 microprocessor

**EXPERIMENT 2** **4 Hours**

Design a display system for hotel using 8086 microprocessor

**EXPERIMENT 3** **5 Hours**

Design a ranking system for students using 8086 microprocessor

**EXPERIMENT 4** **5 Hours**

Design a traffic light controller using TIVA-C microcontroller

**EXPERIMENT 5** **6 Hours**

Design a printing machine with DC and stepper motor using TIVA-C microcontroller

**EXPERIMENT 6** **6 Hours**

Design server room temperature monitoring system using TIVA-C microcontroller

**Total: 75 Hours**

**Reference(s)**

1. Ray K &Bhurchandi K.M, "Advanced Microprocessors and Peripherals: Architecture, Programming and Interface", 3rd Edition, McGraw Hill, New Delhi, 2012.
2. Prasad K V K K Embedded Real Time Systems Concepts, Design and Programming Dreamtech press, 2013.
3. Muhammad Ali Mazidi, SarmadNaimi and SepehrNaimi TI ARM Peripherals Programming and Interfacing Using C Language Pearson Education, 2014.
4. Jonathan W. Valvano Embedded Systems Introduction to Arm Cortex M Microcontrollers 5th edition ISBN 978-1477508992, 2014.
5. Embedded System Design Using TIVA, TI University Program, Learning Material.

## 22HS007 ENVIRONMENTAL SCIENCE 2 0 0 0

**Course Objectives**

- Understand the interdisciplinary and holistic nature of the environment
- Identify the significance of natural resources and environment on the quality of life and stimulate the quest for sustainable development
- Assess the socio-economic, political and ethical issues in environmental science

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

**Course Outcomes (COs)**

1. Apply principles of natural resource management to analyze exploitation cases in forestry, water, minerals, and agricultural sectors, assessing their environmental impacts.
2. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation.
3. Analyze the existing environmental challenges related to pollution and its management.
4. Analyze the impacts of unsustainable practices, waste management, climate change, and water conservation on environmental sustainability.
5. Analyze the impact of population and human activities on environment.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - |
| 2 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - |
| 3 | 2 | 2 | - | - | - | - | 1 | - | - | - | - | - | - |
| 4 | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |

**UNIT I** **6 Hours**

**NATURAL RESOURCES**

Forest resources: Use - over exploitation - deforestation - case studies. Water resources: Use - over utilization of surface and ground water - conflicts over water. Mineral resources: Use - exploitation - environmental effects of extracting and using mineral resources - case studies. Food resources: Effects of modern agriculture - fertilizer-pesticide problems (eutrophication, blue baby syndrome, biomagnification). Energy resources: renewable (solar, wind, and hydro).

**UNIT II** **6 Hours**

**ECOSYSTEMS AND BIODIVERSITY**

Concept of an ecosystem: Structure and function of an ecosystem - producers - consumers - decomposers - food chains - food webs and ecological pyramids - Types of ecosystem: Introduction - characteristic features: desert ecosystem. Biodiversity - value of biodiversity - threats to biodiversity - endangered and endemic species - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

**UNIT III** **6 Hours**

**ENVIRONMENTAL POLLUTION**

Pollution: Definition - causes - effects - control measures of air pollution - water pollution: (Sewage water treatment by activated sludge and trickling filter process) - noise pollution - thermal pollution. Disaster management - causes - effects - control measures of floods – earthquake.

**UNIT IV** **7 Hours**

**SOCIAL ISSUES AND ENVIRONMENT**

Sustainable development - Definition - Unsustainable to sustainable development - solid waste management - causes - effects - 5R Principles (landfills, incineration, composting). Water conservation - rain water harvesting - watershed management. Climate change - global warming - acid rain - ozone layer depletion. E-waste.

**UNIT V** **5 Hours**

**HUMAN POPULATION AND ENVIRONMENT**

Human population: Population growth - characteristics - variation among nations - population explosion - value education - HIV / AIDS. Role of information technology in environment and human health - occupational safety and health administration (OSHA)

**Total: 30 Hours**

**Reference(s)**

1. Anubha Kaushik and C.P. Kaushik, Environmental Science and Engineering, 4th Edition, New Age International Publishers, New Delhi, 2014.
2. T.G.Jr. Miller and S. Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi, 2014.
3. A. K. De, Environmental Chemistry, 7th Edition, New age international publishers, New Delhi, 2014.
4. Raven, P.H , Hassenzahl, D.M. and Berg, L.R., Environment, 8th edition. John Wiley & Sons, 2012.
5. Pepper I.L, Gerba C.P. and Brusseau M.L, Environmental and Pollution Science. Academic Press, 2011.

## 22HS008 ADVANCED ENGLISH AND TECHNICAL EXPRESSION

**0 0 2 1**

### Course Objectives

- To enable students to achieve proficiency in academic writing
- effectively use the language to persuade others
- appreciate the nuances of the language and engage an audience
- use advanced tools of language to improve communicative competence
- prepare for professional demands at the workplace
- give concrete expression to the plans and goals

### Programme Outcomes (POs)

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

### Course Outcomes (COs)

1. Infer the clarity in articulating the objectives and aims and improved proficiency in using the English language
2. Communicate effectively and with good interpersonal skills; speak in public, engage the audience, and lead a group discussion
3. Critically evaluate the ethics of persuasive appeals and confidence to influence opinion
4. Analyse a specific piece of information; take in what is read, and use good writing techniques with proper grammar and syntax in all formal situations
5. Create awareness and empathy to emotional signals in communication

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | 2 | 3 | - | - | - |
| 2 | - | - | - | - | - | - | - | - | 2 | 3 | - | - | - |
| 3 | - | - | - | - | - | - | - | - | 2 | 3 | - | - | - |
| 4 | - | - | - | - | - | - | - | - | 2 | 3 | - | - | - |
| 5 | - | - | - | - | - | - | - | - | 2 | 3 | - | - | - |

**UNIT I** **15 Hours**

**CREATIVE EXPRESSION**

Proposals & Grant applications, Argumentative essays & editorials, Sales Pitches, Campaigning, Commercials/advertisements, effectively answering the famous interview question: 'Why should we hire you?' Sentence and paragraph formation - Rhetorical questions - Emphasis & effective repetition - Empathetic expression, knowing the audience, capturing attention - Creating Memes, Comic Strips, Stand-up comedy, Caption writing, and Limericks, Vocabulary and slang words for comedy - Similes & Metaphors - Homophones, homonyms, alliteration, wordplay

**UNIT II** **15 Hours**

**FORMAL EXPRESSION**

Writing: Action plans, Cover letters, Mind-Mapping, Paragraph writing Logical reasoning - SVA - Advanced level - Style: Clarity, Concision, Coherence, Evocativeness, Efficacious Vocabulary - Conditional Clause - Be verbs- Tenses- advanced - Opening and closing sentences - Action plans, Anecdotal references, order of communication/ narration, complete communication- Wh-questions - Effective beginning and closing - Rhetorical questions - Appraising target audience - Pronunciation, Enunciation, Tone, Pace and Volume. - Writing: SOPs, Research Objectives, Thesis Statement, Indexing, Scholarly Articles, Academic Writing, Executive Summary, Survey Questionnaires, Citations and Bibliography - Reading: Quantitative & qualitative analysis, Analysis and paraphrasing of reference materials Speaking: Commentate live events, give instructions to operate machines/ conduct experiments Listening: Informational listening, Reflective listening, - Discriminative listening - Connective words - Prefixes and Suffixes - Quoting and paraphrasing Proofreading - Directed writing and writing formats - Note taking - Active verbs

**Total: 30 Hours**

**Reference(s)**

1. Sangeeta Sharma et.al. Communication Skills for Engineers and Scientists, PHI Learning Pvt. Ltd, 2011.
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001.
4. Personality Development, Harold R. Wallace & L.Ann Masters, Cengage Learning, New Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji-Macmillan India Ltd. New Delhi, 1990.
6. English Grammar, Composition and Usage by N. K. Agrawal & F. T. Wood, Macmillan India Ltd., New Delhi.

## 22HS010 SOCIALLY RELEVANT PROJECT

**Course Objectives**

- To develop Problem-Solving Skills
- To enhance Research and Analytical Abilities
- To promote Social Responsibility and Ethical Awareness

**Programme Outcomes (POs)**

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

**Course Outcomes (COs)**

1. Interact with society conduct a field surveys and identify societal issues.
2. Analyze societal problems using engineering principles.
3. Develop plan and provide optimal solutions for social issues using their engineering knowledge and skills.
4. Prepare comprehensive reports on their findings and proposed solutions.
5. Enhance the social responsibility and ethical considerations in engineering.
6. Develop community interaction and managerial skills

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | 2 | - | - | 2 | - | - | 3 | 3 | 3 | - | - | - |
| 2 | - | 3 | - | - | - | - | - | 3 | 3 | 3 | - | - | - |
| 3 | - | - | 3 | - | 2 | - | - | 3 | 3 | 2 | - | - | - |
| 4 | - | - | - | - | - | - | - | 2 | 2 | 2 | - | - | - |
| 5 | - | - | - | - | - | - | - | 3 | 3 | 3 | - | - | - |
| 6 | - | - | - | - | - | - | - | 2 | 1 | 2 | - | - | - |

Students have to interact with society, conduct a field survey and identify the issues / problems available in the society. Analyze the issues using engineering knowledge, skills and attitude and provide the optimal solutions to solve the social issues and submit the report.

**Total: 40 Hours**

**22EI501 INDUSTRIAL INSTRUMENTATION 3 0 2 4**

**Course Objectives**

- To understand the different types of level measurements adopted in industrial environment
- To acquire knowledge about the principles of humidity, moisture and viscosity measurements
- To understand and design the99 various types of Pressure, Temperature and flow meters

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Select the appropriate level transducer for the measurement of level in linear and non-linear tank by Analyze the characteristics of electrical type of level meters
2. Examine various methods of Humidity, Moisture, and Viscosity measurement.
3. Analyze the characteristics of pressure measurement transducers and select a suitable method for a specified application.
4. Select the suitable temperature measuring Instruments for a given application based on the temperature ranges.
5. Analyze the characteristics of Mechanical, and electrical type flow meters and select suitable flow meter for a specified flow application.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | 1 | - | - | 1 | 1 | 1 | 2 | - | 2 | 3 | 1 |
| 2 | 3 | 1 | 1 | - | - | 1 | 1 | 1 | 2 | - | 2 | 3 | 1 |
| 3 | 3 | 1 | 1 | - | - | 1 | 1 | 1 | 2 | - | 2 | 3 | 1 |
| 4 | 3 | 1 | 1 | - | - | 1 | 1 | 1 | 2 | - | 2 | 3 | 1 |
| 5 | 3 | 1 | 1 | - | - | 1 | 1 | 1 | 2 | - | 2 | 3 | 1 |

**UNIT I** **9 Hours**

**LEVEL MEASUREMENT**

Definition of level - visual indicators - float gauges: different types - level switches - displacer and torque tube - bubbler tube - boiler drum level measurement - hydra step systems - electrical types of level gauges using resistance, capacitance, nuclear radiation, and ultrasonic sensors - measurement of level of solids - paddle wheel type - differential pressure method.

**UNIT II** **9 Hours**

**MEASUREMENT OF HUMIDITY, MOISTURE, AND VISCOSITY**

Units and definitions - dry and wet bulb psychrometers - hot wire electrode and hair type hygrometers - dew cell - electrolysis type hygrometer - commercial type dew point meter - moisture terms - moisture measurement in granular materials, solid penetrable materials like wood, web type material - capacitance type - NMR probe for moisture detection - viscosity measurement - Saybolt viscometers - continuous measurement of viscosity - rotameter for viscosity measurement.

**UNIT III** **9 Hours**

**PRESSURE MEASUREMENT**

High pressure: Mechanical type- bellows, bourdon, helical, diaphragm or capsule- Dead Weight Piston Gauge - Liquid-Sealed types- Visual Manometers, Float Manometers -D/P transmitter - Electrical types - vacuum gauges: Capacitance Manometers - Pirani, Thermocouple and Thermopile vacuum gauges, hot and cold cathode ionization vacuum gauges - McLeod vacuum calibration gauges.

**UNIT IV** **9 Hours**

**TEMPERATURE MEASUREMENT**

Construction - Characteristics - Linearization - Bimetallic thermometers - Industrial RTD construction requirements - signal conditioning - Two-wire, three-wire and four-wire RTDs - Thermistor - Characteristics, measurement methods linearization, thermo well. Thermocouples - laws of intermediate temperatures and metals - types of thermocouple - cold junction compensation thermocouple construction - Optical, Radiation and Infrared Pyrometers

**UNIT V** **9 Hours**

**FLOW METERS**

Construction - Characteristics - Selection - Installation - Head type flow meters - Positive displacement flow meters - Inferential meter - Turbine flow meter - Mass Flow Meters - Electromagnetic flow meter - vortex shedding flow meter - target flow meter

**EXPERIMENT 1** **5 Hours**

Measurement of water level in overhead tank using Differential pressure transducers

**EXPERIMENT 2** **5 Hours**

Humidity and Vacuum measurement in a closed room

**EXPERIMENT 3** **5 Hours**

Construct a continuous emission measurement system using the dust measurement device in an Industrial Environment

**EXPERIMENT 4** **5 Hours**

Pressure calibration in air compressor using dead weight tester

**EXPERIMENT 5** **5 Hours**

Thermocouple Cold junction compensation for heater in a water bath

**EXPERIMENT 6** **5 Hours**

Measurement of water flow in water distribution system

**Total: 75 Hours**

**Reference(s)**

1. Bela G. Liptak, Process Measurement and Analysis, Volume-I, Instrument Engineers" Handbook, fourth edition, CRC press, USA, 2012.
2. John G. Webster, The Measurement, Instrumentation and Sensors Handbook, CRC and IEEE press, USA, 2017.
3. Tony R. Kuphaldt, Lessons in Industrial Instrumentation, Version 2.33, 2019, open-source textbook. (http://openbookproject.net/books/socratic/sinst/book/)
4. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, Second edition, McGraw-Hill Professional, 2018.
5. Patranabis D, Principal of Industrial Instrumentation, Third edition, Tata McGraw-Hill Education Pvt. Ltd., 2010.

## 22EI502 ELECTRONIC INSTRUMENTATION AND MEASUREMENTS

**3 1 0 4**

**Course Objectives**

- To understand the construction and working of meters used for measurement of current, voltage, power and energy
- To acquire the concepts of the potentiometers and instrument transformers
- To gain knowledge about resistance, inductance and capacitance measuring methods and display/recording devices

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO11.Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Apply the principles of various measuring instruments to accurately determine voltage and current, analyzing their construction and working mechanisms.
2. Evaluate the performance of different watt meters and energy meters by analyzing their operational principles and calibration methods for accurate power measurement.
3. Analyze and compare different potentiometers and instrument transformers to determine their effectiveness in high-precision electrical measurements.
4. Apply various bridge techniques for measuring resistance and impedance in AC and DC circuits, optimizing accuracy and efficiency.
5. Implement advanced display and recording devices, utilizing CRO and digital storage oscilloscopes to enhance the accuracy of electrical parameter measurements.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 2 | - | - | - | - | - | - | - | 1 | 1 | - |
| 2 | 3 | 3 | 2 | - | - | - | - | - | - | - | 1 | 1 | - |
| 3 | 2 | 3 | 3 | - | - | - | - | - | - | - | 2 | 2 | - |
| 4 | 2 | 3 | 3 | - | - | - | - | - | - | - | 3 | 2 | - |
| 5 | 2 | 3 | 3 | - | - | 1 | - | - | - | - | 3 | 3 | - |

**UNIT I** **7 Hours**

**MEASUREMENT OF VOLTAGE AND CURRENT**

Types of ammeters and voltmeters - Construction and working principle of PMMC Instrument, Moving iron Instrument, Dynamometer type Instrument and Rectifier type Instrument.

**UNIT II** **9 Hours**

**MEASUREMENT OF POWER AND ENERGY**

Construction and working principle of Electrodynamometer wattmeter and LPF wattmeter - Phantom loading - Measurement of power in three phase circuits - three phase wattmeters - Construction and working principle of single phase energy meter - Calibration of wattmeter, energy meter.

**UNIT III** **9 Hours**

**POTENTIOMETERS AND INSTRUMENT TRANSFORMERS**

Potentiometers: Construction and working principle of Crompton"s potentiometer, Precision potentiometer, polar and Co-ordinate types - Applications. Instruments Transformers: Construction and working principle of Current transformers and Potential Transformers- Clamp meters

**UNIT IV** **12 Hours**

**MEASUREMENT OF RESISTANCE AND IMPEDANCE**

DC Bridges- Wheatstone bridge, Kelvin double bridge and Direct deflection methods - AC bridges - Maxwell, Wien's bridge, Hay's bridge and Anderson's bridge- Maxwell's inductance-capacitance bridge - De Sauty's bridge, and Schering bridge - Measurement of relative permittivity - Heaviside mutual inductance bridge - Megger.

**UNIT V** **8 Hours**

**DISPLAY AND RECORDING DEVICES**

Cathode ray oscilloscope - Time base generator - Basic CRO circuits - measurement of voltage, current, frequency and phase angle - Digital storage oscilloscope - Seven segment and dot matrix displays - Magnetic tape and disc recorders/reproduces - Protection and grounding circuits.

**Tutorial: 15 Hours**
**Total: 60 Hours**

**Reference(s)**

1. A. K. Sawhney, Puneet Sawhney, A course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai & Company, 2014.
2. Ernest O.Doebelin, Dhanesh N Manik, Measurement systems, Tata McGraw Hill Publishing Co Ltd, New Delhi, 2011.
3. J. B. Gupta, A Course in Electronic and Electrical Measurements and Instrumentation, S.K.Kataria & Sons, Delhi, 2013.
4. H. S. Kalsi, Electronic Instrumentation, Tata McGraw Hill company, New Delhi, 2010.

5. Reissland,U. Martin, Electrical Measurements: Fundamentals, Concepts, Applications, New Age International (P) Ltd., 2012.
6. E. W. Golding and F. C. Widdis, Electrical Measurements & Measuring Instruments, Reem Publications (P) Ltd, 2011.

## 22EI503 INTERNET OF THINGS 3 0 0 3

**Course Objectives**

- To impart knowledge in the Internet of Things (IoT)
- To understand the concept of interfacing smart sensors/actuators with internet connectivity
- To illustrate the various protocol standards deployed in the Internet of Things (IoT) domain

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Analyse the characteristics and various design levels in internet of things.
2. Attribute the network design in IoT deployment.
3. Apply the IoT design principles on connected devices, domains and various protocol standards
4. Design the IoT ad-hoc network using protocol.
5. Analyse the working challenges of IoT on various domain-specific applications.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - |
| 2 | 2 | 2 | 1 | - | 1 | - | - | - | - | - | - | 1 | - |
| 3 | 2 | 3 | 3 | - | 3 | - | - | - | - | - | - | 2 | - |
| 4 | 1 | 3 | 2 | - | 3 | - | - | - | - | - | - | 2 | - |
| 5 | 1 | 3 | 3 | - | 3 | - | - | - | - | - | - | 2 | - |

**UNIT I** **9 Hours**

**INTRODUCTION TO INTERNET OF THINGS**

Introduction to Internet of Things: Overview of Internet of Things, defining characteristics, connected things, functional blocks, architectural models, communicating APIs, Comparing Internet of Things and Machine to Machine (M2M) connectivity, Differences between IoT and M2M

**UNIT II** **9 Hours**

**DESIGN OF INTERNET OF THINGS**

Design of Internet of Things: Physical Design of IoT, Logical Design of IoT, IoT Enabling Technologies, IoT Levels and Deployments, Introduction to Physical Devices and Endpoints.

**UNIT III** **9 Hours**

**DESIGNING CONNECTED COMPONENTS**

Designing Connected Devices: Basic Design Principles, Embedded Computing basics, Prototyping, Embedded prototyping, Sensors, Actuators, Beagle Bone Black, Development Options, Online Prototyping tools and components, APIs, Moving to the market needs, SoC WiFi Controller with Cloud connectivity

**UNIT IV** **9 Hours**

**VARIOUS PROTOCOL STANDARDS AS ENABLERS OF IOT**

Various Protocol Standards as enablers of IoT: Overview of Internet communications - TCP/IP and UDP, Static and Dynamic Assignment, IP Address, IPv4 and IPv6, Wireless Communication Standards for IoT - WiFi Connectivity include Servers - Security Protocols for IoT Networks.

**UNIT V** **9 Hours**

**DOMAIN-SPECIFIC IOT AND THEIR CHALLENGES**

Domain Specific IOT and their challenges: Illustrated Domains - Home Automation, Smart Cities, Environment, Energy, Retail, Logistics, Health and Life Style, Industrial IoT

**Total: 45 Hours**

**Reference(s)**

1. Samuel Greengard, The Internet of Things (Essential Knowledge), MIT Press, 2015.
2. Adrian McEwen and Hakim Cassimally, Designing the Internet of Things, 2015.
3. Arshdeep Bagha & Vijay Madisetti, Internet of Things - A Hands-On Approach,VPT, 2014.

## 22EI504 CONTROL SYSTEMS 3 1 0 4

### Course Objectives

- To understand the basic concepts of open loop and closed loop control systems.
- To analyze the given system in time domain.
- To understand the concept of frequency domain analysis
- To understand the concept of stability of system
- To design the compensator for different control systems

### Programme Outcomes (POs)

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

### Course Outcomes (COs)

1. Develop a mathematical model of a physical system and compute the transfer function using Block diagram reduction technique and Signal flow graph.
2. Analyze the performance of first and second order system and compute the steady state error using different test signals.
3. Analyze the frequency response of a given system and comment the stability.
4. Analyze the stability of a given system using Routh Hurwitz criterion, Nyquist stability criterion and Root Locus techniques.
5. Apply the concept of lag, lead and lag lead compensator for open loop system and examine a system using state variable techniques.

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 |
| 2 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 3 | 3 | 2 | | 2 | - | - | - | - | - | - | - | - | 2 |
| 4 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 3 |
| 5 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | 1 | 3 |

**UNIT I** **9 Hours**

**MATHEMATICAL MODEL OF PHYSICAL SYSTEMS**

Basic elements in control systems Open and closed loop systems with examples Mathematical representation of systems Transfer function mechanical and electrical systems, Electrical analogy of mechanical systems Block diagram reduction techniques Signal flow graphs.

**UNIT II** **9 Hours**

**TIME DOMAIN ANALYSIS**

Standard test signals Time response of first order and second order systems for unit step test signals Time domain Specifications-Steady state response Static error constants steady state error Effects of proportional derivative, proportional integral systems.

**UNIT III** **8 Hours**

**FREQUENCY DOMAIN ANALYSIS**

Frequency response of systems Frequency domain specifications Correlation between frequency domain and time domain specifications frequency domain analysis using Bode plot, Polar plot.

**UNIT IV** **10 Hours**

**STABILITY ANALYSIS OF CONTROL SYSTEM**

Concepts of stability Necessary conditions for Stability Characteristics equation Location of roots in S plane for stability Routh Hurwitz criterion Nyquist stability criterion Root Locus technique- Relative Stability

**UNIT V** **9 Hours**

**COMPENSATOR DESIGN AND STATE VARIABLE ANALYSIS**

Compensators: Deign of Lag compensator Lead compensator Lag-lead compensator (using Bode plot) Concept of state, state variables, and state model, Controllability and observability tests.

**Tutorial: 15 Hours**
**Total: 60 Hours**

**Reference(s)**

1. I.J. Nagrath and M. Gopal, Control System Engineering, New Age International Publisher, 2011.
2. M Gopal, Control Systems Principles and Design, Tata McGraw hill, New Delhi, 2012.
3. K.Ogatta, Modern Control Engineering, Pearson Education, New Delhi, 2015.
4. Benjamin C. Kuo, Automatic Control Systems, Prentice-Hall of India Pvt. Ltd., 2014.
5. Norman S. Nise, Control Systems Engineering, 4th edition, New York, John Wiley, 2003.

**22EI507 MINI PROJECT I** **0 0 2 1**

**Course Objectives**

- Identify the problem statement and apply the engineering concepts to find the solution.
- Improve the analysing capability of the students.
- Increase the exuberance in finding the solution to various problems.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1.Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies
3. Utilize the new tools, algorithms, and techniques that contribute to obtaining the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis of the cost-effectiveness.
5. Prepare the report and present oral demonstrations.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 1 | 1 | 2 | - | - | 2 | 2 | 2 | - | 1 | 1 |
| 2 | 1 | 2 | 1 | 1 | 2 | - | - | 2 | 2 | 2 | - | 1 | 1 |
| 3 | 1 | 2 | 1 | 1 | 2 | - | - | 2 | 2 | 2 | 2 | 1 | 1 |
| 4 | 1 | 2 | 1 | 1 | 2 | - | - | 2 | 2 | 2 | 2 | 1 | 1 |
| 5 | 1 | 2 | - | - | 2 | - | - | 2 | 2 | 2 | - | 1 | 1 |

## 22EI601 PROCESS CONTROL 3 0 2 4

**Course Objectives**

- To obtain the mathematical models for first order and higher order real-time systems and also the characteristics of various controller modes
- To get adequate knowledge about the various controller tuning and multi loop control
- To understand the construction, characteristics and application of different types of actuators and unit operations for real time applications

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Compute the mathematical model for a physical process by using mass and energy balance equations
2. Apply suitable control mode for different applications
3. Analyze the various control schemes and obtain optimum controller settings using tuning methods
4. Apply the suitable final control elements for an appropriate closed loop system
5. Apply complex control schemes for various applications and develop the P&ID structure for level and flow control loops

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 2 | - | 1 | - | - | - | - | - | - | 2 | |
| 2 | 2 | 3 | 2 | - | 1 | - | - | - | - | - | - | 2 | 3 |
| 3 | 2 | 3 | 1 | - | 1 | - | - | - | - | - | 2 | | 3 |
| 4 | 2 | | 1 | - | 1 | - | - | - | - | - | - | 3 | 2 |
| 5 | 2 | 2 | 1 | - | 1 | 3 | - | - | 2 | 2 | 3 | 2 | 3 |

**UNIT I** **9 Hours**

**INTRODUCTION**

Need for process control-continuous and batch process - mathematical model of first order process using mass and energy balance equations - two tank interacting and non-interacting process - servo and regulator operation - degrees of freedom - self-regulation.

**10 Hours**

**UNIT II**

**CONTROLLER CHARACTERISTICS**

Basic control actions - characteristics and step responses of ON-OFF, multi-position, floating-control mode, proportional, integral and derivative control modes - composite control modes: P+I, P+D and P+I+D control modes - step response of composite control modes - bumpless transfer - Proportional and derivative kick, reset windup - Electronic controllers to realize various control actions -Guidelines for selection of controller mode.

**UNIT III** **8 Hours**

**TUNING OF CONTROLLERS AND MULTI-LOOP CONTROL**

Optimum controller settings- Evaluation criteria -IAE, ISE and ITAE - quarter decay ratio - Tuning of controllers by process reaction curve method - damped oscillation method - Ziegler-Nichols tuning - Feed forward control - ratio control - cascade control - averaging control - inferential and split range control.

**UNIT IV** **9 Hours**

**FINAL CONTROL ELEMENT**

I/P and P/I converters - pneumatic and electric actuators - valve positioner - smart positioned-control valve - characteristics of control valves - type of valves: globe, butterfly, diaphragm, ball valves - control valve sizing - cavitation and flashing in control valves - Selection of control valves.

**UNIT V** **9 Hours**

**SELECTED UNIT OPERATIONS**

Binary distillation column - reflux control - Case study: control of heat exchange, evaporator control, reactor control, drum level control and combustion control. Piping and Instrumentation Diagram (P&ID) symbols - P&ID for level and flow control loops.

**EXPERIMENT 1** **5 Hours**

Open loop response of interacting and non-interacting level process.

**EXPERIMENT 2** **5 Hours**

Analyse the response of different types of control valves.

**EXPERIMENT 3** **5 Hours**

Tuning of PID controller for first and second order system.

**EXPERIMENT 4** **5 Hours**

Closed loop Cascade control of level and flow process with and without transportation lag.

**EXPERIMENT 5** **5 Hours**

Closed loop control of temperature process station.

**EXPERIMENT 6** **5 Hours**

Closed loop control of pressure process station.

**Total: 75 Hours**

**Reference(s)**

1. Curtis D. Johnson, Process Control Instrumentation Technology, Pearson New International Edition 2013.
2. George Stephanopoulos, Chemical Process Control, PHI learning Pvt. Ltd., New Delhi, 2012.
3. D.R. Coughanowr, Steven E LeBlanc, Process Systems Analysis and Control, McGraw Hill,Singapore, 3rd Edition, 2009.
4. B. Wayne Bequette, Process Control: modelling, Design, and simulation, PHI learning Pvt Ltd., New Delhi, 2010.
5. Jonathan Love Process Automation Handbook: A Guide to Theory and Practice, Springer, 2010.
6. Peter Harriott, Process Control, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 30th reprint 2010.

## 22EI602 DIGITAL SIGNAL PROCESSING 3 1 0 4

**Course Objectives**

- To understand the signals and systems and their mathematical representation in time/frequency domain.
- To analyze the discrete time systems using Z-transform and Inverse Z-transform.
- To implement the discrete time systems in Discrete Fourier Transform using Fast Fourier Transform algorithm
- To design FIR filters with its response and obtaining its realization structure.
- To design IIR filters with its response and obtaining its realization structure.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Analyse mathematical functions, categorize signals and systems, and implement sampling and quantization techniques for converting analog signals to digital format.
2. Evaluate the stability of discrete-time systems using the Z-transform and use the discrete-time Fourier transform to convert signals from the time domain to the frequency domain.
3. Apply the discrete Fourier transform and fast Fourier transform to analyze discrete-time systems, converting signals from the time domain to the frequency domain.
4. Design and analyze FIR filters, evaluate their responses, and develop their realization structures.
5. Design and analyze IIR filters, assess their responses, and develop their realization structures.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 1 | 1 | - | - | - | - | - | - | - | 2 | 2 |
| 2 | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | - | 2 |
| 3 | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | - | 2 |
| 4 | 3 | 2 | 3 | 1 | - | - | - | - | - | - | - | 2 | 2 |
| 5 | 3 | 2 | 3 | 1 | - | - | - | - | - | - | - | 2 | 2 |

**UNIT I** **10 Hours**

**SIGNALS AND SYSTEMS**

Classification of Systems: Continuous, Discrete, Linear, Causal, Stability, Dynamic, Recursive, Time Variance Systems; Classification of Signals: Continuous and Discrete, Energy and Power; Mathematical representation of Signals; Mathematical Operation of Signals; Sampling Theorem, Sampling techniques, Quantization, Quantization error, Nyquist rate, Aliasing effect.

**UNIT II** **9 Hours**

**DISCRETE TIME SYSTEM ANALYSIS**

Z-transform and its properties, Inverse Z-transforms; Difference equation - Solution by Z-transform, Application to Discrete Systems - Stability analysis, Frequency response - Convolution - Discrete Time Fourier transform, Magnitude and Phase representation.

**UNIT III** **8 Hours**

**DISCRETE FOURIER TRANSFORM**

Discrete Fourier Transform- properties, magnitude and phase representation - Computation of DFT using FFT algorithm - DIT & DIF using radix 2 FFT - Butterfly structure.

**UNIT IV** **10 Hours**

**DESIGN OF FIR DIGITAL FILTERS**

Finite Impulse Response (FIR) design: Amplitude and phase responses of FIR filter - Linear phase characteristics - Need and choice of windows - Windowing Techniques: Rectangular, Hamming and Hanning; Realization of FIR filter using direct, Cascade and lattice structures.

**UNIT V** **8 Hours**

**DESIGN OF IIR DIGITAL FILTERS**

Realization of IIR filters using direct, cascade and parallel forms, Design of analogue Butterworth and Chebyshev Filters. Design of IIR digital filters using impulse invariance technique, bilinear transform Realization of IIR filters using direct, cascade and parallel forms.

**Tutorial: 15 Hours**
**Total: 60 Hours**

**Reference(s)**

1. J.G. Proakis and D.G. Manolakis, 'Digital Signal Processing Principles, Algorithms and Applications', Pearson Education, New Delhi, PHI, Fourth Edition, 2014.
2. S.K. Mitra, 'Digital Signal Processing - A Computer Based Approach', McGraw Hill Edu, 2011.
3. Tarun Kumar Rawat, Digital Signal Processing, Oxford University Press, 2015.
4. Richard G. Lyons, D. Lee Fugal, The Essential Guide to Digital Signal Processing, Pearson Education, 3rd Edition, 2014.
5. S. Salivahanan, A.Vallavaraj, Gnanapriya, Digital Signal Processing, McGraw-Hill, 2nd Edition, 2011.
6. Alan V. Oppenheim, Ronald W. Schafer and John R. Buck, Discrete - Time Signal Processing, Pearson Education, New Delhi, 2013.

## 22EI603 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

**3 0 2 4**

### Course Objectives

- To understand the problem solving intelligent agents and searching techniques.
- To Impart domain knowledge in different machine learning method.
- To realize the different applications in AI

### Programme Outcomes (POs)

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

### Course Outcomes (COs)

1. Analyze the concepts of intelligent agents and its structure
2. Apply appropriate search algorithms for solving given AI problems.
3. Differentiate learning strategies, regression and classification in Artificial Intelligence Systems.
4. Analyze the basic concepts of reinforcement learning and find solutions
5. Apply the machine learning techniques in AI applications.

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | 2 | - | - | 2 | - | - | - | - | - | 1 | 2 |
| 2 | 2 | 2 | 1 | 2 | - | - | - | - | - | - | - | 2 | 2 |
| 3 | 2 | 2 | 2 | 3 | - | - | - | - | - | - | - | 2 | 2 |
| 4 | 3 | 2 | 2 | 1 | - | 2 | - | - | - | - | - | 1 | 2 |
| 5 | - | 2 | 2 | - | - | - | - | - | - | - | - | 2 | 2 |

**UNIT I** **9 Hours**

**INTELLIGENT AGENTS**

Introduction to AI, Agents and Environments, Concept of rationality, Nature of environments, Structure of agents, problem solving agents, search algorithms, uninformed search strategies

**UNIT II** **9 Hours**

**PROBLEM SOLVING**

Heuristic search strategies, Heuristic functions, Local search and optimization problems, Local search in continuous space Online search agents and unknown environments, optimal Decisions in games, Constraint satisfaction problems (CSP).

**UNIT III** **9 Hours**

**MACHINE LEARNING METHODS**

Forms of learning, Supervised learning, Learning decision trees, Evaluation and choosing the best hypothesis, Theory of Learning, Regression and classification with linear models, Artificial Neural network, Non parametric model, Support vector machine, Ensemble learning.

**UNIT IV** **9 Hours**

**REINFORCEMENT LEARNING**

Introduction to Reinforcement Learning, Active and Passive Reinforcement Learning, Generalization in reinforcement learning, Policy Search, Applications of Reinforcement Learning.

**UNIT V** **9 Hours**

**AI APPLICATIONS**

Natural Language Processing Language Models, Text Classification, Information Retrieval, Information Extraction, Machine Translation, Speech Recognition, Robotics, Robotic Hardware and Robotic perception.

**EXPERIMENT 1** **4 Hours**

Develop PEAS descriptions for given AI Experiment.

**EXPERIMENT 2** **5 Hours**

Implement basic search strategies for selected AI applications.

**EXPERIMENT 3** **5 Hours**

Implement a classifier for the sales data.

**EXPERIMENT 4** **5 Hours**

Develop a predictive model for predicting house prices.

**EXPERIMENT 5** **5 Hours**

Apply reinforcement learning and develop a game of your own.

**EXPERIMENT 6** **6 Hours**

Apply Natural language processing to develop filters for spam and non-spam mails.

**Total: 75 Hours**

**Reference(s)**

1. Stuart Jonathan Russell, Peter Norvig, John Canny, Artificial Intelligence: A Modern Approach, Prentice Hall, Fourth Edition, 2020.
2. Ameet V Joshi, Machine Learning and Artificial Intelligence, Springer Publications, 2020.
3. T.M. Mitchell, Machine Learning, McGraw-Hill 2017.
4. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Third Edition 2014.
5. Stephen Marsland, Machine Learning An Algorithmic Perspective, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

## 22EI607 MINI PROJECT II 0 0 2 1

**Course Objectives**

- Identify the problem statement and apply the engineering concepts to find the solution.
- Improve the analysing capability of the students.
- Increase the exuberance in finding the solution to various problems.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Formulate a real-world problem, identify the requirement, and develop the design solutions.
2. Identify technical ideas, strategies, and methodologies.
3. Utilize the new tools, algorithms, and techniques that contribute to obtaining the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis of the cost-effectiveness.
5. Prepare the report and present oral demonstrations.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 1 | 1 | 2 | - | - | 2 | 2 | 2 | - | 1 | 1 |
| 2 | 1 | 2 | 1 | 1 | 2 | - | - | 2 | 2 | 2 | - | 1 | 1 |
| 3 | 1 | 2 | 1 | 1 | 2 | - | - | 2 | 2 | 2 | 2 | 1 | 1 |
| 4 | 1 | 2 | 1 | 1 | 2 | - | - | 2 | 2 | 2 | 2 | 1 | 1 |
| 5 | 1 | 2 | - | - | 2 | - | - | 2 | 2 | 2 | - | 1 | 1 |

## 22EI701 INDUSTRIAL AUTOMATION 3 0 2 4

**Course Objectives**

- To understand the fundamentals of Programmable Logic Controller (PLC), Supervisory Control and Data Acquisition (SCADA) and Distributed Control System (DCS)
- To program and configure the advanced controller for a given application
- To familiarize the functions of Human Machine Interface

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Select the appropriate components for executing logical programming in PLC.
2. Design PLC, PAC and SCADA programming for given real time applications.
3. Compare the Hybrid, Central Computers and Distributed architectures of DCS.
4. Implement various hardware interfacing methods with DCS for real time applications.
5. Apply various hardware interfacing methods with HMI for real time applications.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 2 | 2 | | - | - | - | - | - | - | - | 3 |
| 2 | 2 | 2 | 3 | 2 | 2 | - | - | - | - | - | - | - | 3 |
| 3 | 1 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | 3 |
| 4 | 1 | 2 | 3 | 2 | 2 | - | - | - | - | - | - | - | 3 |
| 5 | 1 | 2 | 3 | 2 | 2 | - | - | - | - | - | - | - | 3 |

**UNIT I** **10 Hours**

**PROGRAMMABLE LOGIC CONTROLLER**

Evolution of PLCs- Components of PLC - Architecture of PLC - Discrete and analog I/O modules - Programming languages - Ladder diagram - Function block diagram (FBD) - Programming timers and Counters- Instructions in PLC - Program control instructions, math instructions, data manipulation Instructions, sequencer and shift register instructions.

**UNIT II** **9 Hours**

**PLC PAC SCADA AND ITS APPLICATIONS**

Case studies in PLC: Automatic Traffic Control, Automatic bottle filling System, Automatic level and flow control- Introduction to SCADA - components of SCADA - features of SCADA- Introduction to PAC- Features of PAC

**UNIT III** **8 Hours**

**DISTRIBUTED CONTROL SYSTEM**

DCS - Various Architectures: Hybrid, Central Computers, Distributed architectures - Comparison - Local control unit - Architectures - Process interfacing issues- Redundant Controller Designs - Remote I/O's - Process Input/ Output Design Issues.

**UNIT IV** **9 Hours**

**INTERFACES IN DCS**

Operator interfaces - Low level and high level operator interfaces - Displays - Engineering interfaces - Low level and high level engineering interfaces - Factors to be considered in selecting DCS - Case studies in DCS- Control of Mixing unit in Cement industries- Automatic elevator control.

**UNIT V** **9 Hours**

**HUMAN MACHINE INTERFACE**

Human Machine Interface function - Data Handling with HMI- Command line interface- Interface design- Configuration and interfacing with PLC and PC- Communication standards, Ethernet, profibus, RS485

**EXPERIMENT 1** **5 Hours**

Control of Level and flow using PLC

**EXPERIMENT 2** **5 Hours**

Control of automatic bottle filling system using PLC

**EXPERIMENT 3** **5 Hours**

Control of Traffic light system using PLC (Sequence output instruction).

**EXPERIMENT 4** **5 Hours**

Control of Pressure and Flow process using DCS

**EXPERIMENT 5** **5 Hours**

Interfacing of AC and DC motors using HMI

**EXPERIMENT 6** **5 Hours**

Interfacing of Variable Frequency Drive with PLC

**Total: 75 Hours**

**Reference(s)**

1. John W Webb and Ronald A Resis, Programmable Logic Controller, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.
2. F.D. Petruzella, Programmable Logic Controllers, Tata Mc-Graw Hill, Third Edition, 2010.
3. Benjamin C Kuo, Automatic Control Systems, Prentice Hall of India, 2012.

## 22EI702 INDUSTRIAL DATA COMMUNICATION AND NETWORKS

**3 1 0 4**

### Course Objectives

- To understand the concept of Data communication and networks and its standards.
- To explain the function of various protocols
- To explore the network security.

### Programme Outcomes (POs)

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

### Course Outcomes (COs)

1. Apply the basics of Data communications to model the networks.
2. Analyze the significance of different industrial networks.
3. Analyze the architecture of HART and Field bus protocol for the industrial applications.
4. Compare Modbus and Profibus protocols.
5. Analyze the industrial network threats and propose appropriate solution.

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | 2 | - | - | - | - | - | - | - | 1 | - | 2 |
| 2 | 3 | 1 | 2 | - | - | - | - | - | - | - | 1 | - | 2 |
| 3 | 3 | 1 | 2 | - | - | - | - | - | - | - | 1 | - | 2 |
| 4 | 3 | 1 | 2 | - | - | - | - | - | - | - | 1 | - | 2 |
| 5 | 3 | 1 | 2 | - | - | - | - | - | - | - | 1 | - | 2 |

**UNIT I** **9 Hours**

**FUNDAMENTALS OF DATA COMMUNICATION AND NETWORKS**

Data communications - Protocols and Standards-Network devices and Topology- Open System Interconnection model of ISO- Data link control protocol- Media Access protocol-TCP/IP-PI Interface systems.

**UNIT II** **9 Hours**

**INDUSTRIAL NETWORKS**

Industrial Ethernet - DeviceNet: Architecture-Physical layer- Data link layer- Actuator Sensor (AS) interface - CAN bus: Architecture-Data handling-message frame.

**UNIT III** **9 Hours**

**HART AND FIELD BUS**

HART communication protocol - HART networks - HART commands - HART multidrop mode- HART applications - Fieldbus - Introduction - General Fieldbus architecture - Basic requirements of Fieldbus standard - Fieldbus topology - Interoperability - Interchangeability

**UNIT IV** **9 Hours**

**MODBUS AND PROFIBUS**

MODBUS protocol structure - function codes- troubleshooting Profibus, Introduction, Profibus protocol stack, Profibus communication model - communication objects - system operation - troubleshooting - Data Highway.

**UNIT V** **9 Hours**

**NETWORK SECURITY AND CRYPTOGRAPHY**

Network security: Security services, Cryptography: Symmetric key cryptography, Security in the Internet: IP Security & Firewalls.

**Tutorial: 15 Hours**
**Total: 60 Hours**

**Reference(s)**

1. Steve Mackay, Edwin Wrijut, Deon Reynders, John Park, Practical Industrial Data Networks Design, Installation and Troubleshooting Newnes Publication, Elsevier First Edition, 2004.
2. William Buchanan, Computer Buses, CRC Press, 2000.
3. Behrouz Forouzan, Data Communications & Networking ,3RD edition, Tata McGraw Hill, 2006.
4. W.Stallings, Data & Computer Communications, PHI, 9th Edition, 2011.
5. W.Stallings, Cryptography & Network Security, Pearson, 5th Edition, 2011.

## 22EI707 PROJECT WORK I 0 0 4 2

**Course Objectives**

- Work in teams to propose, formulate, and solve a challenging open-ended design problem of significant scope, depth, and breadth.
- Understand and incorporate engineering standards and multiple realistic constraints, within realistic design time, budget, and performance objectives.
- Develop a prototype of the proposed design and demonstrate the prototype in accordance with the specifications.
- Effectively communicate information relating to all aspects of the design process in written, oral, and graphical form.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Formulate a real world problem, identify the requirements, and develop the design solutions.
2. Identify technical ideas, strategies, and methodologies.
3. Utilize the new tools, algorithms, and techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis of the cost-effectiveness.
5. Prepare report and present the oral demonstrations.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| 2 | 2 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| 4 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| 5 | 2 | 2 | - | - | 2 | - | - | 3 | 3 | 3 | 2 | 3 | 3 |

## 22EI801 PROJECT WORK II 0 0 20 10

**Course Objectives**

- Work in teams to propose, formulate, and solve a challenging open-ended design problem of significant scope, depth, and breadth.
- Understand and incorporate engineering standards and multiple realistic constraints, within realistic design time, budget, and performance objectives.
- Develop a prototype of the proposed design and demonstrate the prototype in accordance with the specifications.
- Effectively communicate information relating to all aspects of the design process in written, oral, and graphical form.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Formulate a real-world problem, identify the requirement, and develop the design solutions.
2. Identify technical ideas, strategies, and methodologies.
3. Utilize the new tools, algorithms, and techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost-effectiveness.
5. Prepare report and present the oral demonstrations.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| 2 | 2 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| 4 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| 5 | 2 | 2 | - | - | 2 | - | - | 3 | 3 | 3 | 2 | 3 | 3 |

## 22HS201 COMMUNICATIVE ENGLISH II 1 0 2 2

**Course Objectives**

- Command over the English language for day-to-day transactions.
- Improve listening and reading skills
- Increase ability to comprehend complex content
- Enhance confidence in expressing with clarity and elegance
- Enthusiastic and reflective use of the language through sufficient and focused practice
- Articulate fluently and confidently in challenging situations

**Programme Outcomes (POs)**

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

**Course Outcomes (COs)**

1. Engage with the English language in functional contexts
2. Express in both descriptive and narrative formats
3. Interpolate and make effective use of the English Language in Business contexts
4. Actively read and comprehend authentic text
5. Express opinions and communicate experiences.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | 3 | 3 | 3 | - | - |
| 2 | - | - | - | - | - | - | - | - | 3 | 3 | 3 | - | - |
| 3 | - | - | - | - | - | - | - | - | 3 | 3 | 3 | - | - |
| 4 | - | - | - | - | - | - | - | - | 3 | 3 | 3 | - | - |
| 5 | - | - | - | - | - | - | - | - | 3 | 3 | 3 | - | - |

**UNIT I** **15 Hours**

**SELF-EXPRESSIONRESSION**

Personal Goals and Values - Being a Team Player-Expressing strengths and Weaknesses-Abstract nouns - Adjectives-Active Listening Skills-Note Making-Pronunciation and Accent Personal goals and values - Reading for Gist and Details-Professional Ethics-Reported Speech- Conjunctions Reading skills - phonemics, word/phrase recognition, sight words Personal Goals and Values-Conditional clauses- Hypothetical questions and Answers-Sentence Structure-Simple Present Tense-Perfect tense

**UNIT II** **15 Hours**

**CREATIVE EXPRESSION**

Instructive and Expository Expression - Creating brochures, catalogues, and manuals for products/ services, Giving directions, Process writing, Sequencing experiments, Concept Explanation-Reported Speech-Voice Sentence Equivalence-Proofreading

**UNIT III** **15 Hours**

**FORMAL EXPRESSION**

Notices and Announcements-Writing: Creating notices and circulars for events, announcing college tours and lost and Found-Varied Vocabulary - Gender Sensitive Vocabulary, Non-discriminatory Vocabulary, Concise Vocabulary-Paragraph writing - Effective titles, topics and supporting sentences, calling in registrations and queries. Effective communication- Understanding purpose, reach and target audience, achieving complete communication Punctuation - Capitalization, Numeration, Use of proper nouns and Articles-Spelling-Reading: Analyzing and interpreting notices and Circulars-Understanding the gist of short real-world notices, and messages. Culling out keywords Information words vs Supporting words-Interpreting Abbreviations, Acronyms and Short-forms-Listening: Analyzing and interpreting announcements Decoding
- Screening for salient points-Note making-Raising queries for clarification-Speaking: Announcements-Giving complete information-Pronunciation and Enunciation Pace, Intonation, and Pitch-Conducting Events-Speaking: Master of ceremonies, Short speeches - welcome speech, the vote of thanks/ valedictory speech, award-acceptance speech Writing: Invitations, Preparation of script/draft after interviewing someone. Adjectives-Pronunciation/ Punctuation Precision and Concision-Politeness markers

**Total: 45 Hours**

**Reference(s)**

1. Sasikumar, V, et.al. A Course in Listening & Speaking Foundation Books, 2005.
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Prasad, Hari Mohan. A Handbook of Spotting Errors. Mcgraw Hill Education, 2010.
4. Reynolds, John. Cambridge First Language English. 2018th ed., Hodder Education, 2018.
5. Wiggins, Grant P., and Jay McTighe. Understanding by Design. Association for Supervision and Curriculum Development, 2008.

**22HSH01 HINDI** **1 0 2 2**

**Course Objectives**

- To help students acquire the basics of Hindi
- To teach them how to converse in Hindi on simple day- to -day situations
- To help students understand a simple technical text in Hindi

**Programme Outcomes (POs)**

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

**Course Outcomes (COs)**

1. Construct simple sentences and use vocabulary required for day- to -day conversation.
2. Distinguish and understand the basic sounds of Hindi language.
3. Apply appropriate grammar to write and speak in Hindi language
4. Comprehend the conversation and give correct meaning
5. Take up Hindi examinations conducted by Dakshin Bharat Hindi Prachar Sabha

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| 2 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| 3 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| 4 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| 5 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |

**UNIT I** **9 Hours**

**VOWELS AND CONSONANTS**

Hindi Alphabet: Introduction (Self introduction) - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu & Visarg -Table of Alphabet -Vocabulary.

**UNIT II** **9 Hours**

**NOUNS**

Nouns: Genders -Masculine & Feminine -Reading Exercises

**UNIT III** **9 Hours**

**PRONOUNS AND TENSES**

Pronouns and Tenses - Categories of Pronouns - Personal Pronouns - Second person (you & honorific) - Definite & Indefinite pronouns - Relative pronouns - Present tense - Past tense - Future tense - Assertive & Negative Sentences - Interrogative Sentences.

**UNIT IV** **9 Hours**

**CLASSIFIED VOCABULARY**

Classified Vocabulary: Parts of body -Relatives Spices Eatables -Fruit & Vegetables -Clothes -Directions -Seasons Professions.

**UNIT V** **9 Hours**

**CONVERSATIONS**

Speaking -Telling the times -Saying the Numbers from 1 to 50 Speaking practice for various occasions.

**Total: 45 Hours**

**Reference(s)**

1. B.R. Kishore, Self Hindi Teacher for Non-Hindi Speaking People, Vee Kumar Publications (P) Ltd., New Delhi, 2009.
2. Hindi Prachar Vahini - 1
3. Videos, Stories, Rhymes and Songs.

## 22HSG01 GERMAN 1 0 2 2

**Course Objectives**

- To help students appear for the A1 level Examination
- To teach them how to converse fluently in German in day-to-day scenarios

**Programme Outcomes (POs)**

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

**Course Outcomes (COs)**

1. Listen and identify individual sounds of German
2. Use basic phonemes and words while speaking
3. Read and understand short passages on familiar topics
4. Use basic sentence structures while writing
5. Illustrate basic grammar and appropriate vocabulary in completing language tasks

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| 2 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| 3 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| 4 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| 5 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |

**UNIT I** **9 Hours**

**INTRODUCTION**

Introduction to the German language-Alphabets-Numbers Greetings -Days and Seasons-Working with Dictionary.

**UNIT II** **9 Hours**

**LANGUAGE AND ITS COMMON USE**

Nouns -articles-Speaking about oneself-Listening to CD supplied with books-paying special attention to pronunciation

**UNIT III** **9 Hours**

**TECHNICAL DEUTSCHE**

Regular &Irregular verbs -Personal pronouns-family-Introduction to types of sentences

**UNIT IV** **9 Hours**

**INTERROGATION**

Question words -Types of Questions -Nominative case-Verb Conjugation -country -nationalities

**UNIT V** **9 Hours**

**IMPLEMENTATION**

Verbs to be & to have -conjugation -Hobbies -Framing basic Questions and answers

**Total: 45 Hours**

**Reference(s)**

1. Kursbuch and Arbeitsbuch, NETZWERK A1 DEUTSCH ALS FREMDSPRACHE, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2015.
2. Langenscheidt Eurodictionary, German English / English German, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2009.
3. Grundkurs, DEUTSCH Lehrbuch Hueber Munichen, 2007.

## 22HSJ01 JAPANESE 1 0 2 2

**Course Objectives**

- To train students for N5 Level Examination
- To teach them use basic Japanese sentences in day-to-day conversation
- To make students familiar with the Japanese cultural facets and social etiquette

**Programme Outcomes (POs)**

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

**Course Outcomes (COs)**

1. Recognize and write Japanese alphabet
2. Speak using basic sounds of the Japanese language
3. Apply appropriate vocabulary needed for simple conversation in Japanese language
4. Apply appropriate grammar to write and speak in Japanese language
5. Comprehend the conversation and give correct meaning

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| 2 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| 3 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| 4 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| 5 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |

**UNIT I** **9 Hours**

**SELF INTRODUCTION / DEMONSTRATIVES / NOUN MODIFIERS**

Introduction to Japanese Japanese script - Pronunciation of Japanese(Hiragana (Katakana) Long vowels - Pronunciation of in,tsu,ga -Letters combined with ya,yu,yo - Daily Greetings and Expressions -Numerals. Speaking: Self Introduction - Listening: Listening to Greetings, Listening to specific information: Numbers, Time

**UNIT II** **9 Hours**

**TIME EXPRESSION / VERBS - PAST**

Introduction to time -Introduction of verbs -Listening to specific information

**UNIT III** **9 Hours**

**ADJECTIVES**

Word Sentence -Introduction to Adjectives -Technical Japanese Vocabulary -Pair Activity Day to day situational conversation

Listening to Japanese Alphabet Pronunciation -Simple Conversation

**UNIT IV** **9 Hours**

**CONJUGATION OF II ADJECTIVE**

Past tense of Noun sentences and Na adjective sentences -Past tense of ii adjective sentences -houga adjective desu -Technical Japanese Vocabulary -Individual Activity - Listening to conversation with related particles

**UNIT V** **9 Hours**

**CONJUGATION OF VERBS - TE FORM / TA FORM / NAI FORM / PLAIN FORM**

N gahoshidesu - V masu form tai desu - Verb te form - Technical Japanese Vocabulary -Listening to different Counters, simple conversations with verbs and adjectives

**Total: 45 Hours**

**Reference(s)**

1. Minna no Nihongo Japanese for Everyone Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.
2. Minna no Nihongo Japanese for Everyone Elementary Main Textbook 1-2 Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

## 22HSF01 FRENCH 1 0 2 2

**Course Objectives**

- To prepare the students for DELF A1 Examination
- To teach them to converse fluently in French in day-to-day scenarios

**Programme Outcomes (POs)**

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

**Course Outcomes (COs)**

1. Help students acquire familiarity in the French alphabet & basic vocabulary
2. Listen and identify individual sounds of French
3. Use basic sounds and words while speaking
4. Read and infer short passages on familiar topics
5. Interpret and use basic grammar and appropriate vocabulary in completing language tasks

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| 2 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| 3 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| 4 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |
| 5 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - |

**UNIT I** **9 Hours**

**ENTRER EN CONTACT**

La langue franÃƒÂ§aise, alphabets, les numÃƒÂ©ros, les jours, les mois. Grammaire Les verbes s appeler, etre, avoir, les articles definis, indefinis Communication Saluer, s informer sur quelqu un, demander de se presenter Lexique L alphabet, les nationalites, l age, les pays, les couleurs, les jours de la semaine, les mois de l annee, les professions

**UNIT II** **9 Hours**

**PARTAGER SON LIEU DE VIE**

Les francais et leur habitat, des habitations insolites -Grammaire Verbes Conjugaison Present (Avoir / Etre / ER, IR, RE Regulier et Irregulier) Adjectifs les propositions de lieu Communication Chercher un logement, decrire son voisin, s informer sur un logement - Lexique L habitat, les pieces, l equipement, la description physique

**UNIT III** **9 Hours**

**VIVRE AU QUOTIDIEN LES LOISIRS DES FRANCAIS, LES GOUTS DES AUTRES, LES ACTIVITES QUOTIDIENNES**

Grammaire Articles contractes, verbes vouloir, pouvoir, devoir, adjectifs interrogatifs, future proche Communication Exprimer ses gouts, parler de ses loisirs, justifier un choix, exprimer une envie - Lexique le temps libre et les loisirs, les saisons, les activites quotidiennes, le temps (le matin, le soir, la nuit)

**UNIT IV** **9 Hours**

**COMPRENDRE SON ENVIRONNEMENT SOUVRIR A LA CULTURE**

Grammaire Verbes Finir, Sortir, les adjectifs demonstratifs, le passe compose, l imparfait Communication Propose a quelqu un de faire quelque chose, raconter une sortie au passe, parler d un film Lexique Les sorties, la famille, l art, les vetements et les accessoires

**UNIT V** **9 Hours**

**GOUTER A LA CAMPAGNE**

Grammaire La forme negative, les verbes acheter, manger, payer, articles partitifs, le pronom en de quantite Communication Accepter et refuser une invitation, donner des instructions, commander au restaurant Lexique Les services et les commerces, les aliments, les ustensiles, l argent

**Total: 45 Hours**

**Reference(s)**

1. Grammaire Progressive du Francais, CLE International, 2010.
2. Saison1, Marie Noelle Cocton et al, Didier, 2014.
3. Preparation a l examen du DELF A1 Hachette.
4. Reussir le DELF A1 Bruno Girardeau.
5. Website: Francais Linguaphone Linguaphone Institute Ltd., London, 2000.
6. Francais Harrisonburg : The Rosetta Stone : Fairfield Language Technologies, 2001.

**22EI001 / 22EIH01 / 22EIM01 SMART SENSORS 3 0 0 3**

**Course Objectives**

- To impart knowledge about various sensors in multidisciplinary engineering domain
- To familiarize students with different applications and its material handling technology
- To understand the concept of sensing circuits and its static and dynamic characteristics

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Analyze the characteristics of smart sensors and process of micromachining in development of smart sensors.
2. Analyze the use of smart sensors in communication, MEMS and automation.
3. Develop intelligent systems by interfacing the smart sensors to MCUs and DSPs.
4. Apply the suitable smart sensors in different fields and the appropriate applications.
5. Design the simple models of intelligent instrumentation.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 2 | - | - | - | - | - | - | - | 2 | 3 | - |
| 2 | 2 | 3 | 2 | - | - | 2 | - | - | - | - | 2 | 2 | 3 |
| 3 | 3 | 2 | 3 | - | - | - | - | 2 | 2 | - | 3 | 3 | 3 |
| 4 | 2 | 2 | 2 | - | - | 3 | - | - | - | - | 2 | 3 | 3 |
| 5 | 2 | 2 | 3 | - | - | 2 | - | 2 | 2 | - | 3 | 3 | 3 |

**UNIT I** **8 Hours**

**MCUS AND DSPS FOR SENSOR**

Introduction, MCU control, MCUs for sensor interface, DSP control, Software, tools and support, sensor integration.

**UNIT II** **8 Hours**

**SENSOR COMMUNICATION AND MEMS**

Wireless zone sensing, surface acoustical wave devices, intelligent transportation system, RF-ID, Micro optics, micro-grippers, micro-probes, micro- mirrors, FEDs, communications for smart sensors – sources and standards, automotive protocols, industrial networks, office and building automation, home automation, protocols in silicon, other aspects of network communications.

**UNIT III** **9 Hours**

**IMPLICATIONS OF SMART SENSOR STANDARDS AND RECENT TRENDS**

Introduction, sensor plug-and-play, communicating sensor data via existing wiring, automated/remote sensing and web, process control over the internet, alternative standards, HVAC sensor chip, MCU with integrated pressure sensors, alternative views of smart sensing, smart loop.

**UNIT IV** **10 Hours**

**PRESENCE ABSENCE DETECTION AND IDENTIFICATION**

Motion control sensors – Encoders Rotary/Absolute/Programmable-1D/2D Barcodes, RFID Tags Identification- Area Guarding using DeTec4 Safety Light Curtains- Safety Functionality using smart sensor.

**UNIT V** **10 Hours**

**VISION AND DUST MEASUREMENT**

2D Vision Smart Camera sensor - OCR Reading and Quality Inspection- 3D Vision camera sensor – Long Distance Measurement Sensor- LiDAR Scanner- Dust Measurement Device for Continuous Emission Measurement.

**Total: 45 Hours**

**Reference(s)**

1. Edward Sazonov, Michael R. Newman, Wearable Sensors: Fundamentals, Implementation and Applications, 2014, 1st Edition, Academic Press, Cambridge.
2. Kate Hartman, Make: Wearable Electronics: Design, prototype, and wear your own interactive garments, 2014, 1st Edition, Marker Media, Netherlands.
3. Guozhen Shen, Zhiyong Fan, Flexible Electronics: From Materials to Devices, 2015, 1st Edition, World Scientific Publishing Co, Singapore.
4. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer, 2016.

**22EI002 / 22EIH02 / 22EIM02 IoT PROTOCOLS AND INDUSTRIAL SENSORS** **3 0 0 3**

**Course Objectives**

- Understand the basic principles, architectures, physical and logical designs of IoT.
- Explain the IoT communication principles and their protocols.
- Explain the transport and application layer principles and their protocols.
- Understand the working principles of motion, proximity and ranging sensors.
- Explain the principles of force, magnetic and heading sensors and its case studies with real time applications.

**Programme Outcomes (POs)**

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Apply the concepts of IoT Architecture, physical design, logical design and their technologies.
2. Analyze the working principles & concepts of IoT Communication Protocols.
3. Analyze the working principles & concepts of Transport and Application layer Protocols.
4. Apply the various sensors in the Automotive and Mechatronics applications.
5. Analyze the working principles and characteristics of force, magnetic and heading sensors.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 1 |
| 2 | 1 | 2 | 3 | 2 | - | - | - | - | - | - | - | - | 1 |
| 3 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 2 |
| 4 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 2 |
| 5 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 2 |

**UNIT I** **9 Hours**

**INTRODUCTION TO IoT**

Architectural Overview- IoT applications- Sensing - Actuations -Basics of Networking - M2M and IoT Technology fundamentals - Devices and gateways - Design of Internet of Things: Physical Design of IoT, Logical Design of IoT - IoT Enabling Technologies.

**UNIT II** **9 Hours**

**IoT COMMUNICATION PROTOCOLS**

IoT Data Link Layer & Network Layer Protocols, PHY/MAC Layer -3GPP MTC, IEEE 802.11, IEEE 802.15 - Wireless HART, ZWave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN.

**UNIT III** **9 Hours**

**TRANSPORT**

Transport Layer Protocols-Application Protocols for IoT: UPnP, CoAP, MQTT, XMPP, SCADA, Authentication Protocols; IEEE 802.15.4, REST and Websocket.

**UNIT IV** **9 Hours**

**MOTION, PROXIMITY AND RANGING SENSORS**

Motion Sensors - Potentiometers, Resolver, Encoders - Optical, Magnetic, Inductive, Capacitive, LVDT, RVDT - Synchro, Microsyn, Accelerometer, GPS, Bluetooth, Range Sensors - RF beacons, Ultrasonic Ranging, Reflective beacons.

**UNIT V** **9 Hours**

**CASE STUDIES/INDUSTRIAL APPLICATIONS**

IoT applications in home appliances, infrastructures, buildings, security, Industries 4.0

**Total: 45 Hours**

**Reference(s)**

1. Vijay Madisetti, Arshdeep Bahga, Internet of Things, A Hands on Approach, University Press.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.
3. Peter Waher, Learning Internet of Things, Packt Publishing, UK, 2015.
4. Adrian McEwen, Hakim Classically, Designing the Internet of Things, Wiley Publishing, 2015.
5. Dieter Uckelmann, Mark Harrison and Florian Michahelles, Architecting the Internet of Things, Springer, New York, 2011.

**22EI003 / 22EIH03 / 22EIM03 IoT PROCESSORS 3 0 0 3**

**Course Objectives**

- To learn embedded system architecture with its application software.
- To understand ARM and cortex-m3 Architecture.
- To learn about various Cortex exception handling and interrupts.
- To build simple cortex-m3/m4 programming.
- To understand cortex-m3/m4 development and debugging tools.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Analyze the embedded system architecture with its application software.
2. Analyze ARM and cortex-M3 architecture and bus.
3. Analysis cortex exception handling and interrupts.
4. Apply concept of Cortex-M3/M4 Programming for a simple application.
5. Analyze Cortex-M3/M4 Development and Debugging Tools.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 2 | - | - | - | - | - | - | - | - | 1 | - |
| 2 | 2 | 3 | 2 | - | 2 | - | - | - | - | - | - | 2 | - |
| 3 | 2 | 3 | 2 | - | 2 | - | - | - | - | - | - | 2 | - |
| 4 | 2 | 2 | 2 | - | 2 | - | - | - | - | - | - | 1 | - |
| 5 | 2 | 1 | - | 3 | - | - | - | - | - | - | - | 1 | - |

**UNIT I** **9 Hours**

**INTRODUCTION TO EMBEDDED CONCEPTS**

Introduction to embedded systems, Application Areas, Categories of embedded systems, Overview of embedded system architecture, Specialties of embedded systems, recent trends in embedded systems, Hardware architecture, Software architecture.

**UNIT II** **9 Hours**

**OVERVIEW OF ARM AND CORTEX M3**

Background of ARM Architecture, Processor Naming, Instruction Set Development,Thumb-2 and Instruction Set Architecture.Cortex-M3 Instruction Sets.Cortex-M3 Implementation Overview:Pipeline, Block Diagram, Bus. Interfaces on Cortex-M3, I-Code Bus, D Code Bus, System Bus.

**UNIT III** **9 Hours**

**CORTEX EXCEPTION HANDLING AND INTERRUPTS**

Exceptions: Exception Types, Priority, Vector Tables, Interrupt Inputs and Pending Behavior, Fault Exceptions, NVIC: Nested Vectored Interrupt Controller Overview, Basic Interrupt Configuration, Software Interrupts, Interrupt/Exception Sequences.

**UNIT IV** **9 Hours**

**CORTEXM3/M4 PROGRAMMING**

Cortex M3/M4 Programming: Overview, Typical Development Flow, Using C, CMSIS (Cortex Microcontroller Software Interface Standard). Exception Programming: Using Interrupts,Exception/Interrupt Handlers. Memory Protection Unit, MPU Registers, Setting Up the MPU.

**UNIT V** **9 Hours**

**CORTEXM3/M4 DEVELOPMENT AND DEBUGGING TOOLS**

STM32L15xxx ARM Cortex M3/M4 Microcontroller: Memory and Bus Architecture, Power Control.STM32L15xxx, Peripherals: GPIOs, System Configuration Controller, Comparators, USART. Development and Debugging Tools: Software and Hardware tools like Cross Assembler, Compiler, Debugger.

**Total: 45 Hours**

**Reference(s)**

1. Joseph Yiu,The Definitive Guide to the ARM Cortex-M3,Second Edition,Elsevier Inc, 2010.
2. Andrew N Sloss,Dominic Symes,Chris Wright,ARM System Developers Guide Designing and Optimizing System Software,Elsevier Publications, 2006.
3. Steve Furber,ARM System-on-Chip Architecture,2nd Edition, Pearson Education,India ISBN:9788131708408,8131708403, 2015.
4. Dr.K.V.K.Prasad,Embedded/Real Time Systems:Concepts,Design and Programming Black Book,New edition (MISL-DT) Paperback 12 Nov 2003.
5. David Seal ARM Architecture Reference Manual Addison Wesley England Morgan Kaufmann Publishers, 2001.

**22EI004 / 22EIH04 / 22EIM04 IoT SYSTEM DESIGN 3 0 0 3**

**Course Objectives**

- To learn how to design and implement IoT applications that manage big data, streaming data, and/or distributed data.
- To understand Smart Objects and IoT Architectures.
- To learn about various IoT-related protocols.
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT.
- To develop IoT infrastructure for popular applications.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1.Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Analyze the fundamentals of IoT and its architecture.
2. Analyze various protocols for IoT.
3. Design a PoC of an IoT system using Rasperry Pi/Arduino.
4. Apply data analytics and use cloud offerings related to IoT.
5. Analyze applications of IoT in real time scenario.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 2 | - | - | - | - | - | - | - | - | 1 | - |
| 2 | 2 | 3 | 2 | - | 2 | - | - | - | - | - | - | 2 | - |
| 3 | 2 | 3 | 2 | - | 2 | - | - | - | - | - | - | 3 | 2 |
| 4 | 2 | 2 | 2 | - | 2 | - | - | - | - | - | - | 3 | 2 |
| 5 | 2 | 1 | - | 3 | - | - | - | - | - | - | - | 3 | 2 |

**UNIT I** **9 Hours**

**FUNDAMENTALS OF IoT**

Evolution of Internet of Things, Enabling Technologies, IoT Architectures: Simplified IoT Architecture and Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Sensors, Actuators, Smart Objects and Connecting Smart Objects.

**UNIT II** **9 Hours**

**IoT PROTOCOLS**

IoT Access Technologies: IEEE 802.15.4, 802.15.4e, Zigbee protocol, IP versions, CoAP and MQTT. Modern databases: No SQL, New SQL, MongoDb.

**UNIT III** **9 Hours**

**DESIGN AND DEVELOPMENT**

Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks, Arduino Board details, IDE programming, Raspberry Pi and Interfaces.

**UNIT IV** **9 Hours**

**DATA ANALYTICS AND SUPPORTING SERVICES**

Role of Machine Learning: Hadoop Ecosystem, Edge Streaming Analytics and Network Analytics, Google Spreadsheet for IoT & Analytics, ThingSpeak and Firebase, Cloud for IoT, Python Web Application Framework.

**UNIT V** **9 Hours**

**CASE STUDIES/INDUSTRIAL APPLICATIONS**

Cisco IoT system, IBM Watson IoT platform, Power Utility in Industry, Smart and Connected Cities: Smart Lighting, Smart Parking Architecture and Smart Traffic Control.

**Total: 45 Hours**

**Reference(s)**

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals:Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.
2. Arshdeep Bahga, Vijay Madisetti, Internet of Things - A hands-on approach, Universities Press, 2015
3. Olivier Hersent, David Boswarthick, Omar Elloumi , The Internet of Things Key applications and Protocols, Wiley, 2012.
4. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand, DavidBoyle, From Machine-to-Machine to the Internet of Things Introduction to a New Age of Intelligence, Elsevier, 2014.
5. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), Architecting the Internet of Things, Springer, 2011.
6. Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O Reilly Media, 2011.

## 22EI005 / 22EIH05 / 22EIM05 WIRELESS SENSOR NETWORK DESIGN

**3 0 0 3**

**Course Objectives**

- To understand the fundamentals of wireless sensor networks and its application to critical real time scenarios.
- To familiarize with learning of the Architecture of WSN.
- To understand the concepts of Networking and Networking in WSN.
- To study the design consideration of topology control and solution to the various problems.
- To introduce the hardware and software platforms and tool in WSN.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Micro controller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Analyze basics and technologies for wireless networks.
2. Analyze and compare various architectures of Wireless Sensor Networks.
3. Analyze design issues and challenges in wireless sensor networks.
4. Develop the infrastructure and its simulations.
5. Demonstrate the concept of programming in the WSN environment.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 2 | - | - | - | - | - | - | - | 2 | 1 | - |
| 2 | 2 | 3 | 2 | - | - | 2 | - | - | - | - | 2 | 2 | - |
| 3 | 2 | 3 | 2 | - | - | 2 | - | - | - | - | 2 | 2 | - |
| 4 | 2 | 2 | 2 | - | - | 2 | - | 2 | - | - | 2 | 2 | 3 |
| 5 | 2 | 1 | 2 | - | - | 2 | - | - | 2 | - | 2 | 2 | 3 |

**UNIT I** **10 Hours**

**OVERVIEW OF WIRELESS SENSOR NETWORKS**

Introduction: Fundamentals of wireless communication technology, SingleNode Architecture, Network Characteristics, characteristics of wireless channels, modulation techniques, Types of wireless sensor networks.

**UNIT II** **10 Hours**

**ARCHITECTURES**

Network Architecture, Sensor Networks Scenarios, Design Principle, Physical Layer and Transceiver Design Considerations, Optimization Goals and Figures of Merit, Gateway Concepts, Operating Systems and Execution Environments, Internet to WSN Communication.

**UNIT III** **9 Hours**

**NETWORKING SENSORS**

Routing protocols, MAC Protocols for Wireless Sensor Network, Low Duty Cycle Protocols and Wakeup Concept, SMAC IEEE 802.15.4 standar, Wakeup Radio Concepts, Address and Name Management Assignment of MAC Addresses, Routing Protocols Energy Efficient Routing, Geographic Routing.

**UNIT IV** **8 Hours**

**INFRASTRUCTURE ESTABLISHMENT**

Topology Control, Clustering Time Synchronization Localization and Positioning Sensor Tasking and Control Real-time traffic support and security protocols.

**UNIT V** **8 Hours**

**SENSOR NETWORK PLATFORMS AND TOOLS**

Sensor Node Hardware Berkeley Motes Programming Challenges, Nodelevel software platforms Node level Simulators, StateÃ, Âcentric programming.

**Total: 45 Hours**

**Reference(s)**

1. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2005.
2. Feng Zhao and Leonidas J.Guibas, Wireless Sensor Networks An Information Processing Approach, Elsevier, 2007.
3. Waltenegus Dargie , Christian Poellabauer, Fundamentals of Wireless Sensor Networks Theory and Practice, John Wiley and Sons Publications, 2011.
4. K. Akkaya and M. Younis, A survey of routing protocols in wireless sensor networks, Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325-349.
5. Philip Levis, TinyOS Programming.
6. Anna Hac, Wireless Sensor Network Designs, John Wiley & Sons Ltd.

**22EI006 / 22EIH06 / 22EIM06 INDUSTRIAL IoT AND INDUSTRY 4.0** **3 0 0 3**

**Course Objectives**

- To provide the overview about evolution and importance of Industrial IoT in the era of Industry 4.0.
- To introduce the Industrial IoT reference architectures and Business models in industrial automation systems.
- To understand the on-site key technologies for the requirement of a smart factory.
- To get the knowledge of Industrial IoT data Analytics.
- To apply the technologies of Industrial IoT in various Industries as case studies.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Micro controller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Analyze about the evolution of Industry 4.0 in smart factories and cyber physical systems.
2. Find the process of industrial automation system network and control.
3. Demonstrate the reference architectural models and business models with key enabling technologies.
4. Analyze the data of the industrial IoT systems with security.
5. Apply the technologies to various sectors and case study the application of Industrial IoT in smart industries.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | - | - | - | - | - | 2 | - | - | - | - | - | 1 |
| 2 | 2 | 1 | 3 | - | - | - | - | - | - | - | - | - | 1 |
| 3 | 2 | 1 | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 4 | 1 | 2 | - | 3 | 2 | - | - | - | - | - | - | - | - |
| 5 | 1 | - | - | - | - | 2 | 2 | - | - | - | - | - | 2 |

**UNIT I** **9 Hours**

**INTRODUCTION AND KEY TECHNOLOGIES**

Industrial revolutions. Cyber physical systems and Next generation sensors. On-site key technologies in Industry 4.0, AR-VR, Big data Analytics, Smart factories and Lean Manufacturing system.

**UNIT II** **9 Hours**

**INDUSTRIAL AUTOMATION AND IoT**

Evolution of IT and OT convergence. Industrial sensing, Industrial Processes and Industrial Network. Business models and IIRA Reference architecture of IIoT, Industrial internet Consortium (IIC).

**UNIT III** **9 Hours**

**INDUSTRIAL DATA TRANSMISSION AND COMPUTING**

Foundation Fieldbus, Profibus, CC-link, MODBUS, DigitalSTROM, CAN, DeviceNet, ISA 100.11a, Wireless HART, NB-IoT. Edge and Fog Computing solutions. Cloud services.

**UNIT IV** **9 Hours**

**DATA ANALYTICS AND SECURITY**

Necessity of Analytics and IIoT Data Analytics. Machine Learning and Data Science applications in Industries. Artificial Intelligence for IIoT, IoT Security- Vulnerabilities, Threat Analysis, Security model for IoT.

**UNIT V** **9 Hours**

**APPLICATIONS OF IIoT**

Healthcare Applications, Inventory Management and Quality Control. Case studies in Manufacturing Industry, Automotive Industry, Mining Industry, Textile Industry.

**Total: 45 Hours**

**Reference(s)**


1. Industry 4.0: The Industrial Internet of Things, by Alasdair Gilchrist (Apress), 2017.
2. Industrial Internet of Things: Cybermanufacturing Systems, by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), 2017.
3. Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018.
4. Misra, Sudip, Chandana Roy, and Anandarup Mukherjee. Introduction to industrial Internet of Things and industry 4.0. CRC Press, 2021.
5. Ortiz, JesÃƒÂºs Hamilton. "Industry 4.0: Current status and future trends", 2020.
6. Ustundag, Alp, and Emre Cevikcan. Industry 4.0: managing the digital transformation. Springer, 2017.

**22EI007 / 22EIH07 / 22EIM07 DATA ANALYTICS FOR IoT** **3 0 0 3**

**Course Objectives**

- To understand the basics of nature of data.
- To understand basic operation in data analysis using python.
- To understand data manipulation using pandas library.
- Data visualization using different types of charts.
- To understand basic python program for IoT application.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

**Course Outcomes (COs)**

1. Analyze the nature of the data processing quantitatively and qualitatively using python.
2. Analyze the various data operations performed using NumPy library.
3. Analyze the data manipulation process using pandas library in python.
4. Apply data visualization techniques to interpret the data with various parameters.
5. Construct IoT projects using python and Raspberry Pi.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 2 | – | – | – | – | – | – | – | 2 | 2 | – |
| 2 | 2 | 3 | 2 | – | 2 | 2 | – | – | – | – | 2 | 2 | 2 |
| 3 | 2 | 3 | 2 | – | 2 | 2 | – | – | – | – | 2 | 2 | 2 |
| 4 | 2 | 2 | 2 | – | 2 | 2 | – | 2 | 2 | – | 3 | 3 | – |
| 5 | 2 | 1 | 2 | – | 2 | 2 | – | 2 | 2 | – | 2 | 3 | 3 |

**UNIT I** **9 Hours**

**INTRODUCTION TO DATA ANALYSIS AND PYTHON**

Data Analysis, Knowledge Domains of the Data Analyst, Understanding the Nature of the Data, The Data Analysis Process, Quantitative and Qualitative, Data Analysis Python and Data Analysis, Installing Python, and writing Python Code, IPython, The IDEs for Python SciPy.

**UNIT II** **9 Hours**

**BASIC OPERATIONS USING PYTHON**

The NumPy Library, The NumPy Installation, Basic Operations Indexing, Slicing, and Iterating Conditions and Boolean Arrays, Shape Manipulation, Array Manipulation, General Concepts, Structured Arrays, Reading and Writing Array Data on Files

**UNIT III** **9 Hours**

**DATA ANALYSIS**

The Python Data Analysis, Library Pandas, Introduction to pandas, Data Structures, operations between data structures, Function application and mapping, Sorting and Ranking, Not a Number data, Reading and Writing data, Reading data in CSV or Text files, Excel files

**UNIT IV** **9 Hours**

**DATA MANUPULATION**

Data Manipulation, Data Preparation, loading, assembling, merging, Concatenating, combining, reshaping, removing, Data Transformation, removing duplicates, mapping, Detecting and filtering outliers, random sampling, String Manipulation, Data Aggregation, Group Iteration, Chain of Transformation, functions on groups

**UNIT V** **9 Hours**

**DATA VISUALIZATION**

Matplotlib Installation, pyplot, using the Kwargs, Adding further elements to the chart, Handling Date Values, Line chart, Histogram, Bar Chart, Pie Charts, Advanced charts mplot3d, Multi panel plots, Case study, Meteorological data, Recognizing Handwritten Digits

**Total: 45 Hours**

**Reference(s)**


1. Fabio Nelli, Python Data Analytics, APRESS, 2015.
2. Gary Smart, Practical Python Programming for IoT, PACKT Publishing, Birmingham, UK, 2020.
3. Samir Madhavan, Mastering Python for Data Science, PACKT Publishing, Birmingham, UK, 2015.
4. Peters Morgan,Data Analysis from Scratch with Python, AI Sciences, 2016.
5. Agus kurniawan,Micropython for ESP8266 Development workshop, PE PRESS, 2016.
6. Charles Bell, MicroPython for the internet of Things, Apress, 2017.

## 22EI008 ROBOTICS AND AUTOMATION 3 0 0 3

**Course Objectives**

- To understand the basic concepts associated with the design, functioning and applications of robots.
- To differentiate the robotic sensors, actuators and end-effectors.
- To formulate the control algorithms and path planning algorithms for the robots.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Outline the evolution of robotics.
2. Analyze the basic concepts associated with the design, functioning and applications of robots.
3. Apply the kinematics of a robotic manipulator.
4. Design the control algorithms and path planning algorithms for the robots.
5. Select the suitable sensor, actuator and gripper for the robot.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | - | 2 | 1 | - | - | - | - | - | - | - | - | 2 |
| 2 | 3 | - | 2 | 1 | - | - | - | - | - | - | - | - | 2 |
| 3 | 3 | - | 2 | 2 | - | - | - | - | - | - | - | - | 2 |
| 4 | 3 | - | 2 | 3 | - | - | - | - | - | - | - | - | 2 |
| 5 | 3 | - | 2 | 1 | - | - | - | - | - | - | - | 2 | 3 |

**UNIT I** **8 Hours**

**FUNDAMENTALS OF ROBOTICS**

Automation and robots - a brief history of robotics - definition and laws of robotics - anatomy of robot - robot classifications - robot specifications - robot configurations - robot links - robot joints - performance parameter - applications of robots.

**UNIT II** **11 Hours**

**ROBOT KINEMATICS**

Robot architecture - pose of a rigid body - coordinate transformation - homogenous coordinates - Denavit and Hartenborg (DH) parameters - forward position analysis - inverse position analysis - velocity analysis:

The Jacobian matrix, link velocities, singularity - acceleration analysis. Mobile robots dynamics (Newtonian dynamics).

**UNIT III** **8 Hours**

**ROBOT POWER SOURCES AND END EFFECTOR**

Power Sources: Hydraulic, pneumatic and electric drives - mechanical transmission-gear transmission, belt drives, cables, roller chains, rotary to linear motion conversion, rotary to rotary motion conversion. End Effector: Types of end effector - mechanical grippers - vacuum cups - magnetic grippers - adhesive grippers - hooks, scoops, miscellaneous devices - tools as end effector - the robot end effector interface - selection and design of the gripper.

**UNIT IV** **8 Hours**

**ROBOTIC SENSORS AND VISION**

Sensors in robotics - classification - tactile, proximity and range sensors - sensors based systems; Introduction to machine vision - the sensing and digitizing function in machine vision - image processing and analysis - training the vision system - robot programming and languages

**UNIT V** **10 Hours**

**PATH PLANNING, CONTROL OF ROBOTIC MANIPULATORS AND APPLICATIONS**

Considerations on trajectory planning - joint interrelated trajectories - cartesian path trajectories - control of robot - PID control - computed torque technique - Multiple robots - Machine interface Robots in manufacturing and non-manufacturing application - Robot cell design - selection of a robot.

**Total: 45 Hours**

**Reference(s)**

1. Robert J. Schilling, Fundamentals of Robotics: Analysis & Control, Prentice Hall of India Private Limited, New Delhi, 2010.
2. Mikell P.Groover, Mitchell Weiss, Roger N.Nagel, Nicholas G. Odrey, Industrial Robotics, Tata McGraw-Hill Education, 2012.
3. S K Saha, Introduction to Robotics, Tata McGraw-Hill Education, 2013.
4. K S Fu,Ralph Gonzalez,C S G Lee, Robotics: Control, Sensing, Vision, and Intelligence, Tata McGraw-Hill Education, 2010.
5. Klafter R.D., Chimielewski T.A., Negin M., Robotic Engineering - An integrated approach, Prentice Hall of India, New Delhi, 2012.
6. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, Springer-Verlog Berlin Heidelberg, 2008.

## 22EI009 BUILDING AUTOMATION 3 0 0 3

**Course Objectives**

- To understand the principles and application of Building Automation system and building process control.
- To study the dynamic performance of fire alarm system and various access control systems.
- To get knowledge in security systems of different applications.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Develop HVAC system architecture for building automation with human comfort.
2. Demonstrate and analyze the process model for heating, cooling and ventilation applications.
3. Design and develop different architecture of fire alarm system using field and panel components.
4. Select the appropriate CCTV access control system design for different applications in security system aspects.
5. Apply perimeter intrusion technology for advanced security system design applications.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | - | 3 | - | - | 1 | - | - | - | - | 1 | 1 | 1 |
| 2 | 2 | - | 2 | - | - | 1 | - | - | - | - | 1 | 2 | 1 |
| 3 | 1 | - | 2 | - | - | 1 | - | - | - | - | 1 | 1 | 1 |
| 4 | 2 | - | 2 | - | - | 1 | - | - | - | - | 1 | 2 | 1 |
| 5 | 3 | - | 2 | - | - | 1 | - | - | - | - | 1 | 2 | 1 |

**UNIT I** **9 Hours**

**INTRODUCTION TO BUILDING AUTOMATION SYSTEM**

Fundamentals: Introduction to HVAC - Basic Processes (Heating, Cooling) - Air Properties - Psychometric Chart - Heat Transfer mechanisms - Human Comfort: Human comfort zones - Effect of Heat, Humidity - Heat loss

**UNIT II** **9 Hours**

**PROCESSES**

Heating Process & Applications: Boiler, Heater - Cooling Process and Applications: Chillers - Ventilation Process and Applications - Central Fan System - AHU - Exhaust Fans - Unitary Systems - VAV, FCU - Energy Saving concept & methods - Lighting control - Building efficiency improvement - Green Building - Leadership in Energy and Environmental Design (LEED) Certification concept and examples

**UNIT III** **10 Hours**

**FIRE ALARM SYSTEM (FAS)**

Introduction to fire alarm system - Fire modes, Principles of operation, FAS Components: Field Components, Panel Components and Applications. Power Supply design for FAS. Cause & effect matrix: Examples. Fire Standards: NFPA 72A, BS 5839, Indian Standards

**UNIT IV** **9 Hours**

**SECURITY SYSTEMS**

Introduction to Security Systems, Concepts of Access Control System: Access Components, Access control system Design. CCTV: Camera: Operation & types, Camera Selection Criteria, NVR / SAN / Unified storage based design, DVM, Network design, Storage design and CCTV Applications

**UNIT V** **8 Hours**

**PERIMETER INTRUSION SYSTEM**

Concept, Components, Technology and Advanced Applications Security Design: Security system design for verticals

**Total: 45 Hours**

**Reference(s)**

1. Reinhold A. Carlson, Robert A. Di Giandomenico, Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life Safety, Security, Access Control, Lighting, Building Management Programs), R.S. Means Company, Inc 2012.
2. William B. Riddens, Understanding Automotive Electronics, Sixth Edition, Butterworth Heinemann Woburn, 2010.
3. Michael F. Hordeski, HVAC Control in the New Millennium, First edition, Fairmont Press, 2011.
4. NJATC Building Automation Control Devices and applications, First edition, Amer Technical Pub, 2012.

## 22EI010 INTELLIGENT AUTOMATION 3 0 0 3

**Course Objectives**

- To understand the basic concepts associated with Robotic Process Automation.
- To develop practical skills in using RPA tools and platforms to automate repetitive tasks, streamline business processes, and improve operational efficiency.
- To develop skills in implementing intelligent automation solutions by leveraging AI technologies such as natural language processing, computer vision, and predictive analytics.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Outline the basic concepts of Intelligent Automation, applications and implementation procedures.
2. Implement intelligent automation solutions by leveraging AI technologies such as natural language processing, computer vision, and predictive analytics.
3. Design and deploy intelligent automation systems.
4. Outline the advanced topics in intelligent automation, such as cognitive automation, robotic process automation (RPA), and adaptive automation.
5. Apply theoretical knowledge and practical skills to develop innovative solutions that maximize operational efficiency.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | 2 | 1 | - | - | - | - | - | - | - | - | 2 |
| 2 | 3 | 1 | 2 | 1 | - | - | - | - | - | - | - | - | 2 |
| 3 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | - | - | 2 |
| 4 | 3 | 1 | 2 | 3 | - | - | - | - | - | - | - | - | 2 |
| 5 | 3 | 1 | 2 | 1 | - | - | - | - | - | - | - | - | 2 |

**UNIT I** **8 Hours**

**INTRODUCTION TO INTELLIGENT AUTOMATION**

Introduction to Intelligent Automation(IA) - Differentiating IA from AI - IA technologies - implementation of IA - IA use cases.

**UNIT II** **9 Hours**

**AI TECHNOLOGIES FOR INTELLIGENT AUTOMATION**

Introduction to AI technologies used in IA such as natural language processing, computer vision, predictive analytics. AI implementation in robotics.

**UNIT III** **10 Hours**

**INTELLIGENT PROCESS AUTOMATION**

Introduction to IPA-Differences between IPA and RPA-Benefits of IPA-Role of Intelligent Process Automation in Automation-Server based robots-Intelligent workflow solutions that aid in management, integration and handoff processes-cognitive agents-optical character recognition-chatbots.

**UNIT IV** **10 Hours**

**COGNITIVE AUTOMATION AND DECISION MAKING**

Fundamentals and principles - interdisciplinary nature of cognitive science - representations for information and knowledge - principal technology enablers for cognitive computing - cognitive computing architectures, approaches, applications. Cognitive computing and neural networks - adaptive automation.

**UNIT V** **8 Hours**

**APPLICATIONS**

Case studies and real-world examples of successful intelligent automation implementations

**Total: 45 Hours**

**Reference(s)**

1. Bornet, Pascal & Barkin, Ian & Wirtz, Jochen, Intelligent Automation - Learn How to Harness Artificial Intelligence to Boost Business & Make Our World More Human, 2020.
2. Russell, S., Norvig, P. Artificial Intelligence: A Modern Approach. Prentice Hall, 2010.
3. Vijay Raghavan, Venkat Gudivada, Venu Govindaraju, C.R. Rao, Cognitive Computing: Theory and Applications, 2016.
4. Alok Mani Tripathi, Learning Robotic Process Automation, Packt Publishing, 2018.
5. Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant, Independently Published, 1st Edition, 2018.

## 22EI011 SMART MANUFACTURING 3 0 0 3

**Course Objectives**

- To develop a comprehensive understanding of smart manufacturing concepts, technologies, and their impact on the industry.
- To implement and manage smart manufacturing systems, including IoT connectivity, data analytics, and advanced manufacturing technologies.
- To apply theoretical knowledge and practical skills to optimize production processes, enhance quality control, and drive efficiency and productivity in smart manufacturing environments.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Demonstrate smart manufacturing principles, technologies, and their application in real-world scenarios.
2. Implement connectivity solutions and leverage the Internet of Things (IoT) to enable seamless communication and collaboration among machines, systems, and stakeholders.
3. Apply data analytics and artificial intelligence techniques to optimize manufacturing processes, improve product quality, and enable predictive maintenance.
4. Evaluate and select appropriate advanced manufacturing technologies, such as additive manufacturing and robotics, to enhance production efficiency and flexibility.
5. Design and execute strategies for the successful implementation and management of smart manufacturing systems.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | 2 | 1 | - | - | - | - | - | - | 1 | - | 2 |
| 2 | 3 | 1 | 2 | 1 | - | - | - | - | - | - | 1 | - | 2 |
| 3 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | 1 | - | 2 |
| 4 | 3 | 1 | 2 | 3 | - | - | - | - | - | - | 1 | - | 2 |
| 5 | 3 | 1 | 2 | 1 | - | - | - | - | - | - | 1 | - | 2 |

**UNIT I** **8 Hours**

**INTRODUCTION**

Smart manufacturing - implementing smart manufacturing across an industry - Industry 4.0 and international perspective - role of hardware and software in smart manufacturing.

**UNIT II** **10 Hours**

**INDUSTRIAL IOT AND CONNECTIVITY IN SMART MANUFACTURING**

Industrial Internet of Things and Cyber Manufacturing Systems(CMS) - Cyber Physical systems(CPS) engineering for manufacturing - Model-Based Engineering of Supervisory Controllers for Cyber- Physical Systems .CPS-Based Manufacturing with Semantic Object Memories and Service Orchestration for Industry4.0 Applications - Integration of a Knowledge Database and Machine Vision within a Robot-Based CPS - Interoperability in Smart Automation of Cyber Physical Systems - Communication and Networking for the Industrial Internet of Things.

**UNIT III** **10 Hours**

**ARTIFICIAL INTELLIGENCE AND DATA ANALYTICS FOR MANUFACTURING**

Application of CPS in machine tools - Manufacturing CPS (IIOT) - CPS intelligence - Big Data and Machine Learning for the Smart Factory - Solutions for Condition Monitoring, Diagnosis and Optimization - Overview of the CPS for Smart Factories Project: Deep Learning, Knowledge Acquisition, Anomaly Detection and Intelligent User Interfaces.

**UNIT IV** **8 Hours**

**ADVANCED MANUFACTURING TECHNOLOGIES IN SMART MANUFACTURING**

Introduction and basic principles - Development of Additive Manufacturing Technology - Generalized Additive Manufacturing Process Chain - Rapid prototyping - Direct Digital Manufacturing - Applications for Additive Manufacture.

**UNIT V** **9 Hours**

**SMART MANUFACTURING TECHNOLOGIES FOR INDUSTRY 4.0**

Organizational Transformation towards Industry 4.0 Technologies-The Autonomy of Autonomous Robots-Smart Technologies for Industry 4.0 and Its Future. Digital Twin-Based Smart Manufacturing-Concept and Applications.

**Total: 45 Hours**

**Reference(s)**


1. Masoud Soroush, McKetta Michael Baldea, Thomas Edgar, Smart Manufacturing: Concepts and Methods, Elsevier, 2020.
2. Sabina Jeschke,Christian Brecher,Tobias Meisen,Denis ozdemir,Tim Eschert,Industrial Internet of Things,Springer, 2017.
3. Ian Gibson, David Rosen, Brent Stucker, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Springer, 2015.
4. Jayakrishna Kandasamy, Kamalakanta Muduli, V. P. Kommula, Purushottam L. Meena, Smart Manufacturing Technologies for Industry 4.0: Integration, Benefits, and Operational Activities, Taylor and Francis, 2023.

## 22EI012 AI AND EXPERT SYSTEM FOR AUTOMATION

**3 0 0 3**

### Course Objectives

- To understand the fundamentals of artificial intelligence (AI) and expert systems in the context of automation.
- To implement and train machine learning models for automation tasks.
- To design and develop rule-based expert systems for automation decision-making.

### Programme Outcomes (POs)

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

### Course Outcomes (COs)

1. Interpret the history, applications, and ethical considerations of AI in automation.
2. Implement and train machine learning models for automation tasks.
3. Interpret the concepts and techniques of expert systems and knowledge representation in automation.
4. Apply natural language processing (NLP) techniques in automation to enable human-computer interaction and language understanding.
5. Investigate real-world applications of AI and expert systems in various industries.

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | - | 2 | 1 | - | - | - | - | - | - | - | - | 2 |
| 2 | 3 | - | 2 | 1 | - | - | - | - | - | - | - | - | 2 |
| 3 | 3 | - | 2 | 2 | - | - | - | - | - | - | - | - | 2 |
| 4 | 3 | - | 2 | 3 | - | - | - | - | - | - | - | - | 2 |
| 5 | 3 | - | 2 | 1 | - | - | - | - | - | - | - | - | 2 |

**UNIT I** **9 Hours**

**INTRODUCTION TO AI AND EXPERT SYSTEMS**

Definition and scope of AI - .History and evolution of AI - AI applications in various industries - Ethical considerations in AI - Problem-solving methods in AI - Search algorithms, including depth-first search, breadth-first search, and A* search - Heuristic search and informed search techniques - Constraint satisfaction problems and algorithms

**UNIT II** **8 Hours**

**EXPERT SYSTEMS AND KNOWLEDGE REPRESENTATION**

Components and architecture of expert systems- Knowledge representation and reasoning techniques - Rule-based systems and inference engines - Integration of expert systems with other AI techniques

**UNIT III** **10 Hours**

**MACHINE LEARNING ALGORITHMS FOR AUTOMATION**

Introduction to machine learning and its relation to expert systems - Supervised, unsupervised, and reinforcement learning algorithms - Training and evaluation of machine learning models - Integration of machine learning with expert systems

**UNIT IV** **10 Hours**

**NATURAL LANGUAGE PROCESSING FOR AUTOMATION**

Introduction to natural language processing (NLP) - NLP techniques for language understanding and generation - NLP applications in expert systems, such as chatbots and language-based decision-making- Sentiment analysis and opinion mining in expert systems.

**UNIT V** **8 Hours**

**APPLICATIONS**

Process automation-Decision support system-predictive maintenance-supply chain optimization-quality control and inspection-Case study: Develop a comprehensive medical knowledge base containing information information on various diseases, symptoms, risk factors and treatments.

**Total: 45 Hours**

**Reference(s)**

1. Joseph C. Giarratano and Gary D. Riley , Expert Systems: Principles and Programming, 4th Edition, 2022.
2. Stuart Russell and Peter Norvig , Artificial Intelligence: A Modern Approach, Pearson, 2010.
3. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
4. Daniel Jurafsky and James H. Martin,Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, 2nd edition, Pearson, 2013.

## 22EI013 INTELLIGENT CONTROL 3 0 0 3

**Course Objectives**

- To understand the intelligent control techniques and their applications in various domains.
- To design and implement fuzzy logic, neural network, and genetic algorithm-based controllers.
- To apply intelligent control methodologies to address real-world control problems, enhancing system stability, robustness, and responsiveness.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Interpret the intelligent control principles and techniques.
2. Design and implement intelligent control systems using fuzzy logic.
3. Design and implement intelligent control systems using neural network.
4. Design and implement intelligent control systems using genetic algorithm.
5. Outline the challenges in practical implementation of intelligent control system.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | - | 2 | 1 | - | - | - | - | - | - | - | - | 2 |
| 2 | 3 | - | 2 | 1 | - | - | - | - | - | - | - | - | 2 |
| 3 | 3 | - | 2 | 2 | - | - | - | - | - | - | - | - | 2 |
| 4 | 3 | - | 2 | 3 | - | - | - | - | - | - | - | - | 2 |
| 5 | 3 | - | 2 | 1 | - | - | - | - | - | - | - | - | 2 |

**UNIT I** **9 Hours**

**INTRODUCTION TO INTELLIGENT CONTROL**

Overview of control systems and their significance in various domains - Introduction to intelligent control and its applications - Comparison of conventional control and intelligent control approaches - Ethical considerations and challenges in implementing intelligent control systems.

**UNIT II** **10 Hours**

**NEURAL NETWORK CONTROL**

Introduction to artificial neural networks and their architectures - Neural network-based control approaches, such as adaptive control and model predictive control - Training and learning algorithms for neural network controllers - Case studies and applications of neural network control.

**UNIT III** **9 Hours**

**FUZZY LOGIC CONTROL**

Introduction to fuzzy logic and fuzzy sets - Fuzzy logic control architecture and inference mechanisms. Design and tuning of fuzzy logic controllers - Applications of fuzzy logic control.

**UNIT IV** **9 Hours**

**GENETIC ALGORITHM CONTROL**

Introduction to genetic algorithms and evolutionary optimization - Genetic algorithm-based control strategies, including PID tuning and optimal control - Encoding, selection, crossover, and mutation operations in genetic algorithms - Applications of genetic algorithm control in complex systems.

**UNIT V** **8 Hours**

**INTELLIGENT CONTROL SYSTEM INTEGRATION AND OPTIMIZATION**

Integration of different intelligent control techniques for complex systems - Multi-objective optimization in intelligent control system design - Case studies and practical implementation challenges.

**Total: 45 Hours**

**Reference(s)**

1. Jagannathan Sarangapani., Neural Network Control of Nonlinear Discrete-Time Systems, CRC press, 2017.
2. Derong Liu and Panos J. Antsaklis, Intelligent Control Systems: An Introduction with Examples, 2004.
3. Timothy J. Ross, Fuzzy Logic with Engineering Applications, John Wiley, 2010.
4. Xinjie Yu, Mitsuo Gen, and Runwei Cheng, Introduction to Evolutionary Algorithms, Springer, 2010.
5. Pedro Ponce-Cruz and Fernando D. Ramirez-Figueroa, Intelligent Control Systems with LabVIEW, Springer, 2010.

## 22EI014 ANALYTICAL INSTRUMENTS 3 0 0 3

**Course Objectives**

- To understand the various techniques and methods of analysis that occurs in the various regions of the spectrum.
- To impart an adequate knowledge about chromatography method for analysis of industrial gases.
- To understand the concepts of interaction of electromagnetic radiation with matter.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Select the appropriate spectrophotometer techniques for analysing concentration of chemical solution.
2. Differentiate the chromatographic techniques used for industrial applications.
3. Select specific techniques employed for analyzing gas, dissolved component and monitoring different pollutants in air and water.
4. Compare three different electrodes and analyzers used for the detection of silicon, sodium and dissolved oxygen.
5. Choose the appropriate radiation techniques (NMR, ESR, and EPR) to determine the elements present in the sample.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 1 | | 1 | 2 | - | - | - | - | - | 2 | - |
| 2 | 2 | 3 | 2 | | 1 | 1 | - | - | - | - | - | 2 | - |
| 3 | 2 | 3 | 2 | 2 | 1 | 2 | - | - | - | - | - | 2 | - |
| 4 | 2 | 3 | 2 | 2 | | 2 | - | - | - | - | - | 2 | - |
| 5 | 2 | 3 | 2 | 3 | | 2 | - | - | - | - | - | 2 | - |

**UNIT I** **9 Hours**

**COLORIMETRY AND SPECTROPHOTOMETRY**

Beer-Lambert"s law - colorimeters - basic principle of spectroscopy -Emission and absorption of radiation sources and detectors - UV and visible spectrophotometers - single and double beam instruments - IR spectrophotometers - attenuated total reflectance flame photometers - atomic absorption spectrophotometers - FTIR spectrophotometers - flame emission photometers. -mass spectrophotometers.

**UNIT II** **7 Hours**

**CHROMATOGRAPHY**

Gas chromatography - Detectors - Liquid chromatography - Applications - High pressure liquid chromatography – Applications.

**UNIT III** **10 Hours**

**GAS ANALYZERS AND POLLUTION MONITORING INSTRUMENTS**

Gas analyzer: oxygen, NOx and H2S types, IR analyzers, thermal conductivity analyzers - air pollution due to carbon monoxide, hydrocarbons, nitrogen oxides and sulphur dioxide estimation - dust and smoke measurements.

**UNIT IV** **9 Hours**

**PH CONDUCTIVITY AND DISSOLVED COMPONENT ANALYZER**

Principle of pH measurement, glass electrodes, hydrogen electrodes, reference electrodes, selective ion electrodes, ammonia electrodes, biosensors - dissolved oxygen analyzer - sodium analyzer - silicon analyzer.

**UNIT V** **10 Hours**

**NUCLEAR MAGNETIC RESONANCE AND RADIATION TECHNIQUES**

Nuclear radiation - microwave spectroscopy - NMR, ESR and EPR spectroscopy - applications - nuclear radiation detectors - GM counter - proportional counter - solid state detectors - X-ray spectroscopy - detectors - Scanning Electron Microscope (SEM) - Transmission Electron Microscope (TEM).

**Total: 45 Hours**

**Reference(s)**


1. R.S. Khandpur, Handbook of Analytical Instruments, Tata McGraw Hill publishing Co. Ltd., 2nd Edition, 2006.
2. G.W. Ewing, Instrumental Methods of Analysis, McGraw Hill, 2004.
3. Liptak, B.G., Process Measurement and Analysis, CRC Press, 2005.
4. Braun, R.D., Introduction to Instrumental Analysis, McGraw Hill, Singapore, 2006.
5. H.W.Willard, L.L.Merritt, J.A.Dean, F.A.Settle, Instrumental methods of analysis, PHI, 2005.

## 22EI015 VIRTUAL INSTRUMENTATION 3 0 0 3

**Course Objectives**

- To provide an overview of Virtual instruments.
- To bring out the overview of the software.
- To know about the programming structure of the software.
- To familiarize the student with the Applications.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Analyze the basics of Virtual or graphical instrumentation concepts.
2. Analyze the overview of G programming, labels, data types and debug the G programming.
3. Select the appropriate structuring concept to be used in graphical programming.
4. Organize the procedure to install DAQ in various OS and its interfacing methods.
5. Implement the IMAQ Motion control and machine vision concepts for industrial application.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - |
| 2 | 1 | 2 | 1 | 1 | 1 | - | - | - | 1 | - | 1 | 1 | 1 |
| 3 | 1 | 3 | 3 | 2 | 3 | - | - | - | 1 | - | 2 | 2 | 2 |
| 4 | 1 | 3 | 2 | 3 | 3 | - | - | - | 1 | - | 2 | 2 | 3 |
| 5 | 1 | 3 | 3 | 3 | 3 | - | - | - | 1 | - | 2 | 2 | 3 |

**UNIT I** **9 Hours**

**INTRODUCTION**

General functional description of digital instrument - Block diagram of a Virtual Instrument - Advantages of Virtual Instruments over conventional instruments - Architecture of a Virtual Instrument and a its relation to the operating system. Advantages of Virtual Instruments over conventional instruments

**UNIT II** **9 Hours**

**SOFTWARE OVERVIEW**

VI-Graphical user interfaces-Controls and indicators-G programming-Labels and Text-Shape,size and color-Owned and free labels-Data type,Format,Precision and representation-Data types-Data flow programming-Editing-Debugging and Running a Virtual Instrument-Graphical programming palettes and tools-Front panel objects-Data types

**UNIT III** **9 Hours**

**PROGRAMMING STRUCTURE**

FOR Loops, WHILE Loops, CASE Structure, Formula nodes, Sequence structures - Arrays and Clusters - Array Operations - Bundle - Bundle/Unbundle by name, graphs and charts - String and file I/O - High level and Low level file I/O"s - Attribute modes Local and Global variables. Bundle/Unbundle by name

**UNIT IV** **9 Hours**

**OPERATING SYSTEM AND HARDWARE ASPECTS**

Current trends Operating system requirements - Data Acquisition Card(DAQ): DAQ hardware, Grounding methods, Resolution, Analog I/O, Digital I/O - DAQ Software Architecture - Configuring the DAQ hardware/software for temperature measurement.

**UNIT V** **9 Hours**

**APPLICATIONS**

IMAQ Motion Control: components of a motion control system, configuration, prototyping and development - Interfacing Servomotor and Stepper motor in LabVIEW. Machine Vision: Edge Detection.

**Total: 45 Hours**

**Reference(s)**


1. 1. Garry M Johnson, Labview Graphical Programming, Tata McGraw Hill book Co, New Delhi, 2017.
2. Jovitha Jerome, Virtual Instrumentation Using LabVIEW PHI Learning Pvt. Ltd 1st Edition, 2010.
3. Jeffrey Travis and Jim Kring, LabVIEW for Everyone: Graphical Programming made Easy and Fun, Tata McGraw Hill book Co, New Delhi, 2011.
4. LabVIEW: Basics I & II Manual, National Instruments, Bangalore, 2011.

## 22EI016 INSTRUMENTATION IN PETROCHEMICAL INDUSTRIES

**3 0 0 3**

### Course Objectives

- To understand the process involved in petroleum refineries.
- To impact adequate knowledge on the distillation column and its control process.
- To understand the controlling concepts of major unit of refineries like distillation column, reactors, driers, heat exchangers, etc.
- To be acquainted with the safety measures in petroleum industries.

### Programme Outcomes (POs)

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

### Course Outcomes (COs)

1. Analyze the production and consumption patterns of fossil fuels in India, evaluating their impact on the energy sector and economy.
2. Compare and evaluate different control techniques used in distillation processes in petroleum industries to enhance efficiency and yield.
3. Analyze the characteristics of physical parameters in chemical reactors and apply suitable control mechanisms for process optimization.
4. Analyze the process parameters of heat exchange systems in petroleum industries and apply advanced control strategies for energy efficiency.
5. Assess the significance of safety instrumentation (zone 0, 1, and 2) and develop strategies to mitigate industrial hazards and accidents.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 2 | 1 | 1 | - | - | - | - | - | - | - | - |
| 2 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | - |
| 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | 2 | - |
| 4 | 3 | 2 | 3 | 2 | 1 | - | - | - | - | - | - | 2 | - |
| 5 | 2 | 3 | 3 | 1 | 1 | 1 | | - | - | - | - | 2 | - |

**UNIT I** **7 Hours**

**INTRODUCTION**

Formation of oil and gas - Petroleum exploration, production and refining - refining capacity in India - consumption of petroleum products in India - constituents of crude oil

**UNIT II** **10 Hours**

**DISTILLATION PROCESS CONTROL**

Introduction to P & I diagram - atmospheric distillation of crude oil with P&I diagram - Separation of crude oil - vacuum distillation process - thermal conversion process - Catalytic conversion - control of distillation column -feed control - reflux control - reboiler control

**UNIT III** **9 Hours**

**REACTORS PROCESS CONTROL**

Control of chemical reactors: temperature control, pressure control - Dryers: control of dryers - batch dryers - atmospheric and vacuum dryers - continuous dryers

**UNIT IV** **10 Hours**

**HEAT EXCHANGE SYSTEM**

Control of heat exchangers and evaporators - variables and degrees of freedom - liquid to liquid heat exchangers - steam heaters - condensers - reboiler and vaporizers - cascade control - feed forward control - Feedback control- Integrated approach - evaporators: types of evaporators

**UNIT V** **9 Hours**

**SAFETY INSTRUMENTATION**

Hazardous and non-hazardous area - classification of zone 0, zone 1 & zone 2 - pressurization techniques - zener barrier

**Total: 45 Hours**

**Reference(s)**

1. Ram Prasad, Petroleum Refining Technology, Khanna Publishers Ltd, New Delhi, 2007.
2. B.G. Liptak, Instrumentation in Process Industries, Chilton Book Company, New York, 1973.
3. B.G. Liptak, Instrument Engineers Handbook Volume II, 2003.

## 22EI017 FIBER OPTICS AND LASER INSTRUMENTATION

**3 0 0 3**

### Course Objectives

- To enhance the student knowledge in fiber optics fundamentals and fabrication.
- To be recognized with industrial applications of fibers.
- To understand the fundamental concepts about lasers.
- To identify and describe various fiber optic imaging and optoelectronic sensor applications.

### Programme Outcomes (POs)

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

### Course Outcomes (COs)

1. Apply the properties of optical fibers, their light sources, and detectors to optimize signal transmission and efficiency.
2. Apply fiber-optic sensors for the measurement of various physical quantities in industrial applications.
3. Analyze the fundamental principles of lasers, classify different types, and examine their working mechanisms.
4. Analyze the applications of lasers in industrial processes such as material processing, measurement, and pollutant detection.
5. Apply laser instruments in various medical applications and analyse their effectiveness in surgical and therapeutic procedures.

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | - | - |
| 2 | 3 | 2 | 1 | 2 | - | - | - | - | - | - | - | 2 | - |
| 3 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 2 | - |
| 4 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 2 |
| 5 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | 2 | 2 |

**UNIT I** **9 Hours**

**OPTICAL FIBERS AND THEIR PROPERTIES**

Principles of light propagation through a fiber - different types of fibers and their properties - relative merits and demerits - fiber optics production and components - technology of preformed fabrication - fiber drawing - mechanical and thermal characteristics - light sources - photo detectors -source coupling, splicing and connectors.

**UNIT II** **9 Hours**

**INDUSTRIAL APPLICATION OF OPTICAL FIBERS**

Fiber optics instrumentation system - optical fiber sensors, Measurement of pressure, temperature, current, voltage and liquid level - fiber optic communication set up - different types of modulators - detectors.

**UNIT III** **9 Hours**

**LASER FUNDAMENTALS**

Fundamental characteristics of lasers: laser rate equation - three level system - four level system - properties of laser beams - laser modes - resonator configuration - Q- switching and mode locking - cavity dumping - types of lasers: gas lasers, solid state lasers, liquid lasers and semiconductor lasers.

**UNIT IV** **9 Hours**

**INDUSTRIAL APPLICATION OF LASERS**

Lasers for measurement of distance and length, velocity, acceleration, atmospheric effects, sonic boom, pollutants - material processing: laser heating, melting, welding and trimming of materials – removal and vaporization - calculation of power requirements of laser for material processing

**UNIT V** **9 Hours**

**HOLOGRAM AND MEDICAL APPLICATIONS**

Holography: basic principle, methods - holographic interferometry and application, holography for non-destructive - medical applications of lasers, laser and tissue interactive - laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynaecology and oncology

**Total: 45 Hours**

**Reference(s)**


1. J.M. Senior, Optical Fiber Communication - Principles and Practice, Prentice Hall of India, 2010.
2. John F. Ready, Industrial Applications of Lasers, Academic Press, 2012.
3. G. Keiser, Optical Fiber Communications, McGraw Hill, 2010.
4. Wilson and J.F.B. Hawkes, Introduction to Opto Electronics, Prentice Hall of India, 2009.
5. Donald J. Sterling, Technicians Guide to Fiber Optics, Delmar publisher, 2009.
6. Jelinkova, Helena, editor.Lasers for medical applications: diagnostics, therapy and surgery. Elsevier, 2013.

## 22EI018 POWER PLANT INSTRUMENTATION AND CONTROL

**3 0 0 3**

**Course Objectives**

- To gain knowledge on different methods of power generation.
- To provide clear view of the various measurements involved in power generation plants.
- To understand about the Piping and Instrumentation (P&I) diagram.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Apply different methods of power generation and analyse the basic building blocks of a thermal power plant.
2. Apply suitable measurement techniques for electrical and non-electrical parameters in a thermal power plant and analyse their significance.
3. Apply control schemes for combustion processes, including air-fuel ratio, draught, pulverizer, flue gas dew point, and soot blowing, and analyse their efficiency.
4. Analyze major boiler control schemes for feedwater, drum level, steam temperature, and boiler interlocks to ensure safe and efficient operation.
5. Apply control strategies for nuclear power plants and analyse safety instrumentation and turbine control methods for reliability and efficiency.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 2 | 1 |
| 2 | 2 | 2 | 3 | 1 | - | - | - | - | - | - | - | 3 | 1 |
| 3 | 1 | 3 | 2 | 1 | - | - | - | - | - | - | - | 3 | 1 |
| 4 | 1 | 3 | 2 | 1 | - | - | - | - | - | - | - | 2 | 2 |
| 5 | 1 | 1 | 3 | 3 | - | - | - | - | - | - | - | 2 | 2 |

**UNIT I** **9 Hours**

**OVERVIEW OF POWER GENERATION**

Survey of methods of power generation - hydro, thermal, nuclear, solar and wind power - importance of instrumentation in power generation - thermal power plant - building blocks - combined cycle system-combined heat and power system - sub critical and supercritical boilers-details of boiler processes-P&I diagram of boiler - cogeneration

**UNIT II** **9 Hours**

**MEASUREMENTS IN POWER PLANTS**

Electrical measurements - current, voltage, power, frequency, power factor etc.- non electrical parameters -Measurement of feed water flow, air flow, steam flow and coal flow - drum level measurement - steam pressure and temperature measurement - turbine speed and vibration measurement- flue gas analyzer - fuel composition analyzer- pollution monitoring Instruments - dust monitor

**UNIT III** **9 Hours**

**BOILER CONTROL LOOPS I**

Coal handling: Pulverizers and Pulverizers control-Furnace Draught control - Combustion control: Fuel/Air ratio, combustion efficiency-oxygen, CO and CO2 trimming, excess air flue gas dew point control - Burners for liquid and solid fuels - burner management - soot blowing operation

**UNIT IV** **9 Hours**

**BOILER CONTROL LOOPS II**

Boiler feed water processing and control - Types of boilers like FBC, CFBC, Fluidized Bed - drum level control - steam temperature and pressure control - Super heater control - deaerator control – furnace safety interlocks and boiler interlocks -. boiler efficiency calculation

**UNIT V** **9 Hours**

**NUCLEAR POWER PLANT INSTRUMENTATION AND TURBINE CONTROL**

Nuclear power plant instrumentation: Piping and instrumentation diagram of different types of nuclear power plant, Nuclear reactor control loops, reactor dynamics - safety instrumentation, reliability aspects. Turbine-control: Types of steam turbines - governing system - Speed and load control - Vibration and shell temperature control - lubricant oil temperature control - cooling system

**Total: 45 Hours**

**Reference(s)**


1. Krishnaswamy.K and Ponnibala.M., Power Plant Instrumentation, PHI Learning Pvt.Ltd., New Delhi, 2011.
2. Swapan Basu and Ajay Kumar, Power Plant Instrumentation and Control, Elsevier, 2015.
3. Jain R.K., Mechanical and Industrial Measurements,Khanna Publishers, New Delhi, 2013.
4. Liptak B.G., Instrumentation in Process Industries, Chilton Book Company, 2013.
5. Jain R.K., Mechanical and Industrial Measurements,Khanna Publishers, New Delhi, 2013.
6. David Lindsley, Power Plant control and Instrumentation, Institution of Electrical Engineers, London, 2000.

## 22EI019 INSTRUMENTATION IN FOOD PROCESSING INDUSTRIES

**3 0 0 3**

**Course Objectives**

- To provide exposure to various techniques and methods that occurs in the various regions of food analysis.
- To get an adequate knowledge about various techniques for analysis of food substances.
- To understand the concepts of electrodes and biosensors that has potential applications in food and beverage industries.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Apply the role of moisture content in food processing and analyze the measurement techniques for turbidity and humidity.
2. Apply the classification of enzyme sensors, biosensors, and electronic noses in food manufacturing and analyze their working principles.
3. Apply the concepts of automatic controllers and indicators in food industries and analyze their effectiveness in maintaining process control.
4. Implement chromatography and mass spectrometry for food product analysis and analyze their accuracy and reliability.
5. Execute analytical instruments such as Scanning Electron Microscopy and Tandem Electron Microscopy and analyze their applications in food quality assessment.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 2 | 1 | 1 | 1 | - | - | - | - | - | 1 | 1 |
| 2 | 1 | 2 | 3 | 3 | 3 | 1 | - | - | - | - | - | 2 | 2 |
| 3 | 1 | 2 | 3 | 3 | 3 | 2 | - | - | - | - | - | 2 | 2 |
| 4 | 1 | 2 | 3 | 3 | 3 | 3 | - | - | - | - | - | 3 | 3 |
| 5 | 1 | 2 | 3 | 3 | 3 | 2 | - | - | - | - | - | 3 | 3 |

**UNIT I** **9 Hours**

**MOISTURE, TURBIDITY AND HUMIDITY MEASUREMENTS**

Role of moisture content in food - wet and dry method - IR technique. Humidity - Definitions - role in food processing - classical types - wet and dry bulb hygrometer - Electronic methods. Turbidity and colour: Definition and role, standards and units, basic turbidity meter, light scattering and absorbtion type

**UNIT II** **9 Hours**

**FOOD ENZYMES AND FLAVOUR**

Food enzymes and flavour : Human olfaction - Importance of enzyme sensors - biosensors -sensing arrays - Electronics Nose.

**UNIT III** **9 Hours**

**CONTROLLERS AND INDICATORS**

Basic control concept - Temperature controller in dryer - ration control in food pickling -atmospheric controller in food preservation.

**UNIT IV** **9 Hours**

**CHROMATOGRAPHY AND MASS SPECTROMETRY IN FOOD INDUSTRY**

Basics of gas and liquid chromatography - GC and HPLC Application in food analysis - MS application in food analysis

**UNIT V** **9 Hours**

**AUTOMATION IN FOOD INDUSTRY**

Sorting-Food chilling and freezing-Fruits and vegetable processing-Packing of food products-Robotics in food industry

**Total: 45 Hours**

**Reference(s)**


1. 1. Nielsen, S.S, Introduction to the chemical analysis of foods- Jones and Bartlett Publishers, Boston, London, 2004.
2. Mahindru,S.N, -Food additives. Characteristics, detection and estimation-. Tata McGraw Hill Publishing Company Limited, New Delhi, 2000.
3. B.G.Liptak, ed -Instrument Engineers Handbook: Process Measurement and Analysis-, Butterworth & Heinemann, 1995.
4. R G. Moreira, T.P Coultate Automatic Control for Food Processing System, 2001.
5. Gouri S Mittal, Computerized control system in the food industry, Marcel Decker Inc. 1997.

## 22EI020 SEMICONDUCTOR MANUFACTURING 3 0 0 3

**Course Objectives**

- To characterize the materials based on band gap
- To study the light semiconductor interactions
- To analyze the band gap and defects concentration in fabrication process

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Outline the band origination in chemical bonding and electrical conductivity
2. Differentiate the materials types based on their band gap values and use this knowledge as per their requirements.
3. Attribute the junctions formed in PN diode and its theory.
4. Contrast the solar cell and its working with advantages.
5. Examine the band gap, reflection and transmission percentage of a grown film over substrate with contents of defects.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 3 | 1 | 1 | - | - | - | - | - | - | - | - | 1 |
| 2 | 1 | 2 | 1 | 2 | - | - | - | - | - | - | - | - | 1 |
| 3 | 1 | 3 | 1 | 2 | - | - | - | - | - | - | - | - | 1 |
| 4 | 2 | 3 | 1 | 3 | - | - | - | - | - | - | - | - | 1 |
| 5 | 2 | 2 | 1 | 3 | - | - | - | - | - | - | - | - | 1 |

**UNIT I** **9 Hours**

**ELECTRONIC MATERIALS**

Free electron theory, Density of states and energy band diagrams, Kronig-Penny model (to introduce origin of band gap), Energy bands in solids, E-k diagram, Direct and indirect bandgaps, Types of electronic materials: metals, semiconductors, and insulators, Density of states, Occupation probability, Fermi level, Effective mass, Phonons.

**UNIT II** **9 Hours**

**SEMICONDUCTORS**

Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction, Metal-semiconductor junction (Ohmic and Schottky), Semiconductor materials of interest for optoelectronic devices.

**UNIT III** **9 Hours**

**LIGHT-SEMICONDUCTOR INTERACTION**

Optical transitions in bulk semiconductors: absorption, spontaneous emission, and stimulated emission; Joint density of states, Density of states for photons, Transition rates (Fermi"s golden rule), Optical loss and gain; Photovoltaic effect, Exciton, Drude model.

**UNIT IV** **9 Hours**

**MEASUREMENTS**

Four-point probe and van der Pauw method for carrier density, resistivity, and hall mobility; Hot-point probe measurement, capacitance-voltage measurements, parameter extraction from diode I-V characteristics, DLTS, band gap by UV-Vis spectroscopy, absorption/transmission

**UNIT V** **9 Hours**

**MANUFACTURING AND APPLICATIONS**

Semiconductor manufacturing: raw materials, Step-by-step process: Cleaning, Film Deposition, Post-deposition Cleaning, Resist Coating, Exposure, Development, Etching & Implantation of Impurities. Quantum wells, wires, and dots: design, fabrication, and characterization techniques. Hetero-junctions and associated band-diagrams

**Total: 45 Hours**

**Reference(s)**

1. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill, 1995.
2. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc., 2007.
3. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley, 2008.
4. A. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communications, Oxford University Press, New York, 2007.
5. P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India, 1997.
6. Online course: “Semiconductor Optoelectronics” by M R Shenoy on NPTEL.
7. Online course: "Optoelectronic Materials and Devices" by Monica Katiyar and Deepak Guptaon NPTEL.

## 22EI021 AUTOMOTIVE ELECTRONICS 3 0 0 3

**Course Objectives**

- To understand the fundamentals of the Automotive systems
- To gain knowledge in digital engine control, automotive networking, and diagnostics
- To analyse standards, impacts, and economy of electric vehicles

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Outline the basics of automobile dynamics and design electronics.
2. Analyze automotive components, subsystems, and basics of Electronic Engine Control in today's automotive industry.
3. Use available automotive sensors and actuators while interfacing with microcontrollers/ microprocessors during automotive system design.
4. Implement the networking of various modules in automotive systems, communication protocols, and diagnostics of the sub-systems
5. Analyze standards, impact and economy of Electric Vehicles.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 1 | - |
| 2 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 1 | - |
| 3 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 1 | - |
| 4 | 3 | 3 | 2 | 1 | - | - | - | - | - | - | - | 1 | - |
| 5 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | 1 | - |

**UNIT I** **9 Hours**

**AUTOMOTIVE FUNDAMENTALS OVERVIEW**

Evolution of Automotive Electronics, Automobile Physical Configuration, Survey of Major Automotive Systems, The Engine - Engine Block, Cylinder Head, Four Stroke Cycle, Engine Control, Ignition System- Spark plug, High voltage circuit and distribution, Spark pulse generation, Ignition Timing, Diesel Engine, Drive Train - Transmission, Drive Shaft, Differential, Suspension, Brakes, Steering System, Starter Battery --Operating principle.

**UNIT II** **9 Hours**

**AUTOMOTIVE SENSORS**

Automotive Control System applications of Sensors and Actuators - Variables to be measured, Airflow rate sensor, Strain Gauge MAP sensor, Engine Crankshaft Angular Position Sensor, Magnetic Reluctance Position Sensor, Hall effect Position Sensor, Shielded Field Sensor, Optical Crankshaft Position Sensor, Throttle Angle Sensor (TAS), Engine Coolant Temperature (ECT) Sensor, Exhaust Gas Oxygen (02/EGO) Lambda Sensors, Piezoelectric Knock Sensor.

**UNIT III** **9 Hours**

**DIGITAL ENGINE CONTROL SYSTEMS**

Digital Engine control features, Control modes for fuel Control (Seven Modes), EGR Control, Electronic Ignition Control -Closed loop Ignition timing, Spark Advance Correction Scheme, Integrated Engine Control System- Secondary Air Management, Evaporative Emissions Canister Purge, Automatic System Adjustment, System Diagnostics

**UNIT IV** **9 Hours**

**AUTOMOTIVE NETWORKING AND DIAGNOSTICS**

Bus Systems- Classification, Applications in the vehicle, Coupling of networks, Examples of networked vehicles, Buses - CAN Bus, UN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces, Timing Light, Engine Analyzer, On-board diagnostics, Off-board diagnostics.

**UNIT V** **9 Hours**

**ELECTRIC VEHICLES**

Electric vehicles (EVs) - advantages and impacts - EV market and promotion - Infrastructure - Legislation and regulation - Standardization - Energy efficiency - Assessing economy of EVs - Fuel economy - Fuel consumption - Greenhouse gas emissions

**Total: 45 Hours**

**Reference(s)**

1. William B. Ribbens, "Understanding Automotive Electronics", 6th Edition, Elsevier Publishing.
2. Robert Bosch GmbH (Ed.) Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th edition, John Wiley & Sons Inc., 2007.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, 2nd Edition, John Wiley and Sons, 2012.

## 22EI022 GREEN ELECTRONICS 3 0 0 3

**Course Objectives**

- To understand the sustainable practices and principles in electronics manufacturing.
- To implement green electronic solutions, considering energy efficiency, recyclability, and reduction of hazardous materials.
- To evaluate and optimize electronic systems for sustainability, enabling the design and development of eco-friendly electronics.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Outline the principles, regulations, and standards, and their importance in green electronics.
2. Apply sustainable design and manufacturing techniques to develop energy-efficient and environmentally-friendly electronic systems
3. Analyze and evaluate the environmental impact of electronic devices
4. Implement circular economy principles into electronic product design.
5. Attribute the social and economic implications of green electronics.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 2 | - |
| 2 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 1 | - |
| 3 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 1 | - |
| 4 | 3 | 3 | 2 | 1 | - | - | - | - | - | - | - | 1 | - |
| 5 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | 1 | - |

**UNIT I** **9 Hours**

**INTRODUCTION TO GREEN ELECTRONICS**

Overview of green electronics and its significance in sustainability - Environmental impacts of electronic devices and e-waste management - Regulatory frameworks and standards for green electronics - Green design principles and life cycle assessment.

**UNIT II** **9 Hours**

**ENERGY EFFICIENCY IN ELECTRONICS**

Energy consumption analysis in electronic devices - Techniques for improving energy efficiency, such as power management and low-power design - Energy-efficient components and architectures for electronic systems - Energy harvesting and renewable energy sources for powering electronics.

**UNIT III** **9 Hours**

**MATERIALS AND MANUFACTURING FOR GREEN ELECTRONICS**

Sustainable materials selection for electronic components and packaging - Design for disassembly and recycling in electronics manufacturing - Reduction of hazardous substances in electronic products - Green manufacturing techniques, such as clean production and waste reduction.

**UNIT IV** **9 Hours**

**DESIGN FOR CIRCULAR ECONOMY**

Circular economy principles and their application to electronics - Remanufacturing and refurbishment strategies for extending product lifecycles - Reverse logistics and closed-loop supply chains for electronic products - End-of-life management and responsible disposal of electronic waste.

**UNIT V** **9 Hours**

**GREEN ELECTRONICS CASE STUDIES**

Case studies of successful green electronics initiatives and implementations - Emerging trends and technologies in green electronics, such as eco-design software and sustainable packaging - Social and economic implications of green electronics

**Total: 45 Hours**

**Reference(s)**

1. Mohamad K. Hasan Green Electronics: Design and Manufacturing, 2008.
2. Ali Emadi and Mehrdad Ehsani, Energy-Efficient Electronics: Principles and Practice, 2016.
3. Casey B. Chiu, Sustainable Electronics: Design for Energy Efficiency and Environmental Responsibility, 2016.
4. Martin Charter Design for the Circular Economy: Second Edition, 2017.
5. John R. Okyere. Green Electronics: Green Bottom Line Impact on Sustainable Product Design and Profitability, 1999.

## 22EI023 DIGITAL VLSI 3 0 0 3

**Course Objectives**

- To learn the fundamentals of VLSI design with the IC Manufacturing Process
- To familiarize with VLSI combinational logic circuits design
- To familiarize with VLSI sequential logic circuits design
- To learn the various arithmetic circuits and testing methodologies
- To familiarize with the different FPGA architectures

**Programme Outcomes (POs)**

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

**Course Outcomes (COs)**

1. Analyze MOS devices and inverter.
2. Design and analyze combinational logic.
3. Design and analyze Sequential logic.
4. Design and analyze data path cells.
5. Design digital logic using FPGA.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | - |
| 2 | 3 | 2 | 3 | 1 | - | - | - | - | - | - | - | - | - |
| 3 | 3 | 2 | 3 | 1 | - | - | - | - | - | - | - | - | - |
| 4 | 1 | 3 | 3 | 1 | - | - | - | - | - | - | - | - | - |
| 5 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | - |

**UNIT I** **9 Hours**

**MOS TRANSISTOR PRINCIPLES**

MOS Technology and VLSI, Pass transistors, NMOS, CMOS Fabrication process and Electrical properties of CMOS circuits and Device modelling. Characteristics of CMOS inverter, Scaling principles and fundamental limits. Propagation Delays, CMOS inverter scaling, Stick diagram, Layout diagrams, Elmore"s constant, Logical Effort. Case study: Study of technology development in MOS.

**UNIT II** **9 Hours**

**COMBINATIONAL LOGIC CIRCUITS**

Static CMOS logic Design, Design techniques to improve the speed, power dissipation of CMOS logic, low power circuit techniques, Ratioed logic. Pass transistor Logic, Transmission CPL, DCVSL, Dynamic CMOS logic, Domino logic, Dual Rail logic, NP CMOS logic and NORA logic.

**UNIT III** **9 Hours**

**SEQUENTIAL LOGIC CIRCUITS**

Static and Dynamic Latches and Registers, Timing Issues, Pipelines, Clocking strategies, Memory Architectures, and Memory control circuits.

**UNIT IV** **9 Hours**

**DESIGNING ARITHMETIC BUILDING BLOCKS**

Data path circuits, Architectures for Adders, Accumulators, Multipliers, Barrel Shifters, Need for testing- Manufacturing test principles- Design for testability. Case study: Analysis of area, power and delay for 16 bit adder and 8 bit multiplier.

**UNIT V** **9 Hours**

**IMPLEMENTATION STRATEGIES**

Full Custom and Semicustom Design, Standard Cell design and cell libraries, FPGA building block architectures, FPGA interconnect routing procedures. Demo: Complete ASIC flow using Backend tool and fabrication flow Overall case study: Development of IC in commercial aspects (design, testing and fab cost)

**Total: 45 Hours**

**Reference(s)**

1. Jan Rabaey, Anantha Chandrakasan, B.Nikolic, Digital Integrated circuits: A Design Perspective, Prentice Hall of India, 2nd Edition, 2003.
2. N.Weste, K.Eshraghian, Principles of CMOS VLSI DESIGN, A system Perspective, 2nd Edition, Addision Wesley, 2004.
3. A.Pucknell, Kamran Eshraghian, BASIC VLSI DESIGN, Prentice Hall of India, 3rd Edition, 2007.
4. M.J. Smith, Application Specific Integrated Circuits, Addisson Wesley, 1997.
5. R.Jacob Baker, Harry W.LI., David E.Boyee, CMOS Circuit Design, Layout and Simulation, Prentice Hall of India, 2005.

## 22EI024 REAL TIME EMBEDDED SYSTEMS 3 0 0 3

**Course Objectives**

- To provide in depth knowledge about embedded processor, its hardware and software
- To understand the embedded system design and their operating system
- To apply knowledge of embedded processor architecture in various applications

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Outline the architecture and the functionality of ARM Microprocessor
2. Demonstrate the architecture and the functionality of computing devices
3. Outline the basic concepts of operating system
4. Implement an interfacing of networks with Microprocessor/ Microcontroller
5. Design a real time application for various domain using embedded system

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | - | - | - | - | - | - | - | - | - | 2 | - |
| 2 | 2 | 1 | - | - | - | - | - | - | - | - | - | 2 | - |
| 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | - |
| 4 | 2 | 1 | 2 | - | - | - | - | - | - | - | - | 2 | 2 |
| 5 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 1 |

**UNIT I** **9 Hours**

**INTRODUCTION TO ARM PROCEESORS**

Fundamentals of ARM, ARM Instruction set, Thumb Instruction set, ARM assembly language programming, Digital Signal Processing in ARM, Exceptions & Interrupt Handling.

**UNIT II** **9 Hours**

**COMPUTING PLATFORM AND DESIGN ANALYSIS**

CPU buses - Memory devices - I/O devices - Memory Protection Units - Memory Management Units - Component interfacing - Design with microprocessors - Development and Debugging - Program design - Model of programs - Assembly and Linking - Basic compilation techniques - Analysis and optimization of execution time, power, energy, program size - Program validation and testing.

**UNIT III** **9 Hours**

**PROCESS AND OPERATING SYSTEMS**

Multiple tasks and multi processes - Processes - Context Switching - Scheduling policies - Multiprocessor - Inter Process Communication mechanisms - Evaluating operating system performance - Power optimization strategies for processes - Firmware and Operating Systems for ARM processor.

**UNIT IV** **9 Hours**

**HARDWARE ACCELERATES**

Accelerators - Accelerated system design-Distributed Embedded Architecture - Networks for Embedded Systems - Network based design - Internet enabled systems.

**UNIT V** **9 Hours**

**CASE STUDY**

Hardware and software co-design - Data Compressor - Software Modem - Personal Digital Assistants - Set-Top-Box, System-on-Silicon - FOSS Tools for embedded system development.

**Total: 45 Hours**

**Reference(s)**

1. Andrew N Sloss, Dominic Symes and Chris Wright, ARM system developers guide Designing and Optimizing System Software, Morgan Kaufmann publishers, 2004.
2. David E-Simon, An Embedded Software Primer, Pearson Education, 2007.
3. K.V.K.K.Prasad, Embedded Real-Time Systems: Concepts, Design & Programming, Dreamtech Press, 2005.
4. Tim Wilmshurst, An Introduction to the Design of Small Scale Embedded Systems, Pal grave Publisher, 2004.
5. Wayne Wolf, Computers as Components - Principles of Embedded Computer System Design, Morgan Kaufmann Publisher, 2006.

## 22EI025 SOLAR PV FUNDAMENTAL AND APPLICATIONS

**3 0 0 3**

### Course Objectives

- To understand the fundamentals of solar energy and its conversion techniques for both thermal and electrical energy applications.
- To understand the construction details and principle of operations of solar photovoltaic system
- To learn the economic and environmental merits of solar energy for variety applications

### Programme Outcomes (POs)

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

### Course Outcomes (COs)

1. Apply the radiation principles with respective solar energy estimation.
2. Apply the PV technology principles and techniques of various solar cells / materials for lister energy conversion.
3. Apply economic and environmental merits of solar energy for variety applications
4. Analyze the constructional details of solar photovoltaic system and its applications
5. Design the applications of solar energy sources to enhance the passive architecture.

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 2 | 1 | 1 | - | 1 | - | - | - | - | - | - |
| 2 | 2 | 2 | 2 | 1 | 2 | - | 2 | - | - | - | - | - | - |
| 3 | 2 | 1 | 2 | 2 | 1 | - | 2 | - | - | - | - | - | - |
| 4 | 1 | 2 | 1 | 1 | 1 | - | 2 | - | - | - | - | - | - |
| 5 | 2 | 2 | 2 | 1 | 2 | - | 1 | - | - | - | - | - | - |

**UNIT I** **9 Hours**

**SOLAR RADIATION AND COLLECTORS**

Solar angles-day length, angle of incidence on tilted surface-Sunpath diagrams-shadow determination-extraterrestrial characteristics-measurement and estimation on horizontal and tilted surfaces-flat plate collector thermal analysis-heat capacity effect-testing methods-evacuated tubular collectors-concentrator collectors-classification-design and performance parameters-tracking systems-compound parabolic concentrators-parabolic trough concentrators-concentrators with point focus-Heliostats-performance of the collectors.

**UNIT II** **9 Hours**

**APPLICATIONS OF SOLAR THERMAL TECHNOLOGY**

Principle of working, types-design and operation of-solar heating and cooling systems-solar water heaters-thermal storage systems-solar still-solar cooker-domestic, community-solar pond-solar drying.

**UNIT III** **9 Hours**

**SOLAR PV FUNDAMENTALS**

Semiconductor-properties-energy levels-basic equations of semiconductor devices physics. Solar cells-p-n junction: homo and hetro junctions-metal semiconductor interface-dark and illumination characteristics-figure of merits of solar cell -efficiency limits-variation of efficiency with band-gap and temperature-efficiency measurements-high efficiency cells-preparation of metallurgical, electronic and solar grade Silicon-production of single crystal Silicon: Czokralski (CZ) and Float Zone(FZ) method-Design of a complete silicon-GaAs-InP solar cell-high efficiency III-V, II-VI multijunction solar cell; a-Si-H based solar cells quantum well solar cell-thermo-photovoltaic.

**UNIT IV** **9 Hours**

**SOLAR PHOTOVOLTAIC SYSTEM DESIGN AND APPLICATIONS**

Solar cell array system analysis and performance prediction- Shadow analysis: reliability-solar cell array design concepts-PV system design-design process and optimization-detailed array design-storage autonomy-voltage regulation-maximum tracking-use of computers in array design-quick sizing method-array protection and troubleshooting-centralized and decentralized SPV systems-standalone-hybrid and grid connected system-System installation-operation and maintenances-field experience-PV market analysis and economics of SPV systems.

**UNIT V** **9 Hours**

**SOLAR PASSIVE ARCHITECTURE**

Thermal comfort-heat transmission in buildings-bioclimatic classification-passive heating concepts: direct heat gain-indirect heat gain-isolated gain and sunspaces-passive cooling concepts: evaporative cooling-radiative cooling-application of wind, water and earth for cooling; shading-paints and cavity walls for cooling-roof radiation traps-earth air-tunnel. energy efficient landscape design-thermal comfort-concept of solar temperature and its significance-calculation of instantaneous heat gain through building envelope.

**Total: 45 Hours**

**Reference(s)**


1. Garg H P., Prakash J., Solar Energy: Fundamentals & Applications, Tata McGraw Hill, 2000.
2. Duffie, J. A. and Beckman, W. A., Solar Engineering of Thermal Processes, John Wiley, 1991.
3. Alan L Fahrenbruch and Richard H Bube, Fundamentals of Solar Cells: PV Solar Energy Conversion, Academic Press, 1983.
4. Larry D Partain, Solar Cells and their Applications, John Wiley and Sons, Inc, 1995.
5. Roger Messenger and Jerry Vnetre, Photovoltaic Systems Engineering, CRC Press, 2004.

6. Sodha, M.S, Bansal, N.K., Bansal, P.K., Kumar, A. and Malik, M.A.S. Solar Passive Building, Science and Design, Pergamon Press, 1986.
7. Krieder, J and Rabi, A., Heating and Cooling of Buildings: Design for Efficiency, McGraw- Hill, 1994.

## 22EI026 PROCESS MODELING AND SIMULATION 3 0 0 3

**Course Objectives**

- To study the modeling & simulation techniques of chemical processes and to gain skills in using process simulators.
- To obtain the mathematical model for the real time systems by applying fundamental laws
- To analyze the system performance using simulation of the model with appropriate software

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Formulate and analyze mathematical models for chemical processes by applying basic principles
2. Develop and evaluate mathematical models for chemical processes by applying fundamental conservation laws.
3. Analyze mathematical models for various chemical and physical systems, including reactors, separation units, and transport processes.
4. Implement and evaluate process simulation techniques using sequential modular and equation-oriented approaches
5. Develop and solve mathematical models for chemical processes using process simulators.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | - | 2 | - | - | - | - | - | - | - | - | 2 |
| 2 | 1 | 2 | 3 | - | - | - | - | - | - | - | - | - | 2 |
| 3 | 1 | 2 | 3 | - | - | - | - | - | - | - | - | - | 2 |
| 4 | 1 | 2 | 3 | - | - | - | - | - | - | - | - | - | 2 |
| 5 | 1 | 2 | 3 | - | 2 | - | - | - | - | - | - | - | 2 |

**UNIT I** **9 Hours**

**INTRODUCTION**

Use and scope of mathematical modeling, Principles of model formulation, Role and importance of steady-state and dynamic simulation, Classification of models, Model building, Modeling difficulties, Degree-of-freedom analysis, Selection of design variables, Review of numerical techniques, Model simulation.

**UNIT II** **9 Hours**

**FUNDAMENTAL LAWS**

Equations of continuity, energy, momentum, and state, Transport properties, Equilibrium and chemical kinetics, Review of thermodynamic correlations for the estimation of physical properties like phase equilibrium, bubble and dew points.

**UNIT III** **9 Hours**

**MODELING OF SPECIFIC SYSTEMS**

Constant and variable holdup CSTRs under isothermal and non-isothermal conditions, Stability analysis, Gas phase pressurized CSTR, Two phase CSTR, Non-isothermal PFR, Batch and semi-batch reactors, Heat conduction in a bar, Laminar flow of Newtonian liquid in a pipe, Gravity flow tank, Single component vaporizer, Multi- component flash drum, Absorption column, Ideal binary distillation column and non- ideal multi-component distillation column, Batch distillation with holdup etc.

**UNIT IV** **9 Hours**

**SIMULATION**

Simulation of the models, Sequential modular approach, Equation oriented approach, Partitioning and tearing, Introduction and use of process simulation software (Aspen Plus/ Aspen Hysys) for flow sheet simulation.

**UNIT V** **9 Hours**

**MATHEMATICAL MODELS**

Writing and solving models for simple chemical processes, use of process simulator for solving models for mixer, pump, compressor, heat exchanger, reactor, absorption/distillation column and steady state flow sheet simulation.

**Total: 45 Hours**

**Reference(s)**


1. Nagabhushan. S.Sudha.L.K, "Aircraft instrumentation and Systems", International publishing house Private limited, 2014.
2. Mekinley, J.L. and R.D. Bent, "Aircraft Power Plants", McGraw Hill, 1993.
3. Handbooks of Airframe and Power plant Mechanics, US dept. of Transportation, Federal, Aviation Administration, The English Book Store, New Delhi, 1995.
4. Treager, S., "Gas Turbine Technology", McGraw Hill, 1997.

## 22EI027 SYSTEM IDENTIFICATION 3 0 0 3

**Course Objectives**

- To provide an overview system identification based on the Non-parametric methods and spectral analysis methods
- To estimate the system parameters using parametric model structures
- To study the system identification using generalized relay feedback identification
- To familiarize the student with the Identification of systems operating in closed loop as well as practical aspects.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Obtain the mathematical model of a real time system using Non-parametric and spectral analysis methods.
2. Estimate the system parameters using parametric model structures available in the system identification tool box.
3. Determine the mathematical model for stable and unstable system using relay feedback identification methods.
4. Analyze the system Parameter in the closed loop system using direct, indirect and Subspace Identification methods.
5. Explain the procedure and limitation in practical aspects of identification for an experimental setup.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | - | - | - | - | - | - | - | - | - | 2 | - |
| 2 | 3 | 2 | 1 | 1 | 1 | - | - | - | - | - | - | 2 | - |
| 3 | 3 | 3 | 3 | 2 | 3 | - | - | - | - | - | - | 2 | - |
| 4 | 3 | 3 | 2 | 3 | 3 | - | - | - | - | - | - | 2 | - |
| 5 | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | - |

**UNIT I** **9 Hours**

**INTRODUCTION**

System Identification-motivation and overview - Non-parametric methods: Impulse response, step response and Frequency response methods, correlation and spectral analysis methods.

**UNIT II** **9 Hours**

**PARAMETER ESTIMATION METHODS**

Parametric model structures-ARX, ARMAX, OE, BJ models - Linear regression - Least square estimates, statistical properties of LS Estimates. Weighted least squares, maximum likelihood estimation, Prediction error methods, Instrumental variable methods, Recursive Least squares method- Exercises using system identification toolbox.

**UNIT III** **9 Hours**

**RELAY FEEDBACK IDENTIFICATION**

A generalized relay feedback identification method-model; structure selection-relay feedback identification of stable processes: FOPDT and SOPDT model. Relay feedback Identification of unstable processes: FOPDT and SOPDT model- Illustrative examples

**UNIT IV** **9 Hours**

**CLOSED- LOOP IDENTIFICATION**

Identification of systems operating in closed loop: Identifiability considerations-direct identification-indirect identification-Subspace Identification methods: classical and innovation forms, free and structures parameterizations

**UNIT V** **9 Hours**

**PRACTICAL ASPECTS OF IDENTIFICATION**

Practical aspects: experimental design-input design for identification, notion for persistent excitation, drifts and de-trending-outliers and missing data-pre-filtering-robustness -Model validation and Model structure determination-case studies. Introduction to Nonlinear System Identification

**Total: 45 Hours**

**Reference(s)**

1. Arun K. Tangirala "Principles of System Identification Theory and Practice", CRC Press, 2018.
2. Karel J. Keesman, "System Identification an Introduction", Springer, 2011.
3. LennartLjung, "System Identification: Theory for the user", Second edition, Prentice Hall, 1999.
4. Tao Liu, FurongGao, "Industrial Process Identification and control design, Step-test and relay-experiment-based methods", Springer- Verilog London Ltd, 2012.

## 22EI028 NON LINEAR CONTROL 3 0 0 3

**Course Objectives**

- To impart knowledge on phase plane analysis of non-linear systems
- To impart knowledge on Describing function based approach to non-linear systems.
- To educate on stability analysis of systems using Lyapunov's theory.
- To introduce the concept of sliding mode control.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Analyze the nonlinear systems using phase plane methods.
2. Investigate the nonlinearities of the system using describing function and limit cycle methods.
3. Determine the stability of the given nonlinear system using Lyapunov methods.
4. Apply the linearization concepts in feedback for stabilize the nonlinear MIMO and SISO systems.
5. Design the sliding mode controller for a given nonlinear MIMO system with simulation.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 1 | 3 | 3 | - | - | - | - | - | 2 | - | 1 |
| 2 | 3 | 3 | 1 | 3 | 3 | - | - | - | - | - | 2 | - | 1 |
| 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | 2 | - | 2 |
| 4 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - | - | 2 | - | 3 |
| 5 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - | - | 2 | - | 3 |

**UNIT I** **9 Hours**

**PHASE PLANE ANALYSIS**

Concepts of phase plane analysis- Phase portraits- singular points- Symmetry in phase plane portraits- Constructing Phase Portraits- Phase plane Analysis of Linear and Nonlinear Systems - simulation of phase portraits in MATLAB.

**UNIT II** **9 Hours**

**DESCRIBING FUNCTION**

Describing Function Fundamentals-Definitions-Assumptions-Computing Describing Functions- Common Nonlinearities and its Describing Functions-Nyquist Criterion and its Extension-Existence of Limit Cycles-Stability of limit Cycles. Simulation of limit cycles in MATLAB.

**UNIT III** **9 Hours**

**LYAPUNOV THEORY**

Nonlinear Systems and Equilibrium Points-Concepts of Stability-Linearization and Local Stability-Lyapunovs Direct Method-Positive definite Functions and Lyapunov Functions Equilibrium Point Theorems-Invariant Set Theorems-LTI System Analysis based on Lyapunovs Direct Method-Krasovskis Method-Variable Gradient Method-Physically-Control Design based on Lyapunovs Direct Method.

**UNIT IV** **9 Hours**

**FEEDBACK LINEARIZATION**

Feedback Linearization and the Canonical Form-Mathematical Tools-Input-State Linearization of SISO Systems- input-Output Linearization of SISO Systems-Generating a Linear Input-Output Relation- Normal Forms-The Zero-Dynamics-Stabilization and Tracking-Inverse Dynamics and Non-Minimum- Phase Systems-Feedback Linearization of MIMO Systems Zero-Dynamics and Control Design. Simulation of tracking problems in MATLAB.

**UNIT V** **9 Hours**

**SLIDING MODE CONTROL**

Sliding Surfaces- Continuous approximations of Switching Control laws-The Modeling/Performance Trade-Offs- MIMO Systems. simulation of sliding mode controller in MATLAB.

**Total: 45 Hours**

**Reference(s)**

1. Ramirez, W.; "Computational Methods in Process Simulation", 2nd Edn., Butterworths Publishers, New York, 2000.
2. Luyben, W.L., "Process Modelling Simulation and Control", 2nd Edn, McGraw-Hill Book Co., 1990.
3. J A E Slotine and W Li, "Applied Nonlinear control", PHI, 1991.
4. Hasan Khalil, "Nonlinear systems and control", Prentice Hall.
5. S H Zak, "Systems and control", Oxford University Press, 2003.
6. Torkel Glad and Lennart Ljung, "Control Theory-Multivariable and Nonlinear Methods", Taylor & Francis, 2002.
7. G. J. Thaler, “Automatic control systems”, Jaico publishers, 1993.
8. Felix L. Chernousko, Igor M.Ananievski, Sergey A.Reshmin, “Control of Nonlinear Dynamical Systems Methods and Applications, Springer, First Indian Reprint, 2013.

## 22EI029 ADAPTIVE CONTROL 3 0 0 3

**Course Objectives**

- To introduce the need for and effects of adaptive control.
- To illustrate study the parameter identification of systems.
- To illustrate the self-tuning of PID controllers based on parameter identification.
- To illustrate the model reference adaptive control.
- To introduce practical application through case studies.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Apply the principle of adaptive control schemes to implement in a system with a suitable adaptive control system to eliminate the effect of parameter variation and control.
2. Apply the identified model based on parametric identification methods for controller design/tuning.
3. Design the Deterministic and Stochastic Self Tuning Regulators for a given system.
4. Design of model reference adaptive controller for a given system.
5. Design gain scheduling controller and apply adaptive control schemes for industrial processes.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 2 | - | - | - | - | - | - | - | 2 | - | 2 |
| 2 | 3 | 3 | 2 | - | - | - | - | - | - | - | 2 | 1 | 2 |
| 3 | 3 | 3 | 3 | 1 | - | 1 | - | - | - | - | 2 | | 3 |
| 4 | 3 | 3 | 3 | 1 | - | 1 | - | - | - | - | 2 | | 3 |
| 5 | 3 | 3 | 3 | 1 | - | 1 | - | - | - | - | 2 | | 3 |

**UNIT I** **9 Hours**

**INTRODUCTION**

Introduction to adaptive Control-Effects of process Variations-Adaptive Control Schemes-Adaptive Control Problem-Non-Parametric Identification-Step Response Method-Impulse Response Method-Frequency response method.

**UNIT II** **9 Hours**

**PARAMETRIC IDENTIFICATION**

Linear in parameter models-ARX-ARMAX-ARIMAX-Least square estimation-Recursive least square estimation-Extended least square estimation-Maximum likelihood estimation-Introduction to non-linear systems identification-Pseudo random binary sequence.

**UNIT III** **9 Hours**

**SELF-TUNING REGULATOR**

Deterministic in-direct self-tuning regulators-Deterministic direct self-tuning regulators-Introduction to stochastic self-tuning regulators-Stochastic indirect self-tuning regulator.

**UNIT IV** **9 Hours**

**MODEL REFERENCE ADAPTIVE CONTROLLER**

The MIT rule-Lyapunov theory-Design of model reference adaptive controller using MIT rule and Lyapunov theory-Relation between model reference adaptive controller and self-tuning regulator.

**UNIT V** **9 Hours**

**TUNING OF CONTROLLERS AND CASE STUDIES**

Design of gain scheduling controller-Auto-tuning of PID regulator-Stability analysis of adaptive controllers-Application of adaptive control in chemical reactor, distillation column and variable area tank system.

**Total: 45 Hours**

**Reference(s)**

1. Karl J. Astrom & Bjorn Wittenmark, "Adaptive Control", Pearson Education (Singapore), Second Edition, 2003.
2. Shankar Sastry and Marc Bodson, "Adaptive Control: Stability, Convergence, and Robustness", Prentice-Hall, 1994.
3. I. D. Landau, R. Lozano, and M. M Saad, "Adaptive Control", NY: Springer-Verlag, 1998.
4. Gang Tao, "Adaptive Control Design and Analysis", Wiley-IEEE Press, 2003.
5. Kumpati S. Narendra, Anuradha M. Annaswamy, "Stable Adaptive Control Systems", Prentice Hall, 1989.
6. Chalam, "Adaptive Control Systems: Techniques and Applications", CRC Press, 1987.
7. T. C.H.A. Hsia, ‘System Identification’, Lexington books, 1974.
8. Stephanopoulis G. ‘Chemical Process Control’, Prentice Hall of India, New Delhi, 1990.

## 22EI030 DIGITAL CONTROL SYSTEM 3 0 0 3

**Course Objectives**

- To give basic knowledge in digital control system
- To impart necessary knowledge in stability analysis for discrete system
- To model systems in state space representation
- To provide a solution to state equations and to study various computational algorithms
- To know about the compensators in digital controllers

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Apply the sampling theorem for discrete time analysis and reconstruction for an analog signal.
2. Determine the response of a discrete time system and Investigate the stability of the discrete time system
3. Design a digital compensator / controller using frequency and time domain technique.
4. Formulate the state space model and compute the solutions of discrete time state space equation.
5. Design the state feedback controller / observer for a discrete time control system.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | - | - | - | - | - | - | - | - | 2 | 3 | - |
| 2 | 3 | 2 | 1 | 1 | - | - | - | - | - | - | 2 | - | 2 |
| 3 | 3 | 3 | 3 | 1 | - | 1 | - | - | - | - | 2 | - | 3 |
| 4 | 3 | 3 | 3 | 1 | - | - | - | - | - | - | 2 | - | 3 |
| 5 | 3 | 3 | 3 | 1 | - | 1 | - | - | - | - | 2 | - | 3 |

**UNIT I** **8 Hours**

**INTRODUCTION TO DIGITAL CONTROL**

Introduction - components and configuration of digital control system - discrete time system representation - sampling theorem - Mathematical modelling of sampling process - zero order hold - first order hold - Data reconstruction.

**UNIT II** **10 Hours**

**MODELING AND STABILITY ANALYSIS DISCRETE-TIME SYSTEMS**

Revisiting Z transform - Modified Z transform - Mapping of splane to z plane - Pulse transfer function - Pulse transfer function of closed loop system - Jury stability test - Transient and steady state responses.

**UNIT III** **11 Hours**

**DESIGN OF SAMPLED DATA CONTROL SYSTEMS**

Root locus method - Bode plot - Lead, lag and lag-lead compensator design using time, frequency domain - Discrete PID Controller - Design of digital control systems with deadbeat response.

**UNIT IV** **8 Hours**

**DISCRETE STATE SPACE MODEL**

Introduction to state variable model - Various canonical forms - Characteristic equation, state transition matrix - Solution to discrete state equation - Controllability and observability.

**UNIT V** **8 Hours**

**STATE FEEDBACK DESIGN**

Pole placement by state feedback - Set point tracking -controller - Full order observer - Reduced order observer.

**Total: 45 Hours**

**Reference(s)**

1. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2012.
2. K. Ogata, Discrete time control system, Pearson Education Asia, New Delhi, 2011.
3. B.C.Kuo, Digital Control System, 2nd Edition, Oxford University Press, 2010.
4. I.J. Nagarath and M. Gopal, Control System Engineering, New age International Pvt. Ltd, New Delhi, 2011.
5. Lawrence J. Kamm, Understanding Electro Mechanical Engineering: An Introduction to Mechatronics, Prentice Hall of India Pvt., Ltd., 2000.
6. Nitaigour Premchand Mahadik, Mechatronics, Tata McGraw-Hill publishing Company Ltd, 2009.

## 22EI031 OPTIMIZATION TECHNIQUES FOR CONTROLLER DESIGN

**3 0 0 3**

**Course Objectives**

- To introduce the different optimization problems and techniques
- To study the fundamentals of the linear and non-linear programming problem.
- To understand the concept of dynamic programming and genetic algorithm technique

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Translate descriptive statements of the design engineering problems in to a mathematical statement of optimization.
2. Apply the concept of calculus of variation and principal of optimality for solving problems
3. Design of Non-linear optimization controller & Design and Tuning a PID controller via optimization technique.
4. Apply the concept of Linear Quadratic method for solving problems
5. Design of optimal low-order feedforward controllers & model based optimization of a Controller

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 3 | 1 | - | - | - | - | - | - | 2 | - | 2 |
| 2 | 3 | 3 | 3 | 1 | - | - | - | - | - | - | 2 | - | 3 |
| 3 | 3 | 3 | 3 | 1 | - | 1 | - | - | - | - | 2 | - | 3 |
| 4 | 3 | 3 | 3 | 1 | - | - | - | - | - | - | 2 | - | 3 |
| 5 | 3 | 3 | 3 | 1 | - | 1 | - | - | - | - | 2 | - | 3 |

**UNIT I** **8 Hours**

**INTRODUCTION TO OPTIMIZATION**

Engineering application of Optimization-Statement of an Optimization Problem-Optimal Problem Formulation-Classification of Optimization problem. Optimum design concepts: Definition of Global and Local Optima-Optimality Criteria-Review of basic calculus Concepts-Global optimality.

**UNIT II** **10 Hours**

**CALCULUS OF VARIATION AND HAMILTON FORMULATION**

Fundamental concepts – Extremum functionals involving single and several independent functions – Piecewise smooth extremals - Variation of functionals with fixed and free terminal time constrained extrema Pontryagin's minimum principle - State inequality constraints – The Weierstrass Erdmann corner conditions - Solution of Bolza problem. Partial differential equation for cost function – Hamilton Jacobi equation - Principle of optimality, solution of Hamilton Jacobi equation - Matrix Riccati equation - Optimal control law.

**UNIT III** **10 Hours**

**PID DESIGN BY OPTIMIZATION**

Unconstrained, Constrained, Lagrange Multipliers, Quadratic Programming, Merit Functions, Line Search, Trust Region Methods, SQP-Introduction, PID Design, Convex-concave Optimization, MIMO PID Tuning via Iterated LMI Restriction, Model and Assumptions, Design Problem, Quadratic Matrix Inequality Form, Linear Matrix Inequality Restriction.

**UNIT IV** **9 Hours**

**LINEAR QUADRATIC CONTROL PROBLEMS**

Optimal control by Liapunov method - Parameter optimization – Quadratic performance index -Optimal control of systems - Matrix Riccati equation and solution methods of State regulator and discrete systems - Choice of weighting matrices – Linear Quadratic Guassian control – Kalman filter – H2 and H∞ Control and Optimal estimation

**UNIT V** **8 Hours**

**DESIGN OF OPTIMAL LOW-ORDER FEEDFORWARD CONTROLLERS**

Feedforward Structure, Optimal Feedforward Control, Optimal Feedforward Controller Characteristics, Control Signal Considerations, Precompensation, Design Examples. Feedforward controller design using convex optimization and tuning rules for proportional set-point weighting. Plant Models, Controllers and Signals, Error Minimization, Feedforward and Feedback Design, Tuning Rules for Set-Point Weighting.

**Total: 45 Hours**

**Reference(s)**

1. Rao S.S.Engineering Optimization, Theory and Practice New Age International Publishers, 4th Edition, 2012.
2. Design of Low-Order Controllers using Optimization Techniques Hast, Martin, 2015.
3. Deb K.Optimization for Engineering Design Algorithms and Examples, PHI, 2000.
4. Arora J.Introduction to Optimization Design-Elsevier Academic Press, New Delhi, 2004.
5. Saravanan R.Manufacturing Optimization through Intelligent Techniques-Taylor & Francis (CRC Press), 2006.
6. Hardley G.Linear Programming-Narosa Book Distributors Private Ltd., 2002.

## 22EI032 APPLIED SOFT COMPUTING 3 0 0 3

**Course Objectives**

- To expose the concepts of feedforward and feedback neural networks.
- To provide adequate about the concept of fuzziness involved in various systems.
- To expose the ideas about genetic algorithm

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Micro controller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Outline the necessity of soft computing techniques.
2. Analyze the functions and application of Artificial Neural Network
3. Apply the concept of fuzziness involved in various systems
4. Analyze the working of Genetic Algorithm
5. Design the soft computing techniques for linear and nonlinear systems.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 1 | 2 | 1 | - | - | - | - | - | - | - | - |
| 2 | 2 | 2 | 1 | 2 | 1 | - | - | - | - | - | - | - | 2 |
| 3 | 2 | 2 | 1 | 2 | 1 | - | - | - | - | - | - | - | 1 |
| 4 | 2 | 2 | 1 | 2 | 1 | - | - | - | - | - | - | - | 1 |
| 5 | 2 | 2 | 1 | 2 | 1 | - | - | - | - | - | - | - | 1 |

**UNIT I** **9 Hours**

**INTRODUCTION TO SOFT COMPUTING**

Introduction of soft computing - soft computing vs. hard computing- various types of soft computing techniques- applications of soft computing-Neuron- Nerve structure and synapse- Artificial Neuron and its model- activation functions- Neural network architecture- single layer and multilayer feed forward networks- McCullochPitts neuron model- perceptron model- Adaline and Madaline- multilayer perception model- back propogation learning methods- effect of learning rule coefficient –back propagation algorithm- factors affecting back propagation training- applications.

**UNIT II** **9 Hours**

**ARTIFICIAL NEURAL NETWORKS**

Counter propagation network- architecture- functioning & characteristics of counter- Propagation network-Hopfield/ Recurrent network- configuration- stability constraints-associative memory- and characteristics- limitations and applications- Hopfield v/s Boltzman machine- Adaptive Resonance Theory- Architecture- classifications-Implementation and training-Associative Memory.

**UNIT III** **9 Hours**

**FUZZY LOGIC SYSTEM**

Introduction to crisp sets and fuzzy sets-basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control-Fuzzification-inference and defuzzification-Fuzzy knowledge and rule bases-Fuzzy modeling and control schemes for nonlinear systems. Self- organizing fuzzy logic control- Fuzzy logic control for nonlinear time delay system.

**UNIT IV** **9 Hours**

**GENETIC ALGORITHM**

Basic concept of Genetic algorithm and detail algorithmic steps-adjustment of free Parameters- Solution of typical control problems using genetic algorithm- Concept on some other search techniques like tabu search and ant colony search techniques for solving optimization problems.

**UNIT V** **9 Hours**

**APPLICATIONS**

GA application to power system optimization problem- Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox. Stability analysis of Neural Network interconnection systems- Implementation of fuzzy logic controller using Matlab fuzzy logic toolbox- Stability analysis of fuzzy control systems.

**Total: 45 Hours**

**Reference(s)**

1. Laurene V. Fausett, Fundamentals of Neural Networks: Architectures, Algorithms and Applications, Pearson Education.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications" Wiley India.
3. Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2011.
4. David E.Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Pearson Education, 2009.
5. W.T.Miller, R.S.Sutton and P.J.Webrose, "Neural Networks for Control", MIT Press, 1996.

## 22EI033 MACHINE LEARNING TECHNIQUES 3 0 0 3

**Course Objectives**

- To Apply the Machine learning concepts for real-time problems.
- To implement machine learning techniques and computing environment that is suitable for the applications under consideration.
- To apply scaling up machine learning techniques and associated computing techniques and technologies.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Design machine learning systems and evaluation.
2. Apply probabilistic discriminative and generative algorithms for regression and classification problems and analyze the results
3. Apply an unsupervised algorithm to predict the continuous and categorical data and analyze the results.
4. Apply the machine learning algorithms for to solve real-world problems.
5. Generate machine learning model for regression and classification problems

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 3 | - | - | - | - | - | - | - | - | - | - |
| 2 | 1 | 2 | 3 | 3 | 2 | - | - | - | - | - | - | - | - |
| 3 | 1 | 2 | 3 | 3 | 2 | - | - | - | - | - | - | - | 1 |
| 4 | 2 | 2 | 2 | 3 | 3 | - | - | - | - | - | - | - | 1 |
| 5 | 1 | 1 | 2 | 3 | 3 | - | - | - | - | - | - | - | - |

**UNIT I** **7 Hours**

**INTRODUCTION**

Introduction-Definitions, types of learning, designing learning systems, issues in machine learning, - hypothesis space and inductive bias, evaluation, cross-validation.

**UNIT II** **10 Hours**

**SUPERVISED LEARNING**

Regression-Linear and multilinear regression, polynomial, decision trees, random forest. Classification- k-nearest neighbor algorithm, Classification and Regression Tree, logistic regression, SVM.

**UNIT III** **10 Hours**

**UNSUPERVISED LEARNING**

Clustering- k-means clustering and dimensionality reduction-singular value decomposition, principal component analysis, Categorical-Association analysis, Apriori, Frequent pattern growth, Hidden Markov model.

**UNIT IV** **9 Hours**

**NEURAL NETWORKS**

Biological Motivation- McCulloch Pitts Neuron, Thresholding Logic, Perceptron, Perceptron Learning Algorithm, Multilayer Perceptron-Back propagation algorithm, Sigmoid Neurons, neural network representation, Gradient Descent, bagging and boosting.

**UNIT V** **9 Hours**

**APPLICATION**

Machine Learning Frame works- Scikit Learn, Tensor flow, Azure, Theano. Applications-Boston house price prediction, Face recognition, Iris Classification.

**Total: 45 Hours**

**Reference(s)**

1. Stephen Marsland, Machine Learning - An Algorithmic Perspective, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Tom M Mitchell, Machine Learning, First Edition, McGraw Hill Education, 2013.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Second edition, Springer series in Statistics.
4. Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar, "Foundations of Machine Learning (FOML)", MIT Press, 2012.
5. Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms (UML)", Cambridge University Press, 2014.

## 22EI034 DEEP LEARNING TECHNIQUES 3 0 0 3

**Course Objectives**

- To understand the operations of Deep Learning Neural Networks
- To apply the Deep Learning concepts to the real-world applications
- To analyze the performance of deep learning architectures for real time applications.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Analyze the mathematical background and significance of Machine Learning Principles.
2. Apply the mathematical background and significance of Artificial Neural Networks in Deep Learning
3. Apply deep learning concepts into text and image processing.
4. Design a deep generative models for real time applications.
5. Analyze the recent developments and real world examples of Deep Learning architectures.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 2 | 1 | 2 | - | - | - | - | - | 2 | - | - |
| 2 | 1 | 2 | 3 | 1 | 2 | - | - | - | - | - | 2 | - | 1 |
| 3 | 1 | 1 | 2 | 3 | 2 | - | - | - | - | - | 1 | - | - |
| 4 | 1 | 1 | 2 | 3 | 2 | - | - | - | - | - | 1 | - | 2 |
| 5 | 1 | 1 | 2 | 3 | 2 | - | - | - | - | - | 2 | - | 1 |

**UNIT I** **7 Hours**

**INTRODUCTION TO MACHINE LEARNING**

Learning algorithms, Maximum likelihood estimation, Machine Learning Algorithms: Naive Bayes, Support Vector Machine, Decision Tree, Random Forest, Neural Networks - Multilayer Perceptron, Back-propagation algorithm and its variants stochastic gradient decent, Curse of Dimensionality.

**UNIT II** **9 Hours**

**INTRODUCTION TO DEEP NEURAL NETWORKS**

Activation functions, initialization, regularization, batch normalization, model selection, CNN architectures, pooling, visualization.

**UNIT III** **11 Hours**

**DEEP NEURAL NETWORK FOR TEXT AND IMAGE PROCESSING**

Transposed convolution, object detection, semantic segmentation, Recurrent neural networks (RNN), long-short term memory (LSTM), language models, machine translation, image captioning, video processing, visual question answering.

**UNIT IV** **11 Hours**

**DEEP GENERATIVE MODELS**

Auto-encoders, variational auto-encoders, generative adversarial networks, autoregressive models, generative image models, unsupervised and self-supervised representation learning

**UNIT V** **7 Hours**

**DEEP REINFORCEMENT LEARNING**

Policy gradient methods, Q-Learning, Real World Applications of Deep Learning Techniques

**Total: 45 Hours**

**Reference(s)**

1. I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press, 2016.
2. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner"s Approach", O"Reilly Media, 2017.
3. K. P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
4. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.

## 22EI035 PYTHON PROGRAMMING FOR AI AND ML 3 0 0 3

**Course Objectives**

- To study uninformed and Heuristic search techniques.
- To introduce Machine Learning and supervised learning algorithms
- To study ensembling and unsupervised learning algorithms

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

**Course Outcomes (COs)**

1. Analyze the appropriate search algorithms for problem-solving
2. Apply reasoning under uncertainty for the models
3. Design of supervised learning models for the application
4. Design of ensembling and unsupervised models for the application
5. Design of deep learning neural network models for the application

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 2 | 1 | 2 | - | - | - | - | - | 2 | - | - |
| 2 | 1 | 2 | 3 | 1 | 2 | - | - | - | - | - | 2 | - | - |
| 3 | 1 | 1 | 2 | 3 | 2 | - | - | - | - | - | 1 | - | - |
| 4 | 1 | 1 | 2 | 3 | 2 | - | - | - | - | - | 1 | - | - |
| 5 | 1 | 1 | 2 | 3 | 2 | - | - | - | - | - | 2 | - | - |

**UNIT I** **9 Hours**

**PROBLEM SOLVING**

Introduction to AI-AI Applications-Problem solving agents- search algorithms-uninformed search strategies - Heuristic search strategies - Local search and optimization problems - adversarial search - constraint satisfaction problems (CSP)

**UNIT II** **9 Hours**

**PROBABILISTIC REASONING**

Acting under uncertainty - Bayesian inference- naive bayes models. Probabilistic reasoning - Bayesian networks - exact inference in BN - approximate inference in BN - causal networks

**UNIT III** **9 Hours**

**SUPERVISED LEARNING**

Introduction to machine learning - Linear Regression Models: &Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function - Probabilistic discriminative model - Logistic regression, Probabilistic generative model - Naive Bayes, Maximum margin classifier - Support vector machine, Decision Tree, Random forests

**UNIT IV** **9 Hours**

**ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING**

Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization.

**UNIT V** **9 Hours**

**NEURAL NETWORKS**

Perceptron- Multilayer perceptron, activation functions, network training- gradient descent optimization - stochastic gradient descent, error backpropagation, from shallow networks to deep networks- Unit saturation (aka the vanishing gradient problem) -ReLU, hyperparameter tuning, batch normalization, regularization, dropout.

**Total: 45 Hours**

**Reference(s)**

1. Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", Pearson Education, 2007.
2. Kevin Night, Elaine Rich, and Nair B., "Artificial Intelligence", McGraw Hill, 2008.
3. Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006.
4. Deepak Khemani, "Artificial Intelligence", Tata McGraw Hill Education, 2013.
5. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
6. Charu C. Aggarwal, "Data Classification Algorithms and Applications", CRC Press, 2014.
7. Tom Mitchell, “Machine Learning”, McGraw Hill, 3rd Edition, 1997.
8. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, “Foundations of Machine Learning”, MIT Press, 2012.

## 22EI036 OPTIMIZATION TECHNIQUES 3 0 0 3

**Course Objectives**

- To familiarize with the basic concepts and models of the operations research
- To use transportation and assignment model techniques for effective decisions-making.
- To optimization that are tailored to large-scale statistics and machine learning problems

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

**Course Outcomes (COs)**

1. Formulate the basics of convex optimization in linear programming
2. Apply the suitable method to predict the optimum solution for nonconvex problems.
3. Analyze the fundamental concepts of Genetic Algorithm.
4. Analyze the methodology to reduce optimization problems using fuzzy logic and genetic algorithms.
5. Design the various optimization techniques involved in PSO for suitable applications.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 2 | 1 | 2 | - | - | - | - | - | 2 | 2 | 2 |
| 2 | 2 | 2 | 3 | 1 | 2 | - | - | - | - | - | 2 | 2 | 2 |
| 3 | 2 | 1 | 2 | 3 | 2 | - | - | - | - | - | 2 | 2 | 1 |
| 4 | 2 | 1 | 2 | 3 | 2 | - | - | - | - | - | 2 | 2 | 1 |
| 5 | 2 | 1 | 2 | 3 | 2 | - | - | - | - | - | 2 | 2 | 1 |

**UNIT I** **9 Hours**

**BASICS OF CONVEX OPTIMIZATION**

Convex sets, convexity-preserving operations, examples of convex programs (linear programming (LP), second-order cone programming (SOCP), semidefinite programming (SDP)), convex relaxation, KKT conditions, duality

**UNIT II** **9 Hours**

**STOCHASTIC AND NONCONVEX OPTIMIZATION**

Dual averaging, Polyak- Juditsky averaging, stochastic variance reduced gradient (SVRG), Langevin dynamics, escaping saddle points, landscape of nonconvex problems, deep learning

**UNIT III** **9 Hours**

**MODERN OPTIMIZATION IN GA**

Genetic algorithm-Introduction-biological background- traditional optimization and search techniques - Genetic basic concepts-operators-Encoding scheme-Fitness evaluation- crossover -mutation-genetic programming-multilevel optimization- real life problem- advances in GA

**UNIT IV** **9 Hours**

**GENETIC PROGRAMMING**

Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, Random population generation. Fuzzy Systems: Fuzzy set Theory, Optimization of Fuzzy systems

**UNIT V** **9 Hours**

**PARTICLE SWARM OPTIMIZATION**

Swarm Intelligence Swarm intelligence, Particle Swarm Optimization (PSO) Algorithm- Formulations, Pseudo-code, parameters, premature convergence, topology, biases, Real valued and binary PSO, Ant colony optimization (ACO) - Formulations, Pseudo-code. Applications of PSO and ACO.

**Total: 45 Hours**

**Reference(s)**

1. Engineering Optimization (4th Edition) by S.S.Rao, New Age International.
2. Stephen Boyd and Lieven Vandenberghe"s book: Convex Optimization.
3. Nesterov"s old book: Introductory Lectures on Convex Optimization: A Basic Course.
4. Optimization for Engineering Design by Kalyanmoy Deb, PHI Publishers.
5. Genetic algorithms in Search, Optimization, and Machine learning-D.E.Goldberg, Addison- Wesley Publishers.

## 22EI037 NATURAL LANGUAGE PROCESSING 3 0 0 3

**Course Objectives**

- Understand the representation and processing of Morphology and Part-of Speech Taggers
- Express different aspects of natural language syntax and the various methods used for processing syntax
- To know about various applications of natural language processing

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

**Course Outcomes (COs)**

1. Analyze the different linguistic components and models of given sentences
2. Design a morphological analyzer for a language using finite state automata concepts
3. Design a parser by providing suitable grammar and words
4. Recognize the semantic role of the sentence and implement the semantic parsing
5. Apply the machine translation and statistical translation to extract the information from the sentence

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - |
| 2 | 3 | 1 | 1 | 2 | 2 | 1 | 1 | - | - | - | - | - | - |
| 3 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | - | - | - | - | - | - |
| 4 | 3 | 1 | 1 | 1 | 2 | 1 | 1 | - | - | - | - | - | - |
| 5 | 3 | 1 | 1 | 2 | 2 | 1 | 1 | - | - | - | - | - | - |

**UNIT I** **8 Hours**

**INTRODUCTION**

Natural Language Processing tasks in syntax, semantics, and pragmatics -Issues - Applications - The role of machine learning - Probability Basics -Information theory - Collocations -N-gram Language Models - Estimating parameters and smoothing - Evaluating language models

**UNIT II** **9 Hours**

**MORPHOLOGY AND PART OF SPEECH TAGGING**

Linguistic essentials - Lexical synta - Morphology and Finite State Transducers - Part of speech Tagging - Rule-Based Part of Speech Tagging - Markov Models - Hidden Markov Models - Transformation-based Models - Maximum Entropy Models, Conditional Random Fields

**UNIT III** **10 Hours**

**SYNTAX PARSING**

Syntax Parsing - Grammar formalisms and treebanks - Parsing with Context-Free Grammars - Features and Unification -Statistical parsing and probabilistic CFGs (PCFGs)-Lexicalized PCFGs

**UNIT IV** **10 Hours**

**SEMANTIC ANALYSIS**

Representing Meaning - Semantic Analysis - Lexical semantics - Word-sense disambiguation - Supervised - Dictionary-based and Unsupervised Approaches - Compositional semantics- Semantic Role Labelling and Semantic Parsing - Discourse Analysis.

**UNIT V** **8 Hours**

**APPLICATIONS**

Named entity recognition and relation extraction- Information Extraction (IE) using sequence labelling Machine Translation (MT) - Basic issues in MT-Statistical translation-word alignment- phrase-based translation - Question Answering- VXML Applications

**Total: 45 Hours**

**Reference(s)**

1. Daniel Jurafsky and James H. Martin "Speech and Language Processing", Second Edition, Prentice Hall, 2014.
2. Christopher D. Manning and Hinrich Schuetze, "Foundations of Statistical Natural Language Processing", MIT Press, 2014.
3. Roland R. Hausser, "Foundations of Computational Linguistics Human- Computer Communication in Natural Language", Springer, 2014.

## 22EI038 BIOMEDICAL INSTRUMENTATION 3 0 0 3

**Course Objectives**

- To understand the role of instrumentation in bio medical engineering field
- To get ample knowledge on Electro-physiological and non-electric parameter measurement
- To understand principles of medical imaging - CT, MRI, diagnostic and therapeutic devices

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Analyze the human physiology and functioning systems of various organs
2. Outline the various electrodes and signal conditioning for electro physiological measurements
3. Examine the techniques for non-electrical parameter measurements like heart rate, respiration rate and blood pressure measurements
4. Outline the techniques used in medical image analysis and biotelemetry
5. Choose the appropriate assistive and therapeutic devices for illness

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 1 | - | - | 1 | 1 | 1 | - | - | 1 | 2 | - |
| 2 | 2 | 2 | 1 | - | - | 2 | 1 | 1 | - | - | 1 | 2 | 1 |
| 3 | 2 | 2 | 1 | - | - | 3 | 1 | 2 | - | - | 1 | 2 | 1 |
| 4 | 3 | 2 | 1 | - | - | 3 | 1 | 2 | - | - | 1 | 2 | 1 |
| 5 | 3 | 2 | 1 | - | - | 3 | 1 | 2 | - | - | 1 | 2 | 1 |

**UNIT I** **9 Hours**

**HUMAN PHYSIOLOGY AND BIO POTENTIAL ELECTRODES**

Cell and their structures - action and resting potential - nervous system: functional organization of the nervous system, structure of nervous system, neurons, synapse -transmitters and neural communication- cardiovascular system- Physiology of heart and lungs - Circulation and respiration.

**UNIT II** **9 Hours**

**ELECTRO-PHYSIOLOGICAL MEASUREMENT**

Basic components of a biomedical system - Amplifiers - Preamplifiers, differential amplifiers, chopper amplifiers - Isolation amplifier - Bio amplifier circuits - Electrodes - Micro, needle and surface electrodes - electrical safety - grounding and isolation - Transducer - Selection criteria Einthoven triangle - ECG - EEG - EMG - Lead systems and recording methods - Typical waveforms

**UNIT III** **9 Hours**

**NON - ELECTRICAL PARAMETER MEASUREMENTS**

Measurement of blood pressure - Sphygmomanometer - Phonocardiogram - Body Plethysmography - pH of blood - Pulse oximeter - Spirometry

**UNIT IV** **9 Hours**

**MEDICAL IMAGING PARAMETER MEASUREMENTS**

X-RAY machine - Computer Tomography - Magnetic Resonance Imaging system - Ultrasonography- Endoscopy - Bio-Telemetry

**UNIT V** **9 Hours**

**DIAGNOSTIC AND THERAPEUTIC DEVICES**

Cardiac Pacemakers - Defibrillators - Ventilators- Heart Lung machine - Dialyser- Diathermy - Neurostimulator - Elements of audio and visual aids

**Total: 45 Hours**

**Reference(s)**

1. R.S.Khandpur, Hand Book of Bio-Medical instrumentation, Tata McGraw Hill publishing company Ltd., 2016.
2. J.G. Webster, Medical Instrumentation: Application and Design, John Wiley and Sons, New York, 2010.
3. Leslie Cromwell, Biomedical Instrumentation and measurement, Tata McGraw Hill, 2007.
4. E. W. Golding and F. C. Widdis, Electrical measurements and measuring instruments, Ed.5, Pitman Publishing Ltd., London, 1963.
5. Joseph, A., A. Joseph, and Administer. Theory and Problems of Electric Circuits. Mc Graw Hill., 1994.
6. Introduction to Biomedical Technology by J. J. Karr & J. M. Brown, Pearson Publication

## 22EI039 DIGITAL IMAGE PROCESSING 3 0 0 3

**Course Objectives**

- To become familiar with digital image fundamentals
- To get exposed to simple image enhancement techniques in Spatial and Frequency domain.
- To learn concepts of degradation function and restoration techniques.
- To study the image segmentation and representation techniques.
- To become familiar with image compression and recognition methods.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Apply the basics and fundamentals of digital image processing and 2D-transforms.
2. Analyze the techniques of smoothing, sharpening and enhancement in digital images.
3. Analyze the segmentation and features extraction techniques.
4. Execute the restoration concepts and filtering techniques.
5. Implement the image compression using lossy and lossless compression techniques

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | 1 | - |
| 2 | 2 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | 1 | - |
| 3 | 2 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | 1 | - |
| 4 | 2 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | 1 | - |
| 5 | 2 | 3 | 1 | 2 | 2 | - | - | - | - | - | - | 1 | - |

**UNIT I** **9 Hours**

**DIGITAL IMAGE FUNDAMENTALS**

Fundamentals of Image processing: Elements of digital image processing systems, Elements of visual perception, Image sensing and acquisition, Image sampling and quantization. Basic relationships between pixels- Two-dimensional mathematical preliminaries

**UNIT II** **9 Hours**

**IMAGE ANALYSIS**

Image Transforms: DFT, DCT, Hadamard, Haar, KLT, SVD, Wavelet Transform and Slant transform Spatial domain: Histogram processing, Equalization, Basics of spatial filtering, smoothing spatial filters, sharpening spatial filters, Homomorphic filtering, Frequency domain: Image smoothing and sharpening using frequency domain filters.

**UNIT III** **9 Hours**

**IMAGE SEGMENTATION**

Edge detection: Point, line and edge Detection, Detection of isolated points, Line detection, Edge models, Basic edge detection, Edge linking and boundary detection. Thresholding - basic global thresholding, Ots''s method, Multiple, Variable and multivariable thresholding, Region splitting and Region Merging

**UNIT IV** **9 Hours**

**IMAGE RESTORATION AND RECOGNITION**

Image Restoration: Image degradation/ restoration model, Noise models, Restoration-Spatial Filtering, Constrained Least square filtering, inverse filtering, Wiener Filtering, Wiener filtering, Geometric transformations, Image Recognition: Patterns and pattern classes, Matching-Minimum Distance classifiers

**UNIT V** **9 Hours**

**IMAGE COMPRESSION AND COLOUR IMAGE PROCESSING**

Basic compression methods: Huffman coding, Arithmetic coding, LZW coding, Run-length coding, Lossless and Lossy predictive coding, Block transform coding, Wavelet coding, Image Compression Standards. Color image processing fundamentals: Pseudo color image processing- Basics of full color image processing.

**Total: 45 Hours**

**Reference(s)**

1. Digital Image Processing, C. Rafeal Gonzalez and E. Richard Woods, Pearson Education, Fourth Edition, 2018.
2. Fundamentals of Digital Image Processing, Anil K. Jain, Pearson Education, 2015.
3. Digital Image Processing, S Jayaraman, S Esakkirajan T Veerakumar, Mc Graw-Hill, 2010.
4. Digital Image Processing, K. William Pratt, John Wiley, 2007.
5. Digital Image Processing Using MATLAB, C. Rafeal Gonzalez, McGraw Hill, 2017.
6. Image Processing Theory, Algorithm and Architectures, M.A. Sid Ahmed, McGraw-Hill, 1995.

## 22EI040 BIO SIGNAL PROCESSING 3 0 0 3

### Course Objectives

- To study the characteristics of different bio signals
- To learn linear and non-linear filtering techniques to extract desired information
- To understand various techniques for automated classification and decision making to aid diagnosis

### Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

### Course Outcomes (COs)

1. Preprocess the Biosignals and spectral characteristics
2. Analyze biosignals in time domain & to estimate the spectrum.
3. Apply wavelet detection techniques for biosignal processing.
4. Classify Biosignals using neural networks and statistical classifiers
5. Extract the features using multivariate component analysis.

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | 2 | 1 | - | - | - | - | - | - | - | - | - |
| 2 | 3 | 1 | 2 | 1 | - | - | - | - | - | - | - | - | - |
| 3 | 3 | 1 | 2 | 1 | - | - | - | - | - | - | - | - | - |
| 4 | 3 | 1 | 2 | 1 | - | - | - | - | - | - | - | - | - |
| 5 | 3 | 1 | 2 | 1 | - | - | - | - | - | - | - | - | - |

**UNIT I** **9 Hours**

**BIOSIGNAL AND SPECTRAL CHARACTERISTICS**

Characteristics of some dynamic biomedical signals, Noises- random, structured and physiological noises- Filters- IIR and FIR filters- Spectrum - power spectral density function, cross-spectral density and coherence function, cepstrum and homomorphic filtering. Estimation of mean of finite time signals.

**UNIT II** **9 Hours**

**TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION**

Time series analysis - linear prediction models, process order estimation, lattice representation, non-stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG signals, Time varying analysis of Heart-rate variability, model based ECG simulator. Spectral estimation -Blackman Tukey method, periodogram, and model based estimation. Application in Heart rate variability, PCG signals.

**UNIT III** **9 Hours**

**ADAPTIVE FILTERING AND WAVELET DETECTION**

Filtering -LMS adaptive filter, adaptive noise canceling in ECG, improved adaptive filtering in ECG, Wavelet detection in ECG - structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

**UNIT IV** **9 Hours**

**BIOSIGNAL CLASSIFICATION AND RECOGNITION**

Signal classification and recognition - Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification, Application in Normal versus Ectopic ECG beats.

**UNIT V** **9 Hours**

**TIME FREQUENCY AND MULTIVARIATE ANALYSIS**

Time frequency representation, spectrogram, Wigner distribution, Time-scale representation, scalogram, wavelet analysis - Data reduction techniques, ECG data compression, ECG characterization, Feature extraction- Wavelet packets, Multivariate component analysis-PCA, ICA.

**Total: 45 Hours**

**Reference(s)**

1. Arnon Cohen, "Bio-Medical Signal Processing Vol I and Vol II", CRC Press Inc., Boca Rato, Florida, 1999.
2. Rangaraj M. Rangayyan, "Biomedical Signal Analysis-A case study approach", Wiley, 2nd Edition, 2016.
3. Willis J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall of India, New Delhi, 2003.
4. Emmanuel C. Ifeachor, Barrie W.Jervis, "Digital Signal processing- A Practical Approach", Pearson education Ltd., 2004.
5. K.P.Soman, K.Ramachandran, "Insight into wavelet from theory to practice", PHI, New Delhi, 3rd Edition, 2010.

## 22EI041 HUMAN ASSISTIVE DEVICES 3 0 0 3

**Course Objectives**

- To study the role and importance of medical assist devices
- To get exposed to functioning of rehabilitation and related aspects.
- To learn concepts of the design aspects of prosthetic and orthotic devices.
- To become familiar with hearing and visual aids.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Analyze the various electro mechanical techniques that will help failing heart
2. Analyze the functioning of the hemodialysers for the clearance of urea from the blood.
3. Analyze the tests to assess the hearing loss and development of electronic devices to compensate for the loss.
4. Analyze the various orthodic devices and prosthetic devices to overcome orthopaedic problems.
5. Implement the rehabilitation and electrical stimulation techniques used in clinical applications.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 2 | 2 | 1 | 2 | - | - | - | - | - | 1 | - |
| 2 | 2 | 3 | 2 | 2 | 1 | 2 | - | - | - | - | - | 1 | - |
| 3 | 2 | 3 | 2 | 2 | 1 | 2 | - | - | - | - | - | 1 | - |
| 4 | 2 | 3 | 2 | 2 | 1 | 2 | - | - | - | - | - | 1 | - |
| 5 | 2 | 3 | 2 | 2 | 1 | 2 | - | - | - | - | - | 1 | - |

**UNIT I** **9 Hours**

**BASIC COMPONENTS OF BIOMEDICAL SYSTEMS AND CARDIAC ASSIST DEVICES**

Basic components of a biomedical system - Amplifiers - Preamplifiers, differential amplifiers, chopper amplifiers - Isolation amplifier - Bio amplifier circuits - Principle of External counter pulsation techniques, intra-aortic balloon pump, Auxiliary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves.

**UNIT II** **9 Hours**

**HEMODIALYSERS**

Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters

**UNIT III** **9 Hours**

**HEARING AND VISUAL AIDS**

Common tests - audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids-principles, drawbacks in the conventional unit, DSP based hearing aids. Ultra sonic and laser canes, Intra ocular lens, Braille Reader, Tactile devices for visually Challenged, Text to voice converter, Screen readers

**UNIT IV** **9 Hours**

**PROSTHETIC AND ORTHODIC DEVICES**

Hand and arm replacement - different types of models, externally powered limb prosthesis, feedback in orthodic system, functional electrical stimulation, sensory assist devices.

**UNIT V** **9 Hours**

**REHABILITATION MEDICINE AND STIMULATORS**

Physiological aspects of Function recovery, Psychological aspects of Rehabilitation therapy, Legal aspect available in choosing the device, Transcutaneous electrical nerve stimulator, bio-feedback.

**Total: 45 Hours**

**Reference(s)**

1. Joseph D.Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press, 2006.
2. Levine S.N. (ed), "Advances in Bio-medical engineering and Medical physics", Vol. I, II, IV, inter university publications, New York, 1968.
3. Short Textbook of Prosthetics and Orthotics - R Chinnathurai- Jaypee BrothersMedical Publishers (P) Ltd, 2010.
4. R.S. Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw Hill, 2nd Edition, 2003.
5. Kopff W.J, "Artificial Organs", John Wiley and sons, New York, 1976.
6. Albert M.Cook and Webster J.G, “Therapeutic Medical Devices”, Prentice Hall Inc., New Jersey, 1982.

## 22EI042 MEDICAL IMAGING SYSTEMS 3 0 0 3

**Course Objectives**

- To study the medical image acquisition and reconstruction techniques
- To get exposed to functioning of radio isotopic imaging equipments.
- To learn concepts of the MRI, image acquisition and reconstruction techniques.
- To become familiar with X-ray and ultra sound imaging systems.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Analyze the nuclear medical imaging techniques for acquisition of images.
2. Analyze the x-ray medical imaging techniques and its imaging quality.
3. Apply the concept of Neuro Magnetic Science in MRI.
4. Analyze the principle and operation modes of Ultrasound Imaging.
5. Implement the radio isotopes and thermography for imaging techniques.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 2 | 2 | 1 | 1 | - | - | - | - | - | 1 | - |
| 2 | 2 | 3 | 2 | 2 | 1 | 1 | - | - | - | - | - | 1 | - |
| 3 | 2 | 3 | 2 | 2 | 1 | 1 | - | - | - | - | - | 1 | - |
| 4 | 2 | 3 | 2 | 2 | 1 | 1 | - | - | - | - | - | 1 | - |
| 5 | 2 | 3 | 2 | 2 | 1 | 1 | - | - | - | - | - | 1 | - |

**UNIT I** **9 Hours**

**MEDICAL IMAGE FUNDAMENTALS AND ACQUISITION**

Introduction to Imaging Techniques - Single crystal scintillation camera - Principles of scintillation camera - multiple crystal scintillation camera - solid state camera - rectilinear scanner. Image Reconstruction - Mathematical Preliminaries for Two and Three Dimensional Image Reconstructions - Radon Transform- Projection Theorem - central slice Theorem- Sinogram.

**UNIT II** **9 Hours**

**X- RAY AND COMPUTED TOMOGRAPHY**

Priniciples of sectional imaging- scanner configuration -data acquisition system -image formation principles - conversion of x-ray data in to scan image -2-D image reconstruction Techniques-Iteration and Fourier method- types of CT scanners.

**UNIT III** **9 Hours**

**MAGNETIC RESONANCE IMAGING**

Production of ultrasound - properties and principles of image formation, capture and display - principles of A-mode, B-mode and M-mode display - Doppler ultra sound andcolour flow mapping -applications of diagnostic ultra sound.

**UNIT IV** **9 Hours**

**ULTRASOUND IN MEDICINE**

Production of ultrasound - properties and principles of image formation, capture and display - principles of A-mode, B-mode and M-mode display - Doppler ultra sound and colour flow mapping - applications of diagnostic ultra sound.

**UNIT V** **9 Hours**

**RADIO ISOTOPIC AND THERMAL IMAGING**

Rectilinear scanners-linear scanners - SPECT - PET Gamma camera radio nuclides for imaging - emission computed CT. Physics of thermography - imaging systems - pyroelectric vidicon camera clinicalthermography - liquid crystal thermography

**Total: 45 Hours**

**Reference(s)**

1. Steve Webb, "The physics of medical imaging", Adam Hilger, Bristol, England, Philadelphia, USA, 1988.
2. Jerry L.Prince and Jnathan M.Links, Medical Imaging Signals and Systems- Pearson Education Inc. 2006.
3. William R. Hendee, E. Russell Ritenour, Medical Imaging Physics: A John Wiley & sons, Inc., Publication, Fourth Edition, 2002.
4. Z.H. Cho., J-oie, P. Jones and Manbir Singh, Foundations of Medical Imaging: John Wiley and sons Inc. 2003.
5. P.Raghunathan, "Magnetic Resonance Imaging and Spectroscopy in Medicine" Concepts and Techniques, Orient Longman, 2007.

## 22EI043 BRAIN COMPUTER INTERFACE 3 0 0 3

**Course Objectives**

- To study the basic concepts of brain computer interface
- To get exposed to various signal acquisition methods
- To learn concepts of the signal processing methods used in brain computer interface.
- To become familiar with various machine learning methods of BCI.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Analyze the various brain computer interface types and monitoring hardware.
2. Analyze the functioning of the activation patterns and brain stimulations.
3. Execute the various feature extraction methods
4. Analyze the machine learning methods for brain computer interface.
5. Implement the brain computer interface models in various applications.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 2 | 2 | - | 2 | - | - | - | - | - | 1 | - |
| 2 | 2 | 2 | 2 | 2 | - | 2 | - | - | - | - | - | 1 | - |
| 3 | 2 | 2 | 2 | 2 | - | 2 | - | - | - | - | - | 1 | - |
| 4 | 2 | 2 | 2 | 2 | - | 2 | - | - | - | - | - | 1 | - |
| 5 | 2 | 2 | 2 | 2 | - | 2 | - | - | - | - | - | 1 | - |

**UNIT I** **9 Hours**

**INTRODUCTION TO BRAIN COMPUTER INTERFACE**

Introduction - Brain structure and function, Brain Computer Interface Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, ECoG, MEG, fMRI.

**UNIT II** **9 Hours**

**BRAIN ACTIVATION**

Brain activation patterns - Spikes, Oscillatory potential and ERD, slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials - Visual Evoked Potentials -P300 and Auditory Evoked Potentials, Potentials related to cognitive tasks.

**UNIT III** **9 Hours**

**FEATURE EXTRACTION METHODS**

Data Processing - Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artefacts reduction, Feature Extraction, Phase synchronization and coherence

**UNIT IV** **9 Hours**

**MACHINE LEARNING METHODS FOR BRAIN COMPUTER INTERFACE**

Classification techniques - Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF""s, Perceptron's, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis.

**UNIT V** **9 Hours**

**APPLICATIONS OF BRAIN COMPUTER INTERFACE**

Case Studies - Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Noninvasive BCIs: P300 Mind Speller, Visual cognitive BCI, Emotion detection. Ethics of Brain Computer Interfacing.

**Total: 45 Hours**

**Reference(s)**

1. Rajesh.P.N.Rao, "Brain-Computer Interfacing: An Introduction", Cambridge University Press, First Edition, 2013.
2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, "Brain Computer Interfaces: Principles and practice", Oxford University Press, USA, Edition 1, 2012.
3. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010.
4. Ali Bashashati, Mehrdad Fatourechi, Rabab K Ward, Gary E Birch, " A survey of signal Processing algorithms in brain-computer interfaces based on electrical brain signals" Journal of Neural Engineering, 2007.
5. Ella Hassianien A A, Azar.A.T (Editors), “Brain-Computer Interfaces Current Trends and Applications”, Springer, 2015.

## 22EI044 HYDRAULICS AND PNEUMATICS 3 0 0 3

**Course Objectives**

- To learn hydraulic fluid / Pneumatic air fundamentals including generation and distribution
- To understand working principles, operation of hydraulic and pneumatic components
- To expose to various techniques of circuit building in pneumatics

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Attribute the fundamentals of hydraulic and pneumatic systems.
2. Differentiate the various hydraulic system components, pumps and actuators.
3. Outline the selection criteria for hydraulic system.
4. Choose the appropriate pneumatic system components for the given application.
5. Design of pneumatic circuit for simple applications.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 2 | 1 | 3 | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 3 | 1 | 1 | 3 | 2 | - | - | - | - | - | - | - | - | 3 |
| 4 | 1 | 1 | 3 | 2 | - | - | - | - | - | - | - | - | 3 |
| 5 | 1 | 1 | 3 | 2 | - | - | - | - | - | - | - | - | 3 |

**UNIT I** **5 Hours**

**FUNDAMENTALS OF HYDRAULICS AND PNEUMATICS**

Introduction to fluid power, properties - hydraulic fluids, air. Selection of hydraulic fluids, comparison between hydraulics and pneumatics.

**UNIT II** **10 Hours**

**ELEMENTS OF HYDRAULIC SYSTEMS**

Pumps - types, characteristics. Valves for control of direction, flow and pressure - types, typical construction details, Actuators -types and constructional details.

**UNIT III** **10 Hours**

**HYDRAULIC SYSTEM DESIGN**

Power pack elements, design. Pipes- material, pipe fittings. seals and packing. Maintenance of hydraulic systems. Selection criteria for cylinders, valves, pipes. Heat generation in hydraulic system.

**UNIT IV** **10 Hours**

**ELEMENTS OF PNEUMATIC SYSTEMS**

Components, constructional details, filter, lubricator, regulator, constructional features, types of actuators, control valves for direction, pressure and flow, air motors, air hydraulic equipment.

**UNIT V** **10 Hours**

**PNEUMATIC CONTROL SYSTEM DESIGN**

General approach to control system design, symbols and drawings, schematic layout, travel step diagram, circuit, control modes, program control, sequence control, cascade method, Karnaugh-Veitchmapping.

**Total: 45 Hours**

**Reference(s)**

1. Anthony Esposito,Fluid Power with Application, Pearson Education (Singapore) Pvt. Ltd, Delhi, India, 2003.
2. Srinivasan R, Hydraulic and Pneumatic Controls, McGraw Hill education (India) Pvt. Ltd, 2010.
3. MajumdarSR,Oil Hydraulic Systems: Principles and Maintenance, Tata McGraw- Hill., New Delhi, 2003.
4. Majumda SR,Pneumatic Systems: Principles and Maintenance, Tata McGraw- Hill., New Delhi, 1996.
5. Peter Rohner, Fluid Power Logic Circuit Design Analysis, Design, Method and WorkedExamples, The Macmillan Press Ltd., UK 1979.
6. Werner Deppert and Kurt Stoll, Pneumatic Controls: An Introduction to Principles, Vogel-Druck Wurzburg, Germany, 1975.

## 22EI045 SMART AND WIRELESS INSTRUMENTATION 3 0 0 3

**Course Objectives**

- To acquire knowledge on smart instrumentation system with their communication protocol
- To know about wireless sensor networks used in various process industries
- To get adequate knowledge on design, development and challenges in smart and wireless technology

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Outline the functioning elements of a smart sensor and its standards for sensor interfacing
2. Analyze the concepts of smart instrumentation with its HART communication protocol
3. Choose the appropriate wireless instruments for the given applications
4. Attribute industrial wireless technology for process monitoring applications
5. Predict the challenges and opportunities of recent techniques in smart and wireless systems

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 1 | - | - | - | - | - | - | - | 1 | 1 | - |
| 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | 1 | 2 | - |
| 3 | 3 | 3 | 3 | - | - | - | - | - | - | - | 1 | 2 | - |
| 4 | 1 | 2 | 2 | - | - | - | - | - | - | - | 1 | 1 | - |
| 5 | 2 | 3 | 1 | - | - | - | - | - | - | - | 1 | 2 | - |

**UNIT I** **9 Hours**

**SMART SENSORS**

Functional elements of smart sensors: Primary and Secondary sensors - Amplifiers - Filters - Converters - Compensators - Information coding / processing - Data communication - Standards for smart sensor interface Applications.

**UNIT II** **9 Hours**

**SMART INSTRUMENTATION**

Smart instrumentation system - HART communication protocol - Diagnosis of smart instruments - Remote Calibration - Applications: Smart flow and pressure transmitters.

**UNIT III** **9 Hours**

**WIRELESS INSTRUMENTS**

Wireless sensors and transducers - Essential components of a Wireless Instrument - Structure of Wireless Instrument - Wireless Bridges, Routers, Gateways and repeaters - Wireless data logging system - Power considerations of Wireless Instruments.

**UNIT IV** **9 Hours**

**WIRELESS SENSOR NETWORK**

Architecture of Wireless Sensor Network - Effect of IEEE 1451 standards in Wireless Sensor networks Network Topologies - Energy Issues in Wireless Sensor Networks - Wireless Integrated Network Sensors.

**UNIT V** **9 Hours**

**RECENT TRENDS IN SMART AND WIRELESS TECHNOLOGY**

Wireless Human Health Monitoring - Wireless Environmental and Habitat Monitoring Systems - Wireless Consumer Products - WSN based smart precision agriculture system - Challenges and opportunities.

**Total: 45 Hours**

**Reference(s)**

1. Smart Sensors, Measurement and Instrumentation, Subhas Chandra Mukhopadhyay, Springer Heidelberg, New York, Dordrecht London, 2013.
2. Uvais Qidwai, Smart Instrumentation: A data flow approach to Interfacing, Chapman & Hall, 1st Edition, 2013.
3. Kazem Sohraby, Daniel Minoli, Taieb Z Nati, Wireless sensor networks: technology, protocols,and applications, John Wiley & Sons, Inc., Hoboken, New Jersey, 2007.
4. Wireless Sensor Networks: Architectures and Protocols, Edgar H. Callaway Jr. and Edgar H. Callaway.
5. Halit Eren, Wireless Sensors and Instruments Networks, Design and Applications, Taylor and Francis group, 2006.

## 22EI046 MICRO ELECTRO MECHANICAL SYSTEM 3 0 0 3

**Course Objectives**

- To understand the concept of micromachining techniques.
- To get adequate knowledge about various etching techniques in micromachining.
- Analyze the Integration of Polymer and Optical MEMS.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Analyze the characteristics, electrical and mechanical concepts and materials used for MEMS design
2. Outline the working principle and Techniques involved in Micro Sensors based on electrostatic, thermal properties
3. Organize the type of sensors and actuators in MEMS and selecting suitable sensors for the various applications
4. Analyze the four etching techniques and two fabrication methods used for micromachining
5. Compare the polymer MEMS and Optical MEMS based on materials used for fabrication, working principles and application

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | - | - |
| 2 | 2 | 3 | 1 | 1 | - | - | - | - | - | - | - | - | - |
| 3 | 1 | 2 | 3 | 2 | 1 | - | - | - | - | - | - | - | - |
| 4 | 2 | 1 | 2 | 3 | 1 | - | - | - | - | - | - | - | - |
| 5 | 2 | 1 | 2 | 3 | 3 | - | - | - | - | - | - | 2 | - |

**UNIT I** **9 Hours**

**INTRODUCTION**

MEMS Technology - Definition - Laws of Scaling - Intrinsic Characteristics of MEMS - Multi disciplinary nature of MEMS - Energy Domains - Sensors, Transducers and Actuators - Silicon based MEMS processes - Stress and strain analysis - Applications of MEMS in various industries.

**UNIT II** **11 Hours**

**MICRO SENSORS**

Working principle of Microsystems - Micro actuation techniques - Properties and Types of Micro sensors - Capacitor Types - Thermal Sensing and expansion - Magnetic Actuators - Micromagnetic components - Micro accelerometers

**UNIT III** **10 Hours**

**SENSORS AND ACTUATORS**

Piezoresistive sensors - Piezoresistive sensor materials - Stress analysis of mechanical elements - Applications to Inertia, Pressure, Tactile and Flow sensors - Piezoelectric sensors and actuators - piezoelectric effects - piezoelectric materials, Acoustic, Tactile and Flow sensors Applications

**UNIT IV** **8 Hours**

**FABRICATION AND MICRO MACHINING**

Introduction - Photolithography - Ion implantation - Diffusion - Oxidation- CVD - Physical vapor deposition - Etching Techniques: Dry - Wet Etching; Gas Phase Etchants - Surface Micro Machining LIGA - Micro system packaging materials - Packing Techniques - Bonding and Sealing

**UNIT V** **7 Hours**

**POLYMER AND OPTICAL MEMS**

Polymers in MEMS - Polyimide - SU-8 - Liquid Crystal Polymer (LCP) - Parylene -Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors - Optical MEMS - Lenses and Mirrors - Actuators for Active Optical MEMS

**Total: 45 Hours**

**Reference(s)**

1. Nadim Maluf, An introduction to Micro electro mechanical system design, Artech House, 2011.
2. MEMS and Microsystems Design and Manufacture by Tai-Ran Hsu. Tata McGraw-Hill Publishing Company Ltd., 2010.
3. Mohamed Gad-el-Hak, The MEMS Handbook, CRC press Baco Raton, 2012.
4. Julian w. Gardner, Vijay k. varadan and Osama O.Awadelkarim, Micro sensors MEMS and smart devices, John Wiley & son LTD, 2010.

## 22EI047 POWER ELECTRONICS AND DRIVES 3 0 0 3

**Course Objectives**

- To obtain the switching characteristic of different types of power semi-conductor devices
- To determine the operation, characteristics and performance parameters of AC, DC converters.
- To understand application of Power Electronics drives.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Analyze the construction, operation, and characteristics of power semiconductor devices
2. Analyze the functions of single-phase and three-phase controlled rectifiers.
3. Analyze the functions and operating principle of choppers and cycloconverters.
4. Analyze the functions and operating principle of inverters
5. Select the appropriate drives for various control applications.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | - | 3 | - | - | - | - | - | - | - | 1 | - |
| 2 | 1 | 2 | 3 | 3 | - | - | - | - | - | - | - | 1 | - |
| 3 | 1 | 2 | 3 | - | - | - | - | - | - | - | - | 1 | - |
| 4 | 1 | 2 | - | 3 | - | - | - | - | - | - | - | 1 | - |
| 5 | 1 | 2 | 3 | - | - | - | - | - | - | - | - | 1 | - |

**UNIT I** **9 Hours**

**POWER SEMI-CONDUCTOR DEVICES**

Construction, Operation, Characteristics of Power Diode - DIAC- SCR - TRIAC - Power transistor, MOSFET and IGBT - Ratings of SCR - Series parallel operation of SCR, di/dt & dv/dt protection.

**UNIT II** **10 Hours**

**CONTROLLED RECTIFIERS**

Single Phase and Three phase uncontrolled converter - Single Phase and Three phase half and fully controlled converters - Single phase and Three phase dual converter operation - Effect of source inductance.

**UNIT III** **9 Hours**

**CHOPPERS AND CYCLOCONVERTERS**

Principle of chopper operations - control strategies - Step up and step down chopper - Buck and boost switched mode regulators - cycloconverters, Single phase cycloconverters.

**UNIT IV** **9 Hours**

**INVERTERS**

Single phase and three phase (both 120 deg mode and 180 deg mode) inverters - PWM techniques: Sinusoidal PWM modified sinusoidal PWM and multiple PWM - Current source inverters - Voltage source inverter - UPS, Thyristor control of heating element

**UNIT V** **8 Hours**

**DRIVES**

Determination of speed and torque requirements for specific motion profiles, Introduction to DC drives - AC Drives-Frequency control - Stepper motor drives- Position control- Servo drives- applications.

**Total: 45 Hours**

**Reference(s)**

1. Dr.P.S. Bhimbra, Power Electronics, Khanna Publishers, New Delhi, 2012.
2. Ned Mohan, Tore.M.Undeland, William.P.Robbins, Power Electronics: Converters Applications and Design, Wiley India, New Delhi, 3rd Edition, 2010.
3. Singh. M.D & Khanchandani, K.B Power Electronics Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2010.
4. Muhammad H. Rashid, Power Electronics Circuits, Devices & Applications, Prentice Hall of India, New Delhi, 2013.

## 22EI048 CHEMICAL PROCESS SYSTEMS 3 0 0 3

**Course Objectives**

- To introduce various chemical process fundamentals.
- To model different process in chemical industries
- To analyses ome benchmark process in chemical industries

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Interpret thefundamentals of chemical process engineering
2. Implement the material balances in simple chemical process for model determination
3. Interpret the fudamentals of fluid mechanics
4. Analyse different components of P&I diagram.
5. Outline the applications of chemical processes such as distillation columns and reactors with their P&I diagram.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | | | | | | | | | 1 | | 1 |
| 2 | 2 | 2 | 1 | 3 | | | | | | | 2 | | 1 |
| 3 | 2 | 1 | | | | | | | | | 1 | | 1 |
| 4 | 2 | 1 | 2 | 3 | | | | | | | 2 | 1 | 2 |
| 5 | 1 | 1 | 1 | | | | | | | | 2 | 1 | 2 |

**UNIT I** **9 Hours**

**INTRODUCTION TO CHEMICAL PROCESS SYSTEM**

Historical overview of Chemical Engineering: Concepts of unit operations - Unit processes, - More recent developments. Chemical Industry - scope - Features & characteristics - Flow sheets – Symbols for various operations.

**9 Hours**

**UNIT II**

**MATERIAL BALANCES OF CHEMICAL SYSTEM**

Material balances in simple systems involving physical changes and chemical reactions –Systems involving recycle –purge - Bypass - Combustion reactions - Forms of energy - Optimum utilization of energy - Energy balance calculations in simple systems. Introduction to Computer aided calculations –Steady state material and energy balances-Combustion reactions.

**9 Hours**

**UNIT III**

**BASIC FLUID CONCEPTS**

Dimensions and Units - Velocity and Stress Fields - Viscosity and surface tension - Non Newtonian viscosity - Dimensional Analysis (Buckingham PI theorem) - Types of flows - Methods of Analysis –Fluid Statics. Pipe flow Pumps-Agitation and Mixing–Compressors.

**UNIT IV** **9 Hours**

**PROCESS AND INSTRUMENTATION DIAGRAM**

Symbol identification of mechanical equipment - Process connections - Instruments symbols – Control loop.

**9 Hours**

**UNIT V**

**APPLICATIONS**

Fundamental principles and classification of Distillations, Heat exchangers-Steam Drum Level-Membrane Process- Energy and Mass Conservation in process systems and industries.

**Total: 45 Hours**

**Reference(s)**

1. G.T. Austin, R.N. Shreve, Chemical Process Industries, 5th ed., McGraw Hill, 1984.
2. W.L. McCabe, J.C. Smith and P. Harriott, Unit Operations of Chemical Engineering, Sixth Edition, McGraw Hill, 2011.
3. R. M. Felder and R.W. Rousseau, Elementary Principles of Chemical Processes, 3rd ed., John Wiley, New York, 2012.
4. L.B. Anderson and L.A. Wenzel, Introduction to Chemical Engineering, McGraw Hill, 1961.
5. H.S. Fogler, Elements of Chemical Reaction Engineering, 4th Ed., Prentice-Hall, 2011.

## 22EI049 INSTRUMENTATION AND CONTROL FOR PROCESS INDUSTRIES 3 0 0 3

**Course Objectives**

- To get adequate knowledge about the standards in process industries.
- To know about various measurements involved inprocess control.
- To have a knowledge about instrumentation in process industries.

**Programme Outcomes (POs)**

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**Course Outcomes (COs)**

1. Understand the basic ISA standards with the control processes involved.
2. Select instrumentation techniques for Iron and Steel Industries.
3. Implement instrumentation techniques for Paper Industries.
4. Execute instrumentation techniques for Sugar Industries.
5. Demonstrate instrumentation techniques for Cement Industries.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 3 | | - | - | - | - | - | - | - | - | - |
| 2 | 1 | 2 | | 3 | - | - | - | - | - | - | - | - | - |
| 3 | 1 | 2 | 3 | | - | - | - | - | - | - | - | - | - |
| 4 | 1 | 2 | | 3 | - | - | - | - | - | - | - | - | - |
| 5 | 1 | 2 | 3 | | - | - | - | - | - | - | - | - | - |

**UNIT I** **6 Hours**

**ISA STANDARDS AND BASIC PROCESS CONTROL**

ISA Standard Purpose- loop identification- Instrument line and function symbols.
Temperature, Pressure and Flow control.

**UNIT II** **12 Hours**

**INSTRUMENTATION IN IRON AND STEEL INDUSTRIES**

Description of the process - typical control system in iron and steel industry - blast furnace and Basic oxygen furnace - blast furnace stove combustion control system - gas and water control in BOF furnace-stand casting mold level control.

**UNIT III** **10 Hours**

**INSTRUMENTATION IN PAPER INDUSTRIES**

Description of process of pulp and paper industry-blow down task control-stock chest level control Basis weight control of a paper machine-valves used in paper industry –consistency control.

**7 Hours**

**UNIT IV**

**INSTRUMENTATION IN SUGAR INDUSTRIES**

Flow diagram of a sugar plant and its instrumentation set up - batch process - Fermenter Control –juice extraction control process and instrumentation.

**UNIT V** **10 Hours**

**INSTRUMENTATION IN CEMENT INDUSTRIES**

Level Measurement in rock crushers, Solid level measurement in rock crushers, Build-up measurement in cyclones, Mass flow measurement in convey orbelts, Pressure measurement in cementsilos.

**Total: 45 Hours**

**Reference(s)**

1. B.G.Liptak, Instrumentation in Processing Industries, Chiller Book Co, 2015
2. ISA, Instrumentation Symbols and Identifications, ISA Society (1st Module), 2017
3. Andrews & William, Applied Instrumentation in Process Industries, 2016
4. Considine and Ross, Handbook of Applied Instrumentation, 2018
5. Dale R. Patrick & Stephan W. Fardo, Industrial Process Control Systems, Vikas Publishing House, 2015

## 22EI050 PRODUCT DESIGN AND DEVELOPMENT 3 0 0 3

**Course Objectives**

- Basic Engineering Knowledge
- Engineering Graphics and Design
- Knowledge of Project Management Fundamentals

**Programme Outcomes (POs)**

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

**Course Outcomes (COs)**

1. Understand the fundamentals of product development by identifying customer needs, development challenges, and planning processes involved in creating successful products.
2. Develop appropriate product specifications and evaluate alternative design concepts through systematic concept generation, screening, scoring, and testing methods.
3. Analyze product architecture and industrial design principles to plan manufacturing, prototyping, and robust product development strategies.
4. Apply the principles of patents and intellectual property rights to formulate invention strategies, draft claims, and manage the patenting process effectively.
5. Assess product development economics and manage projects using financial modeling, sensitivity analysis, and qualitative evaluation for effective project execution and evaluation.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 2 | | - | - | - | - | - | - | 1 | 1 | - |
| 2 | 2 | 2 | 2 | | - | - | - | - | - | - | 1 | 1 | - |
| 3 | 2 | 2 | 2 | | - | - | - | - | - | - | 1 | 1 | - |
| 4 | 1 | 1 | 1 | | - | - | - | - | - | - | 1 | 1 | - |
| 5 | 1 | 1 | 1 | | - | - | - | - | - | - | 1 | 1 | - |

**UNIT I** **10 Hours**

**INTRODUCTION**

Product Development- Successful Product Development- Duration and Cost- Challenges. Product Planning: Planning Process- Identifying Customer Needs

**UNIT II** **8 Hours**

**PRODUCT SPECIFICATIONS**

Establishing Target Specification- Setting the Final specification. Concept Generation: The Activity of Concept Generation. Concept Selection: Concept Screening-Concept Scoring- Concept Testing

**UNIT III** **10 Hours**

**PRODUCT ARCHITECTURE**

Implications-Establishment-Delayed Differentiation– Platform Planning– Related System Level Design Issues. Industrial Design: Assessing the Need-The Impact-The Industrial Design Process Management and Assessment. Design for Manufacturing. Prototyping-Basics-Principles-Prototyping Technologies Planning. Robust Design

**UNIT IV** **7 Hours**

**PATENTS AND INTELLECTUAL PROPERTY**

Formulate a Strategy and Plan- Study Prior Inventions- Outline Claims- Write the Description of the Inventi the Results and the Process

**UNIT V** **10 Hours**

**PRODUCT DEVELOPMENT ECONOMICS**

Elements of Economic Analysis- Build a Base–Case Financial Model- Perform Sensitivity Analysis, Use Sensitivity Analysis to Understand- Consider the influence of the Qualitative Factors on Project Success- Carrying out Qualitative Analysis. Managing Projects: Understanding and Representing Tasks- Baseline Project Planning- Project Execution-Postmortem-Project Evaluation.

**Total: 45 Hours**

**Reference(s)**

1. Karl. T. Ulrich, Steven D Eppinger, "Product Design and Development", 2nd Edition, Irwin McGraw Hill, 2000.
2. Kevin Otto, Kristin Wood, "Product Design", 1st Edition, Pearson Education, 2003.
3. A C Chitale, R C Gupta, "Product Design and Manufacturing", 6th Edition, Prentice Hall of India, New Delhi, 2003.
4. Timjones, "New Product Development", 1st Edition, Butterworth Heinmann, 1997. 5. Geoffery Boothroyd, Peter Dewhurst, Winston Knight, "Product Design for Manufacture and Assembly", 3rd Edition, Taylor and Francis, 2002

## 22EI051 SYSTEM VERILOG PROGRAMMING 3 0 0 3

**Course Objectives**

- To introduce SystemVerilog as a hardware verification language.
- To understand advanced programming constructs used in verification environments.
- To develop object-oriented modeling skills using SystemVerilog.
- To learn constrained random verification techniques.
- To apply assertions and functional coverage for verification.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Interpret SystemVerilog features for hardware verification.
2. Apply procedural and interface constructs in SystemVerilog design environments.
3. Develop object-oriented verification models using classes.
4. Implement constrained random stimulus generation.
5. Apply assertions and functional coverage techniques for verification.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | - |
| 2 | 2 | 3 | 2 | - | - | - | - | - | - | - | - | 2 | 2 |
| 3 | 2 | 2 | 3 | 2 | - | - | - | - | - | - | - | 2 | 2 |
| 4 | - | 2 | 2 | 3 | - | - | - | - | - | - | - | 2 | 2 |
| 5 | - | - | 2 | 3 | 2 | - | - | - | - | - | - | 3 | 2 |

**UNIT I** **9 Hours**

**INTRODUCTION TO SYSTEM VERILOG**

Evolution of HDL, Verilog vs System Verilog, Design and Verification features, Data types, 2-state and 4-state logic, Arrays (Static, Dynamic, Associative), Queues, Structures and Enumerations, Packages and compilation units.

**UNIT II** **9 Hours**

**PROCEDURAL BLOCKS AND INTERFACES**

Procedural blocks, Tasks and Functions, Argument passing methods, Timing controls, Interfaces and Modports, Clocking blocks, Inter-process communication, Testbench fundamentals

**UNIT III** **9 Hours**

**OBJECT-ORIENTED PROGRAMMING**

Classes and objects, Class properties and methods, Constructors, Encapsulation, Inheritance, Polymorphism, Virtual methods, Abstract classes, Object handling in verification environments.

**UNIT IV** **9 Hours**

**RANDOMIZATION AND CONSTRAINTS**

Constrained random verification, Random variables, Constraint blocks, Inline constraints, Constraint control, Distribution constraints, Pre randomize and Post randomize methods, Stimulus generation techniques.

**UNIT V** **9 Hours**

**ASSERTIONS AND FUNCTIONAL COVERAGE**

Introduction to assertions, Immediate and concurrent assertions, SystemVerilog Assertions (SVA), Functional coverage, Covergroups, Coverpoints, Cross coverage, Coverage-driven verification concepts.

**Total: 45 Hours**

**References:**

1. Chris Spear and Greg Tumbush, SystemVerilog for Verification: A Guide to Learning the Testbench Language Features, Springer, 3rd Edition, 2012.
2. Ashok B. Mehta, Introduction to SystemVerilog, Springer, 2021.
3. Mike Mintz and Robert Ekendahl, Hardware Verification with SystemVerilog: An Object-Oriented Framework, Springer, 2007.
4. Vaibbhav Taraate, SystemVerilog for Hardware Description: RTL Design and Verification, Springer, 2020.
5. Janick Bergeron, Writing Testbenches using SystemVerilog, Springer, 2006.

## 22EI052 FUNDAMENTALS OF VLSI VERIFICATION 3 0 0 3

**Course Objectives**

- To introduce verification concepts in modern VLSI design flow.
- To understand verification planning and methodologies.
- To study verification environment architecture.
- To learn coverage-driven verification techniques.
- To understand industrial verification flow and sign-off process.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Illustrate verification requirements in ASIC/SoC design.
2. Develop verification plans and strategies.
3. Describe verification testbench architecture.
4. Analyze coverage metrics and debugging techniques.
5. Understand industrial verification methodologies and flows.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | - |
| 2 | 2 | 3 | 2 | - | - | - | - | - | - | - | - | 2 | 2 |
| 3 | 2 | 2 | 3 | 2 | - | - | - | - | - | - | - | 2 | 2 |
| 4 | - | 2 | 2 | 3 | - | - | - | - | - | - | - | 2 | 2 |
| 5 | - | - | 2 | 3 | 2 | - | - | - | - | - | - | 3 | 2 |

**UNIT I** **9 Hours**

**INTRODUCTION TO VLSI VERIFICATION**

Need for verification, Design flow in ASIC and SoC, Verification challenges, Verification versus validation, Functional verification concepts, Levels of verification, Design Under Test (DUT).

**UNIT II** **9 Hours**

**VERIFICATION PLANNING AND STRATEGY**

Verification lifecycle, Verification planning, Test strategies, Directed testing, Random testing, Functional verification approach, Verification metrics, Documentation practices.

**UNIT III** **9 Hours**

**VERIFICATION ENVIRONMENT ARCHITECTURE**

Testbench components, Generator, Driver, Monitor, Scoreboard, Transaction-based verification, Layered testbench architecture, Reusability concepts.

**UNIT IV** **9 Hours**

**COVERAGE AND DEBUG METHODOLOGY**

Code coverage concepts, Functional coverage overview, Coverage analysis, Coverage closure, Debug techniques, Regression testing, Verification management.

**UNIT V** **9 Hours**

**INDUSTRIAL VERIFICATION FLOW**

Block-level verification, Subsystem verification, SoC verification overview, Assertion-based verification concepts, Verification sign-off, Industry case studies

**Total: 45 Hours**

**References:**

1. Janick Bergeron, Eduard Cerny, Alan Hunter and Andrew Nightingale, Verification Methodology Manual for SystemVerilog, Springer, 2006.
2. Chris Spear and Greg Tumbush, SystemVerilog for Verification: A Guide to Learning the Testbench Language Features, Springer, 3rd Edition, 2012.
3. Mike Mintz and Robert Ekendahl, Hardware Verification with SystemVerilog: An Object-Oriented Framework, Springer, 2007.
4. Janick Bergeron, Writing Testbenches using SystemVerilog, Springer, 2006.
5. Matthew Ballance, Ray Salemi, Adam Erickson, The UVM Primer, Cadence Design Systems, First Edition, 2013.

## 22EI053 BARE METAL EMBEDDED SYSTEMS APPLICATION DEVELOPMENT

**3 0 0 3**

### Course Objectives

- To understand the fundamentals of embedded system architecture.
- To learn the embedded C build process and linker concepts.
- To understand startup mechanisms and interrupt handling in ARM Cortex-M.
- To develop peripheral interfacing skills using GPIO, ADC, and Timers.
- To implement bare-metal applications on Infineon PSoC 4100S platform.

### Programme Outcomes (POs)

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

### Course Outcomes (COs)

1. Interpret embedded system architecture and memory organization.
2. Describe the embedded C build process and linker script usage.
3. Implement startup code and interrupt handling mechanisms.
4. Interface GPIO and ADC peripherals using register-level programming.
5. Develop timer and PWM-based embedded applications.

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | 1 |
| 2 | 2 | 2 | 2 | 1 | 2 | - | - | - | - | - | - | - | 1 |
| 3 | 3 | 1 | 2 | 3 | 3 | - | - | - | - | - | - | - | 2 |
| 4 | 3 | 2 | 3 | 3 | 3 | - | - | - | - | - | - | - | 2 |
| 5 | 3 | 2 | 3 | 3 | 3 | - | - | - | - | - | - | - | 2 |

**UNIT I** **6 Hours**

**COMPUTER ARCHITECTURE**

Computer Architecture: Introduction to embedded systems - Types, Evolution of embedded systems, CPU Architecture – Von-Neumann and Harvard architecture, Address space and peripherals, Memory Architecture and its types, Memory hierarchy on microcontrollers, Memory mapping, Interconnects, Infineon PSoC 4100S ARM Cortex M0. Cortex M0 Architecture: Understanding different types of processors, Elements of microcontroller.

**UNIT II** **10 Hours**

**EMBEDDED SOFTWARE BUILD PROCESS**

Life of a C Program, Compilation and Linking process, Linker Script, Memory sections, make file, Build automation, Binary image generation.

**UNIT III** **11 Hours**

**OVERVIEW OF INFINEON PSOC 4100S ARCHITECTURE AND INTERRUPTS**

Overview of Infineon PSoC 4100S architecture - Programmer's model, memory mapping, interrupts and exceptions, NVIC, Debug system, Program image and start-up sequence. Interrupts and Exceptions – Event Driven System, Polling Method of event, Exception, Interrupt and Exception handler, Different types of Exceptions, Operation Modes, Register Bank, Interrupt Controller, Brief overview of NVIC, NVIC Registers, Vector Table, Exception Entry Sequence, Exception Exit Sequence, Interrupt Process

**UNIT IV** **9 Hours**

**GPIO AND ADC**

GPIO Pins, Pads, Ports, Power supplies, Basic Pad configuration, PSoC Port architecture, Register Port Management. ADC - Introduction & Basics of Signal, Analog signal to digital signal conversion, Sample and Hold circuit, SAR ADC, SAR ADC Architecture, A/D converter Properties, SAR ADC – Interrupts, SAR ADC – Registers.

**UNIT V** **9 Hours**

**TIMERS AND PWM**

Introduction to timers and counters, Timer architecture, Applications of timers and counters. Introduction to TCPWM module, PSoC Register configuration, Clocking system. Interfacing of Infineon PSoC 4100S Board with GPIO, LED, LDR (ADC), Timers and PWM.

**Total: 45 Hours**

**Reference(s)**

1. Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C, Yifeng Zhu, Third Edition, E-Man Press LLC, 2017.
2. The Definitive Guide to the ARM Cortex-M0 and Cortex-M0+ Processors by Joseph Yiu, Newnes publications.
3. PSoC Microcontroller Programming: A Hands-on Guide, Dogan Ibrahim, Second edition, Newnes publications.
4. PSoC 4 Architecture Technical Reference Manual (TRM), Infineon Technologies AG.
5. PSoC™ 4100S Plus Datasheet, Infineon Technologies AG.

## 22EI054 EMBEDDED LINUX 3 0 0 3

**Course Objectives**

- To understand the concept of embedded linux and desktop linux.
- To Configure Linux environment and Tool-Chain.
- To Demonstrate Linux Booting Process and to configure Linux Kernels.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

**Course Outcomes (COs)**

1. Analyze the concepts of embedded Linux development model.
2. Construct a Linux Board Support Package and storage for a hardware platform.
3. Analyze the features and internal architecture of kernel and tool chain.
4. Analyze the porting issues in Linux Environment.
5. Apply the various development tools to customize the embedded linux application.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | 1 | - |
| 2 | 3 | 2 | 3 | - | - | - | - | - | - | - | - | 1 | - |
| 3 | 2 | 3 | 3 | - | - | - | - | - | - | - | - | 2 | - |
| 4 | 2 | 3 | 3 | 3 | - | - | - | - | - | - | - | 2 | - |
| 5 | 1 | 2 | 3 | 2 | - | - | - | - | - | - | - | 2 | - |

**UNIT I** **9 Hours**

**INTRODUCTION**

History of Embedded Linux, Embedded Linux versus Desktop Linux, Embedded Linux Distributions, Architecture of Embedded Linux, Linux Kernel Architecture, Linux StartUp Sequence.

**UNIT II** **9 Hours**

**LINUX FUNDAMENTALS**

Board Support Package: Inserting BSP in Kernel Build Procedure, Boot Loader Interface, Memory Map, Interrupt Management, PCI Subsystem Embedded Storage: Flash Map, MTD: Memory Technology Device, MTD Architecture, MTD Block and Character devices, Optimizing Storage Space.

**UNIT III** **9 Hours**

**ARCHITECTURE OF EMBEDDED LINUX**

Kernel Architecture, Kernel Functional Overview, Commands in Linux, Configuring the Linux Environment, Tool-chain: Configuration and Cross-Compilation, Linux Bootloader & U-Boot, Embedded Linux Kernel, Building Root File System.

**UNIT IV** **9 Hours**

**PORTING APPLICATIONS**

Architectural Comparison, Application Porting Road Map, Programming with Pthreads, Operating System Porting Layer (OSPL), Kernel API Driver.

**UNIT V** **9 Hours**

**DEVELOPMENT TOOLS**

Embedded development environment, GNU debugger, tracing & profiling tools, binary utilities, kernel debugging, debugging embedded Linux applications, porting Linux, Linux and real time, SDRAM interface.

**Total: 45 Hours**

**Reference(s)**

1. Chris Simmonds "Mastering Embedded Linux Programming", Second Edition, PACKT Publications Limited. 3rd Edition, 2021.
2. Karim Yaghmour, Jon Masters, Gillad Ben Yossef, Philippe Gerum, "Building embedded Linux systems", O'Reilly, 2008.
3. P Raghvan, Amol Lad, Sriram Neelakandan, "Embedded Linux System Design and Development", Auerbach Publications, 2019.
4. Christopher Hallinan, "Embedded Linux Primer: A Practical Real World Approach", Prentice Hall, 2nd Edition, 2010
5. Derek Molloy, "Exploring Beagle Bone: Tools and Techniques for Building with Embedded Linux", Wiley, 1st Edition, 2014.
6. Christopher Hallinan, "Embedded Linux Primer: A practical real world approach", Prentice Hall, 2007.

## 22OCE01 ENERGY CONSERVATION AND MANAGEMENT

**3 0 0 3**

**Course Objectives**

- To develop an understanding and analyze the energy data of industries
- To carryout energy accounting and balancing
- To conduct energy audit and suggest methodologies for energy savings and
- To utilize the available resources in optimal ways

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

**Course Outcomes (COs)**

1. Classify and characterize the energy resources.
2. Illustrate the concept of green building.
3. Outline the sustainable construction practices.
4. Understand the hydropower production and conservation of water.
5. Emphasis the significance of energy and resource recovery from waste materials.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | | | | | | | | | | 1 | | |
| 2 | 1 | 2 | | | | | 2 | | | | 1 | | |
| 3 | 1 | 2 | | | | | 2 | | | | 1 | | |
| 4 | 1 | 2 | | | | | 2 | | | | 1 | | |
| 5 | 1 | 2 | | | | | 2 | | | | 1 | | |

**UNIT I** **9 Hours**

**INTRODUCTION TO ENERGY SCIENCE**

Introduction to energy systems and resources; Introduction to Energy, sustainability & the environment. Energy - Past & Present scenario of World; Renewable and Nonrenewable energy resources

**UNIT II** **9 Hours**

**ENERGY CONSERVATION IN BUILDINGS**

Principles of Planning of buildings: orientation, energy efficiency, utility. Components of building-classification of buildings. Green building - LEED building assessment standard – LEED certification process - Building rating system - Building energy issues – Building energy design strategies – Energy Auditing

**UNIT III** **9 Hours**

**SUSTAINABLE CONSTRUCTION**

Equipment use in excavations, foundation, concreting. Advanced Techniques in tunneling, under water construction, piling techniques, Innovations & efficiency in Highways, Railways & Harbours - linkages between economic and environmental outcomes

**UNIT IV** **9 Hours**

**WATER CONSERVATION & SUSTAINABILITY**

Types of reservoirs and its functions – Hydropower production – Types of Turbines & selections of turbines & Energy calculations. Water losses from reservoirs and channels – Canal lining & its economic aspects. Water supply systems & Irrigation methods - Rain Water Harvesting methods & benefits.

**UNIT V** **9 Hours**

**ENERGY RECOVERY FROM WASTE**

Classification and sources of wastes- Factors affecting MSW generation – Waste management hierarchy - Energy recovery from wastes: Thermochemical methods for energy production - Details of incineration, gasification and pyrolysis & biochemical conversions - Landfill gas recovery system - Principles of fermentation - Concept of MFC - Trans-esterification process - Biofuel processing - Biomass gasification - Organic waste for hydrogen production.

**Total: 45 Hours**

**Reference(s)**

1. Boyle, Godfrey, Bob Everett, and Janet Ramage (Eds.) (2004), Energy Systems and Sustainability: Power for a Sustainable Future. Oxford University Press.
2. Charles. J. Kibert, Sustainable Construction: Green Building Design and Delivery, John Wiley & Sons, Inc., New Jersey, 2008.
3. H. M. Raghunath, Irrigation Engieering, Wiley India (P) Ltd, 2011.
4. E H Thorndike (1976), Energy & Environment: A Primer for Scientists and Engineers, Addison-Wesley Publishing Company.
5. M. Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, ISBN-10: 8173191409,1997.
6. Lal, P.M. Sarma, Priyangshu M, Wealth from Waste: Trends and Technologies, 3rd Edition, The Energy and Resources Institute, New Delhi, ISBN: 9788179934241, 2011.
7. W. McDonough, M. Braungart, Cradle to Cradle: Remaking the Way We Make Things, United States: North Point Press, ISBN-10: 0865475873, 2002.

## 22OCS01 OBJECT ORIENTED PROGRAMMING 3 0 0 3

**Course Objectives**

- Understand the concepts of Object Oriented Programming
- Study the concepts of objects and classes.
- Familiarize in the types of constructors.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

**Course Outcomes (COs)**

1. Identify the characteristics and data types of C++ language.
2. Develop programs using objects and classes for real world applications
3. Construct programs to implement operator overloading and inheritance techniques
4. Apply Polymorphism and File streams concepts to develop C++ program
5. Design applications using templates and apply exception handling mechanisms

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | | | 3 | | | | | | | | | |
| 2 | 1 | 2 | 3 | | 3 | | | | | | | | | |
| 3 | 1 | 2 | 2 | | 3 | | | | | | | | | |
| 4 | 1 | 2 | 3 | | 3 | | | | | | | | | |
| 5 | 1 | 2 | 3 | | 3 | | | | | | | | | |

**UNIT I** **9 Hours**

**INTRODUCTION**

Need for object oriented programming - Procedural Languages vs. Object oriented approach - Characteristics Object oriented programming - C++ Programming Basics: Basic Program Construction - Output Using cout - Input with cin - Data types- Variables and Constants - Operators - Control Statements-Manipulators - Type conversion. Function Prototyping- call by reference, return by reference- Inline function- Default arguments - Function overloading.(sona).

**UNIT II** **9 Hours**

**OBJECTS AND CLASSES**

Objects and Classes Simple Class - C++ Objects as Physical Objects - C++ Object as Data types-CONSTRUCTORS: Parameterized Constructors - Multiple Constructors in a Class - Constructors with Default Arguments - Dynamic Initialization of Objects - Copy and Dynamic Constructors - Destructors(PSG) - Structures and Classes - Arrays and Strings

**UNIT III** **9 Hours**

**OPERATOR OVERLOADING AND INHERITANCE**

Operator Overloading and Inheritance Need of operator overloading- Overloading Unary Operators-Overloading binary Operators - Overloading Special Operators - Data Conversion Inheritance: Derived Class and Base Class - Derived Class Constructors-Overriding Member Functions-Class Hierarchies- Public and Private Inheritance-Levels of Inheritance-Multiple Inheritance.

**UNIT IV** **9 Hours**

**POLYMORPHISM AND FILE STREAMS**

Polymorphism and File Streams Virtual Function - Friend Function - Static Function-Assignment and Copy Initialization- Memory Management: new and delete Pointers to Objects, this Pointer- Streams - String I/O - Character I/O - Object I/O - I/O with Multiple Objects - File Pointers - Disk I/O with Member Functions- Error Handling in File I/O.

**UNIT V** **9 Hours**

**TEMPLATES AND EXCEPTION HANDLING**

Templates: Introduction - Function Templates - Overloading Function Templates-, user defined template arguments(sona) - Class Templates - Exception Handling - Syntax, multiple exceptions, exceptions with arguments.

**Total: 45 Hours**

**Reference(s)**


1. Deitel & Deitel, C++ How to program, Prentice Hall, 2005.
2. Robert Lafore, Object Oriented Programming in-C++, Galgotia Publication.
3. D.S.Malik, C++ Programming, Thomson, 2007.
4. K.R. Venugopal, Rajkumar and T.Ravishankar, Mastering C++, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2006.
5. E.Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill Publishing, New Delhi, 2006.

## 22OCS02 JAVA FUNDAMENTALS 3 0 0 3

**Course Objectives**

- Implement applications based on core Java Concepts with examples
- Construct application using inheritance, packages and exception handling for real time problems.
- Integrate the Java I/O concepts to handle input and output operations.
- Develop programs to perform string manipulation in java.
- Design GUI with Java for event handling and database applications.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

**Course Outcomes (COs)**

1. Demonstrate applications based on core Java Concepts with examples
2. Construct application using inheritance, packages and exception handling for real time problem
3. Explain the Java I/O concepts to handle input and output operations.
4. Develop programs to perform string manipulation in Java.
5. Design GUI with Java for event handling and database applications.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | 2 | 3 | 2 | | 2 | | | | | | | | | |
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| 5 | 2 | 2 | 2 | | 2 | | | | | | | | | |

**UNIT I** **9 Hours**

**BASICS OF JAVA**

The Genesis of Java - Overview of Java - Data Types, Variables, and Arrays - Operators – Control Statements - Introducing Classes - Methods and Classes.

**UNIT II** **9 Hours**

**INHERITANCE, PACKAGES AND EXCEPTIONS**

Inheritance: Basics - Using Super - Creating a Multilevel Hierarchy - Method overriding - Using Abstract Classes - Packages and Interfaces: Packages - Access Protection - Importing Packages- Interfaces Definitions and Implementations - Exception Handling: Types - Try and Catch - Throw.

**UNIT III** **9 Hours**

**EXPLORING JAVA I/O**

I/O Basics - Reading Console Input -Writing Console output - Native Methods - I/ O Classes and Interfaces - File - The Byte Streams - The Character Streams - Using Stream I/ O - Serialization.

**UNIT IV** **9 Hours**

**JAVA STRINGS**

String Handling: Special String operations and Methods - String Buffer - Exploring java.lang: Simple type Wrappers - System - Math - Collections Framework: Collections Interfaces and Classes – Utility Classes: String Tokenizer - Date and Time.

**UNIT V** **9 Hours**

**GUI WITH JAVA**

Applet Basics - Applet Architecture - Applet Display Methods - Parameter Passing - Event Handling Mechanisms - Event Classes - Event Listener - Working with Windows, Graphics, Colors and Fonts - AWT Controls - Layout Managers and Menus – JDBC

**Total: 45 Hours**

**Reference(s)**

1. Herbert Schildt, Java 2-Complete Reference, Tata Mc Graw Hill, 2015.
2. Deitel & Deitel, Java How to Program, Prentice Hall of India, 2010.
3. Gary Cornell and Cay S.Horstmann, Core Java Vol.1 and Vol.2, Sun Microsystems Press, 2008.

## 22OCS04 E-LEARNING TECHNIQUES 3 0 0 3

**Course Objectives**

- Understand the technologies involved in e-learning.
- Gain the fundamentals of e-learning techniques
- Determine the characteristics of Teaching-Learning Process

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

**Course Outcomes (COs)**

1. Acquire knowledge about the basic concepts of e-learning.
2. Explain the technology mediated communication in e-learning
3. Exemplify of e-learning and content the process management.
4. Analyze the teaching and learning processes in e-learning environment.
5. Assess the various applications of e-learning.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
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| 4 | 2 | 2 | 2 | | | | | | | | | | | |
| 5 | 2 | 2 | 2 | | | | | | | | | | | |

**UNIT I** **9 Hours**

**INTRODUCTION**

Evolution of Education - Generations of Distance Educational Technology - Role of E-Learning - Components of e-learning: CBT, WBT, Virtual Classroom - Barriers to e-Learning Roles and Responsibilities: Subject Matter Expert - Instructional Designer - Graphic Designer - Multimedia Author - Programmer - System Administrator - Web Master

**UNIT II** **9 Hours**

**TECHNOLOGIES**

Satellite Broadcasting - Interactive Television - Call Centers - Whiteboard Environment - Teleconferencing: Audio Conferencing - Video Conferencing -Computer Conferencing. Internet: E-mail, Instant Messaging, Chat, Discussion Forums, Bulletin Boards, Voice Mail, File Sharing, Streaming Audio and Video.

**UNIT III** **9 Hours**

**MANAGEMENT**

Content: E-Content, Dynamic Content, Trends - Technology: Authoring, Delivery, Collaboration - Services: Expert Service, Information Search Service, Knowledge Creation Service - Learning Objects and E-Learning Standards. Process of E-Learning: Knowledge acquisition and creation, Sharing of knowledge, Utilization of knowledge - Knowledge Management in E-Learning.

**UNIT IV** **9 Hours**

**TEACHING-LEARNING PROCESS**

Interactions: Teacher-Student - Student-Student - Student-Content - Teacher- Content - Teacher-Teacher - Content-Content Role of Teachers in E-Learning - Blended Learning -Cooperative Learning - Collaborative Learning - Multi Channel learning -Virtual University - Virtual Library.

**UNIT V** **9 Hours**

**APPLICATIONS**

Customer service training - Sales training - Customer training - Safety training - IT training – Product training - Healthcare training.

**Total: 45 Hours**

**Reference(s)**

1. E-Learning: An Expression of the Knowledge Economy, Gaurav Chadha, S.M. Nafay Kumail, Tata McGraw-Hill Publication, 2002.
2. E-Learning: New Trends and Innovations, P.P. Singh, Sandhir Sharma, Deep & Deep Publications, 2005. 4. 4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002
3. E-Learning: Concepts, Trends and Applications, Epignosis LLC, LLC publications, 2014.
4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002.

## 22OEC04 PRINCIPLES OF COMPUTER COMMUNICATION AND NETWORKS

**3 0 0 3**

### Course Objectives

- To understand the concept of data communication and networking models.
- To study the various networking Components and Networks.
- To explore the routing, addressing and security and management aspects of computer networks.

### Programme Outcomes (POs)

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

### Course Outcomes (COs)

1. Classify the types of computer networks and analyze the seven layers of OSI model.
2. Analyze the basic operations of Routing Algorithms and Routing devices
3. Analyze the local and wide area networking technologies.
4. Apply the ISDN and ATM interface connections in broadband networks.
5. Analyze the security and management techniques related with networks.

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
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| 3 | 1 | 1 | 2 | 3 | | | | | | | | |
| 4 | 1 | 1 | 3 | | | | | | | | | |
| 5 | 1 | 2 | 3 | 3 | | | | | | | | |

**UNIT I** **9 Hours**

**NETWORK FUNDAMENTALS**

Types of Computer Networks: by Area, by Topology; Communication Services: Serial and Parallel, Synchronous and Asynchrounous, Simplex and Duplex, Analog and Digital; Speed and Capacity; Multiplexing and Switching; Network Architecture: OSI Seven-Layer Network model.

**UNIT II** **9 Hours**

**INTERNETWORKING AND COMPONENTS**

Routing Concepts: Routing Algorithms, RIP, RIP-2, OSPF and other routing Protocols; Switches and Hubs: Store and Forward Switch, Cut-Through Switch,Hybrid Switch, Performance of Switches ; Repeaters; Repeater Vs Hubs; Bridges: Standards, Bridges Vs Repeaters; Routers and Gateways.

**UNIT III** **9 Hours**

**LOCAL AND WIDE AREA NETWORKING TECHNOLOGIES**

LAN Components and Topologies; Access Techniques; Transmission Protocols and Media; Ethernet and IEEE 802.3 Networks: History, 10-MBPS Ethernet, Switched Ethernet, 100-MBPS Ethernet, Gigabit Ethernet.

**UNIT IV** **9 Hours**

**BROADBAND NETWORKS**

ISDN: Evolution, ISDN Channel and Interface Structures; Broadband ISDN: Basics, Principles and General Architecture; Asynchronous Transfer Mode(ATM): Introduction, Concepts, Components, Connection Supported by ATM network and Concept of Virtual Channel and Virtual Path, Traffic control and Congestion Control, Operation and Maintenance aspects.

**UNIT V** **9 Hours**

**NETWORK SECURITY AND MANAGEMENT**

Security: Need of Security, Security Threats, Vulnerabilities, Methods, tools and Techniques for Attacks; Network Security: Levels of Security, Cryptosystems; Data Encryption Standard (DES), Public Key Cryptography, Firewalls; Network Management: Functions and Elements, Distribution of Management; Simple Network Management Protocol (SNMP), Remote Network Management Services.

**Total: 45 Hours**

**Reference(s)**

1. Michael A.Gallo, William M. Hancock, Computer Communications and Networking Technologies, 1 Ed, Thomson Learning, 2002.
2. Kenneth C. Mansfield, Jr.James L. Antonakos, An Introduction to Computer Networking, 1Ed, Prentice Hall of India, 2002
3. A Shanmugam, S Rajeev, Computer Communication Networks, 1Ed, ISTE Learning Materials Centre, 2001
4. Discrete-Time Signal Processing by Alan V. Oppenheim and Ronald W. Schafer, 3rd edition, 2010, Prentice Hall
5. Digital Signal Processing by Sanjit Mitra, 4th edition, 2011, McGraw-Hill, New York, NY

## 22OME01 DIGITAL MANUFACTURING 3 0 0 3

**Course Objectives**

- To understand the process of generating 3D Computer Aided Design (CAD) model by different method.
- To explain the constructional features and develop simple program for CNC lathe and Milling machines.
- To provide an exhaustive knowledge on various generic process and benefits of Additive Manufacturing.
- To familiarize about materials and process parameters of liquid and solid based AM techniques.
- To educate powder based methodology and emerging trends with case studies, applications of AM techniques.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

**Course Outcomes (COs)**

1. Design a 3D model from the 2D data.
2. Develop a CNC program for simple components.
3. Generate stl file and manipulate parameters of AM machine
4. Select appropriate liquid or solid materials based AM process to the respective application
5. Select appropriate process to fabricate a functional/prototype for aerospace, automotive, electronics, manufacturing and medical applications.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | 2 | 2 | 2 | 2 | 2 | | | | | | | | |
| 3 | 2 | 2 | 2 | 2 | 2 | | | | | | | | |
| 4 | 2 | 2 | 2 | 2 | 2 | | | | | | | | |
| 5 | 2 | 2 | 2 | 2 | 2 | | | | | | | | |

**UNIT I** **9 Hours**

**CAD MODELING**

Introduction - Design process - Stages. CAD - Input and Output devices, Modeling methods - Wire frame modelling, Surface modelling, Solid modelling - Constructive Solid Geometry and Boundary Representation Techniques. CAD/CAM data exchange - IGES, STEP. Product Life cycle management (PLM).

**UNIT II** **10 Hours**

**AUTOMATION AND CNC MACHINES**

Introduction to Automation - Definition, types, reasons for automating. CNC Machines - Principles, types, features, advantages, applications. CNC Machine structure - Linear motion bearings, Recirculating ball bearings, drive system, and control system. CNC Lathe and Milling programming - Linear and circular interpolation, threading and drilling programs.

**UNIT III** **7 Hours**

**ADDITIVE MANUFACTURING**

Introduction - Impact of Additive Manufacturing (AM) and Tooling on Product Development - Distinction between AM and CNC Machining - The Generalized AM Process chain - CAD Model - Input file formats - Generation and Conversion of STL file - File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - AM Benefits - Classification of AM process

**UNIT IV** **8 Hours**

**LIQUID AND SOLID MATERIAL BASED SYSTEMS**

Stereo lithography Apparatus (SLA), Digital Light Processing (DLP), Fused Deposition Modelling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Process, Materials and Applications

**UNIT V** **11 Hours**

**POWDER BASED PROCESSES AND APPLICATIONS OF ADDITIVE MANUFACTURING**

Selective Laser Sintering (SLS), Color Jet Printing (CJP), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS) - Working Principle, Construction, Process Variables, Materials and Applications. Reverse Engineering using 3D scanner. Application of Additive Manufacturing in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries.

**Total: 45 Hours**

**Reference(s)**

1. Ibrahim Zeid, R.Sivasubramania, CAD/CAM Theory and Practice, Tata McGraw Hill, 2010.
2. M. Aditan, B.S. Pabala, CNC Machines, New age International, 2012.
3. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
4. D. T.Pham, S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.
5. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015.
6. http://www.springer.com/978-1-4939-2112-6
7. www.grabcad.com, www.all3dp.com

## 22OME02 INDUSTRIAL PROCESS ENGINEERING 3 0 0 3

**Course Objectives**

- To impart the knowledge on production planning methodologies and layout design
- To learn about production planning and its control methods
- To provide the knowledge of work study, process charts and ergonomic condition
- To impart the knowledge on inventory control and material handling
- To learn about system analysis and different types of maintenance processes

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

**Course Outcomes (COs)**

1. Select proper plant layout for the required production system
2. Plan the resources required for the production and to perform the control methods
3. Apply work study method, prepare charts to outline the process and develop ergonomic condition suitable for the processes.
4. Analyze the inventory required based on production needs and material handling
5. Perform system analysis and use different types of maintenance process for smooth operations.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
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| 3 | 1 | 3 | 3 | | 2 | | | | | | | | | |
| 4 | 2 | 3 | 1 | | 2 | | | | | | | | | |
| 5 | 2 | 3 | 1 | | 2 | | | | | | | | | |

**UNIT I** **9 Hours**

**INDUSTRIAL ENGINEERING AND PRODUCTION SYSTEM**

Industrial engineering - Concept, History and development, Applications, Roles of Industrial engineer- Production management, Industrial engineering versus production management, operations management. Plant layout, Criteria for good layout, Types of layout - Process layout, Product layout, Combination layout and fixed position layout, Flow (material movement) pattern, Workstation Selection and design.

**UNIT II** **10 Hours**

**PROCESS PLANNING AND PRODUCTION CONTROL**

Introduction to Process planning-Definition, Procedure, Process selection, Machine capacity, Process sheet.Process analysis - Group technology, classification and coding system, formation of component family - Production planning, loading, scheduling. Production control -dispatching, routing - Progress control bar, curve, Gantt chart, route and schedule chart.

**UNIT III** **8 Hours**

**WORK STUDY AND ERGONOMICS**

Work study - Definition, Need, Advantages, objectives of method study and work measurement, method study procedure, Process chart - symbols, outline process chart, flow process chart, principles of motion economy, ergonomics- applications of ergonomic principles in the shop floor- work benches-seating arrangement, Industrial physiology.

**UNIT IV** **10 Hours**

**INVENTORY MANAGEMENT**

Inventory control, classification, management, objectives, functions. Economic order quantity, Economic batch quantity, inventory models,ABC analysis, Material Requirement Planning(MRPI), Manufacturing Resource Planning (MRPII), Operating cycle, lean manufacturing, Supply chain management - Material handling.

**UNIT V** **8 Hours**

**SYSTEM ANALYSIS AND MAINTENANCE**

System concept - system analysis, systems engineering, value engineering, value control, types of values. Plant maintenance - objectives, importance. Maintenance engineer - duties, functions and responsibilities. Types - breakdown, scheduled, preventive and predictive - Plant maintenance schedule, Condition monitoring.

**Total: 45 Hours**

**Reference(s)**

1. Khanna O.P., Industrial Engineering and management, Dhanpat Rai Publications., 2010.
2. Martand T.Telsang, Industrial Engineering and Production Management, S Chand Publishers, 2006.
3. Panneerselvam R., Production and operations management, Heritage Publishers, 2006.
4. Ravi Shankar, Industrial Engineering and Management, Golgotia Publications Pvt. Ltd., New Delhi, 2009.

## 22OME03 MAINTENANCE ENGINEERING 3 0 0 3

**Course Objectives**

- To understand the principles, objectives and importance of maintenance adopted in industry for successful progress.
- To introduce different maintenance categories, its merits and types of lubrication.
- To expose the idea of condition monitoring, methods and instruments used for allied measurements.
- To learn about failure analysis and repair methods for few mechanical elements.
- To promote computerization in maintenance and inventory management.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

**Course Outcomes (COs)**

1. Explain the principles, objectives and importance of maintenance adopted in industry.
2. Select the suitable maintenance category and lubrication type.
3. Apply the appropriate methods and instruments for condition monitoring.
4. Analyze the failures of mechanical systems and select suitable repair methods.
5. Utilize computers in maintenance and inventory management.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
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| 4 | 1 | 2 | 1 | | 2 | 2 | 2 | | | | | | | |
| 5 | 2 | 2 | 2 | | 1 | 1 | 1 | | | | | | | |

**UNIT I** **9 Hours**

**PRINCIPLES OF MAINTENANCE PLANNING**

Basic principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Maintenance organization - Maintenance economics.

**UNIT II** **9 Hours**

**MAINTENANCE CATEGORIES AND LUBRICATION**

Maintenance categories - Comparative merits of each category - Preventive maintenance, Maintenance schedules, Repair cycle - Total Productive Maintenance - Principles and methods of lubrication.

**UNIT III** **9 Hours**

**CONDITION MONITORING**

Condition based maintenance - Cost comparison with and without Condition Monitoring - Methods and instruments for condition monitoring - Noise, vibration, wear and temperature measurement.

**UNIT IV** **9 Hours**

**FAILURE ANALYSIS AND REPAIR METHODS**

Failure analysis - Failures and their development - Role of Non Destructive Testing in failure analysis - Repair methods for bearings, cylinder block, fuel pump, shaft.

**UNIT V** **9 Hours**

**COMPUTER AIDED MAINTENANCE MANAGEMENT**

Approach towards Computerization in maintenance - computer-aided maintenance management system (CAMMS) - Advantages of CAMMS - spare parts and inventory centre performance reporting.

**Total: 45 Hours**

**Reference(s)**

1. Srivastava S.K, Maintenance Engineering, S Chand and Company, 2010.
2. Mishra R.C, Pathak K, Maintenance Engineering and Management, Second edition, Prentice Hall India Learning Pvt. Ltd., 2012.
3. Keith Mobley R, Lindley R. Higgins and Darrin J. Wikoff, Maintenance Engineering Handbook, Seventh edition, McGraw-Hill Professional, 2008.
4. Davies A, Handbook of Condition Monitoring: Techniques and Methodology, Springer, 2012.
5. Otegui Jose Luis, Failure Analysis, Fundamentals and Applications in Mechanical Components, Nineteenth edition, Springer, 2014.

## 22OME04 SAFETY ENGINEERING 3 0 0 3

**Course Objectives**

- To study the principles of safety management system.
- To introduce the provisions contained in the industrial laws.
- To provide knowledge on safety requirements for engineering industry.
- To learn safety requirement for chemical industry.
- To study the various safety measures adopted in construction industries.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change

**Course Outcomes (COs)**

1. Explain safety management system of an industry.
2. Implement the provisions of acts and rules in industries.
3. Implement and review the safety performance followed in various industries
4. Evaluate safety appraisal in chemical industries.
5. Generate safety reports on construction industries.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | | | | | 1 | | | 3 | | | | | |
| 3 | 2 | | | | | | | | | | 3 | | |
| 4 | 2 | 3 | | | | | | | 2 | | | | |
| 5 | | | | | 2 | 1 | | 1 | | | | | |

**UNIT I** **9 Hours**

**SAFETY MANAGEMENT**

Concepts - Evolution, International Labour Organization (ILO), National Safety Council, Techniques - Job Safety Analysis (JSA), Safety survey, Safety inspection, Safety Sampling, Accident Reporting and Investigation - Concept of an accident, Accident causation models, cost of accident, investigation, Safety Performance Monitoring - Safety indices.

**UNIT II** **9 Hours**

**SAFETY AND LAW**

Factory Act 1948-Safety and Health chapters, Tamil Nadu Factories Rules- Safety and Health chapters, Environment and Pollution Laws, Building and other construction works act 1996, Electricity Rules.

**UNIT III** **9 Hours**

**SAFETY IN ENGINEERING INDUSTRIES**

Safety in machine shop, - Principles of machine guarding - Personal protective equipment- Safety in handling industrial gases - Safety in cold forming and hot working of metals- Safety in finishing, inspection and testing, heat treatment, electro plating, leak test, radiography.

**UNIT IV** **9 Hours**

**SAFETY IN CHEMICAL INDUSTRIES**

Safety in process design, unit operations, pressure vessel, heat exchanger, safety valves -Plant commissioning and inspection, pressure vessel, Plant maintenance and emergency planning, management of maintenance HAZOP study.

**UNIT V** **9 Hours**

**SAFETY IN CONSTRUCTION INDUSTRY**

Construction regulations, contractual clauses, permit to work, - Education and Training-Hazards of construction and prevention- excavation, scaffolding, dismantling, road works, construction of high rise buildings - Working at heights, -Working on fragile roofs, work permit Systems-Construction machinery, cranes, chain pulley blocks, earth moving equipment, conveyors- Manual handling, Safety in demolition work, - Safety in confined space

**Total: 45 Hours**

**Reference(s)**

1. Blake R.B., Industrial Safety, Prentice Hall, Incorporated, New Jersey, 1973.
2. National Safety Council, Accident Prevention Manual for Industrial Operations, Chicago, 1988.
3. Subramanian V., The Factories Act, 1948, with Tamil Nadu Factories Rules, 1950, Madras.
4. Environmental Pollution Control Act, 1986.
5. BOCW Act,1996, Madras Book agency, Chennai-1.
6. Explosive Act, 1884, Eastern Book Company, Lucknow -266 001.

## 22OBT01 BIOFUELS 3 0 0 3

**Course Objectives**

- To understand and explore the scope of biofuels the most efficient renewable source of energy.
- To develop the expertise in the technology pertaining to their generation and employment in order to surrogate the existing conventional fuels and hence strives towards sustainable development
- To give way to the bolster green technology and incline towards more eco-friendly options.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

**Course Outcomes (COs)**

1. Apply thee bio resources that can be used for the production of biofuels.
2. Analyze the physical and chemical properties of the biodiesel.
3. Analyze the mechanisms of improvising the quality and performance of engines using biofuels
4. Analyze the bio-fuel conversion technologies and their environmental attributes
5. Evaluate the designing aspects of major unit processes/operations of an integrated bio- refinery

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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**UNIT I** **9 Hours**

**CLASSIFICATION AND RESOURCES**

Introduction, biofuel as a renewable energy, classification of biofuels - First, second, third and fourth generation biofuels, different plant sources as biofuel feedstocks, Biogases, physical and chemical characteristics of vegetable oils - iodine number, hydroxyl, acid values, rancidity, hydrogenolysis and hydrolysis, Food vs energy.

**UNIT II** **9 Hours**

**BIODIESEL**

Definition, basics and chemistry of biodiesel, vegetable oils in biodiesel production, Transesterificati on: Chemical methods, enzymatic methods and types of catalysts, separation and purification, physical properties and characterization of biodiesel - Cloud point, pour point, cold filter plugging point, flash point, viscosity and cetane number.

**UNIT III** **9 Hours**

**QUALITY BIODIESEL AND ENVIRONMENT**

Producing Quality Biodiesel, quality control, test methods, ASTM specifications. Oxidative and thermal stability, estimation of mono, di, triglycerides and free glycerol, engine performance test, blending of ethanol with biodiesel, blending of biodiesel with high-speed diesel (HSD) and their combustion properties.

**UNIT IV** **9 Hours**

**BIOETHANOL AND BIOGASES**

Ethanol as a fuel, microbial and enzymatic production of ethanol from biomass - lignocellulose, sugarcane, sugar beet, corn, wheat starch, and purification - wet and dry milling processes, saccharification- chemical and enzymatic. Production of bio methane and biohydrogen.

**UNIT V** **9 Hours**

**BIOREFINERIES**

Definition and types of biorefineries, co-products of biorefineries-oil cake and glycerol, purification of glycerol obtained in biodiesel plant; anaerobic and thermal gasification of biomass, economics of biorefineries.

**Total: 45 Hours**

**Reference(s)**

1. Caye Drapcho, John Nghiem and Terry Walker, Biofuels Engineering process technology, McGraw Hill Professional, 2008.
2. Mousdale, Biofuels, CRC Press, 2008.
3. Ahindra Nag, Biofuels Refining and Performance, McGraw-Hill Professional, 2007.
4. Lisbeth Olsson, Biofuels (Advances in Biochemical Engineering/ Biotechnology), Springer, 2007.

## 22OFD01 TRADITIONAL FOODS 3 0 0 3

### Course Objectives

- To understand the importance of traditional foods and food habits
- To know the traditional processing of snack, sweet and dairy food products
- To infer the wide diversity and common features of traditional Indian foods and meal patterns.

### Programme Outcomes (POs)

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

### Course Outcomes (COs)

1. Justify the processing methods of traditional foods in terms of its health benefits
2. Assess the production methods of traditional sweets, snacks and dairy products
3. Differentiate Traditional fermented foods products based on its raw material
4. Implement a large scale production of tradition foods for its increased consumption
5. Compare the health aspects of traditional foods with modern foods

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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### UNIT I 9 Hours

**TRADITIONAL METHODS OF FOOD PROCESSING**

Introduction - food culture -geographical features and food. Traditional methods of milling grains - rice, wheat and corn - equipment and processes as compared to modern methods. Equipment and processes for edible oil extraction- comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation - sun-drying, osmotic drying, brining, pickling and smoking.

**UNIT II** **9 Hours**

**TRADITIONAL SWEETS, SNACKS AND DAIRY PRODUCTS**

Production, formulation, preparation and processing of Indian traditional sweet and snack food products:- Rasgolla, Gulab jamun; formulation and preparation of namkeen, potato chips, banana chips. Acid coagulated and fermented dairy products- paneer, dahi, shrikhand, lassi - processing conditions, defects etc. Fat rich products- Butter, ghee and its processing.

**UNIT III** **9 Hours**

**TRADITIONAL FERMENTED FOOD PRODUCTS**

Idli, Soya sauce, fish pickle, dry fish, meat and vegetable fermented products. Various alcohol based products. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation. Best cooking and processing methods to retain nutrients

**UNIT IV** **10 Hours**

**COMMERCIAL PRODUCTION OF TRADITIONAL FOODS**

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods - types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods - ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters

**UNIT V** **8 Hours**

**HEALTH ASPECTS OF TRADIONAL FOODS**

Comparison of traditional foods with typical fast foods / junk foods - cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

**Total: 45 Hours**

**Reference(s)**

1. Sen and Colleen Taylor, Food Culture in India, Greenwood Press, 2005.
2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes:" East West Books, 2001.
3. Steinkrus.K.H. Handbook of Indigenous Fermented Foods, CRC press, 1995.
4. Aneja. R.P, Mathur.BN, R.C. Chandan,and Banerjee.A.K. Technology of Indian Milk Products. Dairy India Year Book, 2009.

## 22OFD02 FOOD LAWS AND REGULATIONS 3 0 0 3

**Course Objectives**

- To introduce the concept of food hygiene, importance of safe food and laws governing it
- To learn common causes of food borne illness - viz. physical, chemical and biological and identification through food analysis
- To understand food inspection procedures employed in maintaining food quality

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

**Course Outcomes (COs)**

1. Analyse the food safety strategies and nutritional quality of the food
2. Check the food regulatory mechanism and mandatory laws for food products
3. Determine the national and international regulatory agencies
4. Understand and apply the voluntary regulatory standards
5. Assess the implementation of food safety for a food processing industry

**Articulation Matrix**

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**UNIT I** **10 Hours**

**INTRODUCTION**

Introduction, concept of food safety and standards, food safety strategies. Food hazards and contaminations - biological (bacteria, viruses and parasites), chemical (toxic constituents / hazardous materials) pesticides residues / environmental pollution / chemicals) and physical hazards. Preventive food safety systems - monitoring of safety, wholesomeness and nutritional quality of food. Prevention and control of physical, chemical and microbiological hazards. Principles of food safety - Establishment: design and facilities - emergency preparedness - Maintenance cleaning and sanitation - personal hygiene - packaging and labelling - transportation - traceability - recall procedure - visitor policy. Adulteration: Intentional and unintentional - Preservatives - antioxidants, sweeteners, flavours, colours, vitamins, stabilizers - indirect additives - organic resides - inorganic residues and contaminants.

**UNIT II** **10 Hours**

**FOOD LAWS**

Indian and Food Regulatory Regime (Existing and new), PFA Act and Rules, Food Safety and Quality Requirements, Additives, Contaminants and Pesticide Residue. Food Safety and Standards Act, 2006, FSSAI roles and responsibilities, Essential Commodities Act, 1955, Global Scenario, Codex Alimentarius, WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR) WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR). Food safety inspection services (FSIS) and their utilization.

**UNIT III** **10 Hours**

**REGULATIONS**

Introduction to OIE & IPPC, Other International Food Standards (e.g. European Commission, USFDA etc). WTO: Introduction to WTO Agreements: SPS and TBT Agreement, Export & Import Laws and Regulations, Export (Quality Control and Inspection) Act, 1963. Role of Agricultural and Processed Food Products Export Development Authority (APEDA), Customs Act and Import Control Regulations, Other Voluntary and mandatory product specific regulations, Other Voluntary National Food Standards: BIS Other product specific standards; AGMARK. Nutritional Labelling, Health claims.

**UNIT IV** **10 Hours**

**STANDARDS**

Voluntary Quality Standards and Certification GMP, GHP, HACCP, GAP, Good Animal Husbandry Practices, Good Aquaculture Practices ISO 9000, ISO 22000, ISO 14000, ISO 17025, PAS 22000, FSSC 22000, BRC, BRCIOP, IFS, SQF 1000, SQF 2000. Role of NABL, CFLS.

**UNIT V** **5 Hours**

**IMPLEMENTATION AND RISK ASSESSMENT**

Implementation of food safety for a desired food processing industry. Risk assessment studies: Risk management, risk characterization and communication.

**Total: 45 Hours**

**Reference(s)**

1. Singal RS (1997). Handbook of indices of food quality and authenticity. Woodhead Publ. Cambridge, UK.
2. Shapton DA (1994). Principles and practices of safe processing of foods. Butterworth Publication, London. Winton AL (1999) Techniques of food analysis, Allied Science Publications New Delhi.
3. Pomeranze Y (2004). Food analysis - Theory and Practice CBS Publications, New Delhi.
4. Jacob MB (1999). The chemical analysis of foods and food products. CBS Publ. New Delhi.

## 22OFD03 POST HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES

**3 0 0 3**

### Course Objectives

- To understand the importance and different methods of post-harvest handling and storage of fruits and vegetables.
- To gain knowledge on different preservation methods of fruits and vegetables
- To familiarize with the value added products from fruits and vegetables

### Programme Outcomes (POs)

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

### Course Outcomes (COs)

1. Implement the different post harvest handling practices for the storage of fruits and vegetables
2. Analyze the suitable preservation method (sugar, salt or dehydration) to produce value added products from fruits and vegetables
3. Evaluate the requirement of low temperature and irradiation methods to preserve specific fruits and vegetables
4. Apply the concentration and fermentation methods to preserve fruits and vegetables
5. Implement the canning method to preserve fruits and vegetables

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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**UNIT I** **9 Hours**

**POST-HARVEST PRACTICES AND PROCESSING**

Maturity indices for harvesting; pathological spoilage's during storage, ripening and control measures, Post-harvest handling, sorting & grading, packaging, storage, transportation, Methods of pre-cooling, post-harvest treatments to hasten and delay ripening; Methods of storage at farm level - cold storage, controlled/modified atmosphere storage, Quality management, export requirements, Nutritive value, nutraceutical properties

**UNIT II** **9 Hours**

**PRESERVATION AND VALUE ADDITION**

General principles and methods of fruit and vegetable preservation. Preservation using sugar: Principle and Preparation of jam, jelly, marmalade, squash, RTS, carbonated beverages, crush, nectar, cordial, fruit bar, preserves, candies and carbonated fruit beverages. Processing using salt: Principle - Brining - Preparation of pickles, chutney and sauces, ketchup.

**UNIT III** **9 Hours**

**PRESERVATION BY LOW TEMPERATURE AND IRRADIATION**

Preservation by low temperature: definition, principle, methods - Refrigeration, freezing. Methods of freezing- changes during freezing. Preparation of frozen foods. Minimal Processing of Fruits and Vegetables - techniques involved - Preservation by irradiation: definition- principle, application, irradiation unit.

**UNIT IV** **9 Hours**

**PRESERVATION BY DRYING**

Machineries involved in processing of fruits and vegetables products. Drying and dehydration: definition, principle, Types of driers: Solar, cabinet, spray drier, drum drier, fluidized bed drier. Preparation of product for dehydration. Dehydration principles and equipment. Preparation of fruits - powder production. Problems related to storage of dehydrated products.

**UNIT V** **9 Hours**

**PRESERVATION BY CANNING**

Canning: principles, Types of cans, packing of canned products-preparation of canned products - general considerations in establishing a commercial fruit and vegetable cannery, machineries involved in canning and bottling unit- spoilage of canned foods. Bottling of fruit and vegetable. Precautions in canning operations.

**Total: 45 Hours**

**Reference(s)**


1. S.Ranganna, HandBook of Analysis and Quality Control for Fruit and Vegetable Products, McGraw Hill Education (India) Private Limited, Chennai, 2017.
2. N.W. Desrosier, the Technology of Food Preservation, CBS Publisher & Distributions, New Delhi, 1987.
3. R.P. Srivastava and S. Kumar, Fruit and Vegetable Preservation: Principles and Practices, Second Edition, International Book Distribution Co., Lucknow, 1998.
4. G. Lal, G. Siddappa and G.L. Tondon, Preservation of Fruits and Vegetables, Indian Council of Agricultural Research, New Delhi, 1986.
5. Chakraverty, A.S. Mujumdar, G.S.V. Raghavan and H.S. Ramaswamy, Handbook of Post-harvest Technology, Marcel Dekker Press, USA, 2001.
6. D.K. Salunkhe, and S.S. Kadam, Handbook of Fruit Science and Technology: Production, Composition and Processing, Marcel Dekker, New York, 1995.

## 22OFD04 CEREAL, PULSES AND OILSEED TECHNOLOGY

**3 0 0 3**

**Course Objectives**

- To understand the application of scientific principles in the processing technologies specific to the materials
- To understand the storage methods and handling techniques followed for cereals, pulses and oil seeds
- To develop the knowledge in the area of Cereals, pulses and oil seed processing and technology

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

**Course Outcomes (COs)**

1. Identify the specific processing technologies employed for cereals
2. Analyse the composition of millets and their nutritional importance
3. Relate the compositional changes and processing methods of pulses and legumes
4. Create the competence in processing of oilseeds technology
5. Relate the storage processing of food grains with quality aspects

**Articulation Matrix**

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**UNIT I** **9 Hours**

**CEREALS**

Cereal Grains- Basic agricultural aspects, structure and composition; Storage, Insect control; Processing: Wheat- milling, (Atta and maida), quality aspects of flour, wheat proteins and their function, rheology of flour; wheat based baked products - Bread, Biscuit, Cakes, Extruded products, Pizza, Chapatis, malting and malt products; Rice-Milling, Parboiling, Quick cooking rice, Traditional Indian Products- Puffed Rice, flaked rice, Idli/Dosa/vada mixes and other savouries; Corn- Wet and dry milling, Corn Products - Corn flakes, Corn starch, canned corn products, puffed product; Oats-Milling, Oat Products - Steel cut,rolled oats, quick cooking; Traditional and Fermented cereal products.

**UNIT II** **9 Hours**

**OTHER CEREALS AND MILLETS**

Sorghum, Pearl Millet, Finger millet, Foxtail Kodo Millet - Basic agricultural millet, aspects, structure and composition; storage, insect control; processing - pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet.

**UNIT III** **9 Hours**

**PULSES AND LEGUMES**

Basic agricultural aspects, structure, composition, storage, insect control, processing Milling/splitting, dhal milling, products - puffed, flakes, flour, legume-based traditional products, flour based Indian sweets and savouries, soya milk, soy protein Isolate, soya paneer

**UNIT IV** **9 Hours**

**OIL SEEDS AND NUTS**

Basic agricultural aspects structure, composition, Storage, Insect control; processing: traditional and modern methods of oil extraction, refining, bleaching, deodorizing, hydrogenation; oil blends; applications of different oils and fats in food processing & products.

**UNIT V** **9 Hours**

**STORAGE AND HANDLING**

Bag Storage - Advantages and Disadvantages, Cover Plinth Storage Structures, CAP storage (Cover and Plinth Storage). Protection against Rodents, Fungi, Pests and Mites. Fumigation Processes for bag storage piles. Bulk Storage in silos and large Bins. Conveyors and Elevators for feeding and discharging.

**Total: 45 Hours**

**Reference(s)**

1. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 1995.
2. Delcour, Jan A. and R. Carl Hoseney., Principles of Cereal Science and Technology, 3rd Edition, American Association of Cereal Chemists, 2010.
3. Karl Kulp, Handbook of Cereal Science and Technology, 2nd Rev. Edition, CRC Press, 2000.
4. N.L.Kent and A.D.Evans, Technology of Cereals (4th Edition) Elsevier Science (Pergaman),Oxford, UK, 1994.
5. Matz, Samuel A., The Chemistry and Technology of Cereals as Food and Feed, 2nd Edition,CBS, 1996.
6. Morris, Peter C. and J.H. Bryce., Cereal Biotechnology, CRC/Wood head publishing, 2004.

## 22OFT01 FASHION CRAFTSMANSHIP 3 0 0 3

**Course Objectives**

- To impart theoretical and practical knowledge about various handi-craft techniques
- To enhance innovative skills on hand crafts.
- To build confidence on doing handicrafts.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

**Course Outcomes (COs)**

1. Outline the classification, techniques and criteria for selecting raw materials for making various handicraft materials and produce textile based handicrafts. Produce various decorative and appealing products
2. Design and construct various wall hangings and fashion accessories.
3. Design and construct toys and accessories
4. Design and construct head accessories, home furnishings and paintings
5. Design and construct various decorative and appealing products for interiors

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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**UNIT I** **9 Hours**

**TECHNIQUES OF HANDICRAFT MATERIALS**

Definition of Handicraft, Classification: Reusable, Non reusable, Raw materials used in various craft materials: printed, embroidered, stitched and handmade, Criteria for selection of raw materials: material types and end uses.

**UNIT II** **9 Hours**

**DECORATIVE AND APPEALING PRODUCTS - INTERIORS**

Designing and Construction procedures for following various decorative and appealing products: Wall hangings - String Art on plywood, Pressed Flower Art frames.

**UNIT III** **9 Hours**

**DECORATIVE AND APPEALING PRODUCTS - ACCESSORIES**

Designing and Construction procedures for following various decorative and appealing products: Handbags, Hats, footwear.

**UNITI V** **9 Hours**

**DECORATIVE AND APPEALING PRODUCTS - ORNAMENTS**

Designing and Construction procedures for following various decorative and appealing products: Stone necklace using Macrame Technique, Tribal Jewellery using woollen threads, Floral Jewellery using Resin Technique, Fabric Jewellery using Tie and Dye Technique.

**UNIT V** **9 Hours**

**DECORATIVE AND APPEALING PRODUCTS - FANCY ITEMS**

Designing and Construction procedures for following various decorative and appealing products: Jewellery Box, Utility Holder, Gift items. Lampshade decors from cardboard, Driftwood Frames for pictures and Mirrors.

**Total: 45 Hours**

**Reference(s)**

1. Handmade in India: A Geographic Encyclopaedia of India Handicrafts. Abbeville press; 1 edition October 20, 2009.
2. Encyclopaedia of Card making Techniques (Crafts), Search Press Ltd, illustrated edition, 2007.
3. All about Techniques in Illustration, Barron Educational Series, 2001.
4. Printing by Hand: A Modern Guide to printing with Handmade stamps, Stencils and Silk Screens, STC Craft/A Melanie Falick Book, 2008.
5. Materials & Techniques in the Decorative Arts: An Illustrated Dictionary, University of Chicago Press, 2000.
6. https://www.marthastewart.com/274411/fashion-crafts

## 22OFT02 INTERIOR DESIGN IN FASHION 3 0 0 3

**Course Objectives**

- To impart knowledge on interior design.
- To improve the design skills, sustainable with socially-conscious designs

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

**Course Outcomes (COs)**

1. Interpret the elements of interior design concepts and resolve the personality requirements
2. Develop graphical representations of interior design concepts
3. Resolve the space planning requirements of residential home as per CPWD guidelines
4. Determine the aesthetic requirements of interior design components.
5. Appraise the roles and responsibilities of interior designer.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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**UNIT I** **9 Hours**

**INTRODUCTION**

Interior designing - definition, importance, requirements and types - Structural design, Decorative Design - Designing interiors, Good taste; Design themes, types and application. Personality of the Home - Art elements - Line: types, characteristics and importance; form: size and shape, characteristics; Colour - sources, qualities, emotional effects, colour wheel and schemes.

**UNIT II** **9 Hours**

**GRAPHICAL PRESENTATIONS**

3D composition; Isometric and Axonometric- Still life- Furniture Sketching- Object Drawing with color rendering - Interior elements, Lighting, plants. Perspective, Axonometric Isometric drawing. Orthographic Projection - Lifts and escalators.

**UNIT III** **9 Hours**

**SPACE PLANNING**

Space planning concepts- interiors, circulation. Definition, application of ergonomic principals in interiors. Residential house space planning case study- CPWD guidelines. Lighting for different locations and activities, measurement, ventilation and indoor air quality, noise control methods.

**UNIT IV** **9 Hours**

**INTERIOR COMPONENTS**

Application of colour in interiors; Texture - types and significance; Pattern: types and effects; Light - importance. Importance of Furniture Design for Interiors- Ancient Age / Middle Age / Contemporary. Doors, Windows, Staircase designs, False Ceiling, Partitions, Wall Panelling, Comics, Mosaic, Cladding- Flooring and Wall Cladding

**UNIT V** **9 Hours**

**ROLES AND RESPONSIBILITIES OF INTERIOR DESIGNER**

Role of an Interior Designer- Responsibility towards society and need of an Interior Designer to better the environment- Ethics and Code of Conduct- Responsibility towards client, contractor and supplier, Estimation. Professional Fees- Work of an Interior Designer- Making of portfolio, JD Annual Design Awards.

**Total: 45 Hours**

**Reference(s)**

1. Joanna Gaines, Homebody: A guide to creating spaces you never want to leave, Harper design, 2018.
2. Erin gates, Elements of Style: Designing a Home and a life, Simon and Schuster, 2014.
3. Simon Dodsworth, The Fundamentals of Interior Design, AVA publishing, 2009.
4. V. Mary. Knackstedt, The Interior Design Business Handbook: A Complete Guide to Profitability, Wiley, New Jersey; 2006.
5. M. G. Shah, C. M. Kale, and S.Y. Patki, Building Drawing with an Integrated Approach to Build Environment, Tata McGraw Hill, 2002.
6. Https://eclectictrends.com

## 22OFT03 SURFACE ORNAMENTATION 3 0 0 3

**Course Objectives**

- To familiarize the students about the various techniques of surface embellishment with relevance to garment embellishments.
- To aware of various types of embroidery and methods of producing it.
- To make the students confident about doing surface embellishment work

**Programme Outcomes (POs)**

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**Course Outcomes (COs)**

1. Analyze the raw material requirements for surface ornamentation and its application
2. Implement hand embroidery stitches on fabric and show the stitch development procedure in diagrammatic representations
3. Apply the machine and computerized embroidery stitches
4. Analyze the surface embellishment techniques and its application
5. Assess the quality maintenance parameters of all embroidered products and analyze the 6 traditional embroidery techniques

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
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**UNIT I** **9 Hours**

**INTRODUCTION TO SURFACE ORNAMENTATION**

Introduction, Definition, Need, Types, Raw materials, Importance of surface ornamentation, Selection of needle, thread and fabric for hand embroidery and machine embroidery. various methods of surface embellishment- embroidery and surface ornamentation.

**UNIT II** **9 Hours**

**HAND EMBROIDERY**

General rules for hand embroidery. Types of hand embroidery stitches-Running, Couching, Button hole, Satin, Long & Short, Wheat, Chain, Stem, Herringbone, Cross stitch, Knotted stitches, Fish bone, Fly stitch, Braids, Back, Hem, Seed, Needle weaving, Whip stitches.

**UNIT III** **9 Hours**

**MACHINE EMBROIDERY**

General rules for machine embroidery. Types of frames and methods of transferring the designs. Attachments to sewing machines for embroidery, Types of machine embroidery stitches- Eyelet work, Cut work, patch work, Mirror work, Applique, Shaded embroidery, Shadow work, Bead and Sequins work, Vermicelli, Zigzag, Granite stitch. Computerized embroidery machine- Concept of design and development, software used in embroidery machines, process of designing, method and types of stitch application, punching and digitizing.

**UNIT IV** **9 Hours**

**EMBELLISHMENT TECHNIQUES**

Materials used and Applications. Types of embellishment techniques- fabric painting-hand, Stencil-dabbing and Spraying. Dyeing and printing-advanced tie and dye techniques, batik and block printing. Trimmings and decorations-Laces, Pompons, Fringes, Tassels, Tucks, Show buttons, Crocheting.

**UNIT V** **9 Hours**

**TRADITIONAL EMBROIDERIES OF INDIA AND CARE**

Care and maintenance of embroidered articles-care and maintenance methods for embroidered apparel, pressing. Traditional Embroideries of India-Phulkari, Kasuti, Kashmiri embroidery, Kutch work, Chikkankari, Kantha.

**Total: 45 Hours**

**Reference(s)**

1. Ruth Chandler, Modern Hand Stitching-Dozens of stitches with creative free-form variations, 2014.
2. Sophie Long, Mastering the Art of Embroidery: Traditional Techniques and Contemporary Applications for Hand and Machine Embroidery, Heritage Publishers, London, 2013.
3. Christen Brown ,Embroidered & Embellished, C&T Publishing, 2013.
4. Sheila Paine, Embroidered Textiles, Thames and Hudson Publisher, UK, 1990.
5. Gail Lawther, Inspirational Ideas for Embroidery on Clothes & Accessories, Search Press Ltd, UK, 1993.
6. http://www.needlenthread.com/tag/hand-embroidery-stitches

## 22OPH01 NANOMATERIALS SCIENCE 3 0 0 3

**Course Objectives**

- Impart knowledge on Nanoscience
- Explore different techniques of producing nanomaterials
- Create expertise on the applications of nanomaterials in various fields

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

**Course Outcomes (COs)**

1. Summarize the origin and advance of nanomaterials and its classification
2. Compare the different types of methods adopted for synthesizing nanomaterials
3. Analyze the characterization techniques for analyzing nanomaterials
4. Explain the physical properties exhibited by nanomaterials
5. Organize the nanomaterials developed for advanced technological applications

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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| 5 | 3 | 2 | 2 | 1 | 1 | | | | | | 1 | | |

**UNIT I** **9 Hours**

**NANO SCALE MATERIALS**

Introduction-Feynman's vision-national nanotechnology initiative (NNI) - past, present, future -classification of nanostructures, nanoscale architecture - effects of the nanometer length scale - changes to the system total

energy, and the system structures- effect of nanoscale dimensions on various properties -differences between bulk and nanomaterials and their physical properties.

**UNIT II** **9 Hours**

**NANOMATERIALS SYNTHESIS METHODS**

Top down processes - mechanical milling, nanolithography and types based on radiations - Bottom up process physical method: physical vapour deposition, RF sputtering, CVD- chemical method: colloidal and sol-gel methods - template based growth of nanomaterials - ordering of nanosystems, self-assembly and self-organization.

**UNIT III** **9 Hours**

**CHARACTERIZATION TECHNIQUES**

General classification of characterization methods - analytical and imaging techniques - microscopy techniques - electron microscopy, scanning electron microscopy, transmission electron microscopy, atomic force microscopy - diffraction techniques - X-ray spectroscopy - thermogravimetric analysis of nanomaterials.

**UNIT IV** **9 Hours**

**SEMICONDUCTOR NANOSTRUCTURES**

Quantum confinement in semiconductor nanostructures - quantum wells, quantum wires, quantum dots, super lattices-epitaxial growth of nanostructures-MBE, metal organic VPE, LPE - carbon nano tubes- structure, synthesis and electrical properties -applications- quantum well laser- quantum efficiency of semiconductor nanomaterials

**UNIT V** **9 Hours**

**NANOMACHINES AND NANODEVICES**

Microelectromechanical systems (MEMS) and Nanoelectromechanical systems (NEMS)-fabrication, actuators-organic FET- principle, description, requirements, integrated circuits- single electron transistor - organic photovoltaic cells- spintronics

**Total: 45 Hours**

**Reference(s)**


1. W A Goddard and D W Brenner, Handbook of Nanoscience, Engineering, and Technology, CRC Press, 2012.
2. Charles P Poole, Jr and Frank J Owens, Introduction to Nanotechnology, Wiley Interscience, 2007.
3. Guozhong Cao, Y Wang, Nanostructures and Nanomaterials-Synthesis, Properties & Applications, Imperials College Press, 2011.
4. T Pradeep, NANO: The Essentials Understanding Nanoscience and Nanotechnology, McGraw - Hill Education (India) Ltd, 2012.
5. Robert W Kelsall, Ian W Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley and Sons Ltd, 2006.
6. Viswanathan B, AuliceScibioh M, Fuel cells: Principles and Applications, University Press, 2009.

## 22OPH04 BIOPHOTONICS 3 0 0 3

**Course Objective:**

- To understand the light-matter interaction in biological cells or tissues by using the principles of optics and lasers.
- To apply the properties of biological cells or tissues in biomedical applications by various optical imaging, sensing and activation techniques.
- To analyze the concepts of Modern optical measurement techniques and devices in early detection of disease and cure them.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

**Course Outcomes (COs)**

1. Infer the laws of optics and lasers to interpret the biological cells and tissues.
2. Identify the properties of different optical instruments in biological systems to represent their behavior in structure and design of detection engineering instruments.
3. Use laser tweezers techniques to infer the activities of cells (tissues) and explain the single molecule detection processes in medical diagnosis.
4. Outline the properties of ultra short laser pulses and tissue engineering to rectify the affecting factors in biological cells.
5. Compare the various types of bio-imaging methods to detect the infected cells and molecules in biological science.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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**UNIT I** **9 Hours**

**INTRODUCTION TO BIOPHOTONICS**

Light as Photon Particles – Coherence of light - lasers – classification of lasers – Mechanisms of Non-linear Optics (NLO) processes associated with Biophotonics - Light scattering mechanisms: Rayleigh scattering, Miescattering, Brillouin Scattering, Raman Scattering -Different light sources – Quantitative description of light: Radiometry

**UNIT II** **9 Hours**

**PHOTOBIOLOGY**

Interaction of light with cells and tissues – Light – Tissue Interaction Variables – Light –Tissue Interaction Theory: Radiative Transport Theory – Photo process in biopolymers – In Vivo Photo excitation – photo-induced physical, chemical, thermal and mechanical effects in biological systems – Optical biopsy – Single molecule detection

**UNIT III** **9 Hours**

**BIONANO PHOTONICS**

Laser Microtools, Semiconductor quantum dots for bioimaging, Metallic nanoparticles and nanorods for biosensing – Optical biosensors: Fibre-Optic, evanescent wave, surface Plasmon resonance (SPR) based biosensors – biomaterials for photonics – Principle and design of laser tweezers – laser trapping and dissection for biological manipulation.

**UNIT IV** **9 Hours**

**TISSUE ENGINEERING WITH LIGHT**

Basics of tissue optics: Light absorption and scattering in tissues, Wavelength effects and spectra– the therapeutic window, Light penetration in tissues – Absorbing agents in tissues and blood –Skinoptics, response to the UV radiation, Optical parameters soft tissues – tissue welding – tissue contouring – tissue regeneration – Femto laser surgery – low level light therapy and photo dynamic therapy

**UNIT V** **9 Hours**

**BIO-IMAGING TECHNIQUES AND ITS APPLICATIONS**

An overview of optical imaging – Fluorescence Microscopy – Scanning Microscopy – In vivo Confocal Microscopy – Multi photon Microscopy – Optical Coherence Tomography (OCT) – Fluorescence Resonance Energy Transfer (FRET) imaging – fluorescence lifetime imaging Microscopy (FLIM) – Nonlinear optical imaging – Coherent Anti-stokes Raman Scattering –Bioimaging Applications.

**Total: 45 Hours**

**Reference(s)**


1. Paras N Prasad, Introduction to Biophotonics, Wiley Inter-science, A John Wiley & Sons, Inc., Publication, 2003.
2. Andrew GWebb, Introduction to Biomedical Imaging, IEEE Press, 2002.
3. Lihong V Wang and HSin-i Wu, Biomedical Optics: Principles and Imaging, Wiley 2007.
4. R Splinter and B A Hooper, An Introduction to Biomedical Optics, Wiley Inter science , Taylor & Francis, 2007.
5. D E Chandler and R W Roberson, Bioimaging Current Concepts in Light and Electron Microscopy, Jones and Bartlett publishers, 2008.
6. Peter Torok and Fu-Jen Kao, Optical Imaging and Microscopy: Techniques and Advanced Systems, Springer, 2004.

## 22OPH05 PHYSICS OF SOFT MATTER 3 0 0 3

**Course Objectives**

- To recognize the properties of soft matter and hard matter
- To understand the fundamental interactions of colloids and gels
- To explain the structure and phase behavior of liquid crystals and supra molecules
- To summarize the soft matter properties of structures and components of life

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

**Course Outcomes (COs)**

1. Identify the salient features of soft matter and hard matter
2. Exemplify the fundamental interactions and stability of colloids and gels
3. Illustrate the structure and properties of liquid crystals
4. Outline the aggregation and phase behavior of surfactants, polymers, copolymers and block copolymers
5. Analyze the soft matter behavior of nucleic acids, proteins, polysaccharides and membranes

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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**UNIT I** **9 Hours**

**CONDENSED MATTER**

Intermolecular forces-Condensation and freezing-mechanical response: Hookean solid-Newtonian liquid-viscoelasticity. Glasses: relaxation time-viscosity- glass forming liquids. Soft matter: length scales-fluctuations and Brownian motion

**UNIT II** **9 Hours**

**COLLOIDAL DISPERSIONS & GELS**

Forces between colloidal particles: vander Waals forces-electrostatic double layer forces-steric hindrance-depletion interactions. Stability and phase behaviour: Crystallisation-strong colloids-weak colloids. Physical and chemical gels-classical theory of gelation-elasticity of gels

**UNIT III** **9 Hours**

**LIQUID CRYSTALS**

Liquid crystal phases-distortions and topological defects-electrical and magnetic properties-polymer liquid crystals-Fredricks transition and liquid crystal displays

**UNIT IV** **9 Hours**

**SUPRAMOLECULAR SELF ASSEMBLY**

Aggragation and phase separation-types of micelles- bilayers and vesicles. Phase behaviour of concentrated surfactant solutions-phase separation in polymers, copolymers and block copolymers

**UNIT V** **9 Hours**

**SOFT MATTER IN NATURE**

Components and structures of life - Nucleic acids – proteins - interaction between proteins – polysaccharides - membranes

**Total: 45 Hours**

**Reference(s)**

1. Richard A L Jones, Soft Condensed Matter, Oxford University Press, UK, 2002.
2. Masao Doi, Soft Matter Physics, Oxford University Press, UK, 2013.
3. Ian W Hamley, Introduction to Soft Matter, John Wiley & Sons, 2007.
4. Fernandez-Nieves A and Puertas A M, Fluids, Colloids and Soft materials: An Introduction to Soft Matter Physics, John Wiley & Sons, 2016.
5. Maurice Kleman, and Oleg D Lavrentovich, Soft Matter Physics: An Introduction, Springer-Verlag, New York, 2003.

## 22OCH01 CORROSION SCIENCE AND ENGINEERING

**3 0 0 3**

**Course Objectives**

- Analyse the loss incurred due to corrosion in different sectors and terminologies related to corrosion
- Identify forms and types of corrosion with suitable mechanism
- Apply various methods of corrosion control, corrosion testing and monitoring

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

**Course Outcomes (COs)**

1. Explain if corrosion can occur under specific operating conditions in a given equipment or construction and indicate regions of immunity, corrosion and passivity of a metal
2. Compare different corrosion types on metals when exposed to air, water and at high temperatures (> 100 C)
3. Identify the corrosion mechanism on steel, iron, zinc and copper metal surfaces
4. Calculate the rate of corrosion on metals using electrochemical methods of testing
5. Propose the correct materials, design and operation conditions to reduce the likelihood of corrosion in new equipment and constructions

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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**UNIT I** **9 Hours**

**CORROSION**

Importance of corrosion - spontaneity of corrosion - units of corrosion rate (mdd and mpy) - direct and indirect damage by corrosion - importance of corrosion prevention in industries - Pilling Bedworth ratio and its significance - passivation - area relationship in both active and passive states of metals - Pourbaix digrams of Mg, Al and Fe and their advantages and disadvantages

**UNIT II** **7 Hours**

**TYPES OF CORROSION**

Eight forms of corrosion: uniform, galvanic, crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion-Catastrophic oxidation corrosion

**UNIT III** **9 Hours**

**MECHANISM OF CORROSION**

Hydrogen embrittlement - corrosion fatigue - filiform corrosion - fretting damage and microbes induced corrosion. Corrosion mechanism on steel, iron, zinc and copper metal surfaces

**UNIT IV** **10 Hours**

**CORROSION RATE AND ITS ESTIMATION**

Rate of corrosion: Factors affecting corrosion. Electrochemical methods of polarization: Tafel extrapolation polarization and linear polarization. Weight loss method - testing for intergranular susceptibility and stress corrosion. Non destructive testing methods: Visual testing - liquid penetrant testing - magnetic particle testing - Ultrasonic monitoring, and eddy current testing

**UNIT V** **10 Hours**

**CORROSION CONTROL METHODS**

Fundamentals of cathodic protection - types of cathodic protection(sacrificial anodic and impressed current cathodic protection). Stray current corrosion, problems and its prevention. Protective coatings: Metal coatings: Hot dipping (galvanizing, tinning and metal cladding) - natural inhibitors. Selection of suitable design for corrosion control.

**Total: 45 Hours**

**Reference(s)**

1. Mouafak A. Zaher, Introduction to Corrosion Engineering, Create Space Independent Publishing Platform, 1st Edition, 2016.
2. E. McCafferty, Introduction to Corrosion Science, Springer, 1st Edition, January 2010.
3. R. Winstone Revie and Herbert H. Uhlig, Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering, 4th Edition, John Wiley & Science, 2008.
4. Mars G. Fontana, Corrosion Engineering, Tata McGraw Hill, Singapore, 2nd Edition, 2008.
5. David E.J. Talbot and James D.R. Talbot, Corrosion Science and Technology, Second Edition (Materials Science & Technology), CRC Press, 2nd Edition, 2007.

## 22OCH02 POLYMER SCIENCE 3 0 0 3

**Course Objectives**

- Explain the properties of different polymers with its mechanism
- Select the appropriate polymerization techniques to synthesize the polymers
- Identify suitable polymers for various industrial applications

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

**Course Outcomes (COs)**

1. Illustrate the types of mechanism of polymerization reactions and analyze the natural and synthetic polymers
2. Identify the suitable polymerization techniques to synthesize the high quality polymers
3. Identify the structure, thermal, and mechanical properties of polymers for different applications
4. Apply the polymer processing methods to design polymer products
5. Analyze the polymers used in electronic and biomedical applications.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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**UNIT I** **10 Hours**

**POLYMERS AND ELASTOMERS**

Classification of polymers - Mechanism: Addition polymerization - free radical, cationic, anionic and co-ordination (Ziegler-Natta) polymerization - copolymerization - condensation polymerization (nylon-6,6) - ring opening polymerization (nylon-6). Elastomers: Natural rubber and synthetic rubber: styrene -butadiene rubber (SBR), butyl, neoprene, thiocol rubbers. High performance polymers: polyethers, polyether ether ketone (PEEK), polysulphones and polyimides

**UNIT II** **8 Hours**

**POLYMERIZATION TECHNIQUES**

Homogeneous and heterogeneous polymerization - bulk polymerization (PMMA, PVC) - solution polymerization - polyacrylic acid, suspension polymerization (ion-exchange resins) - emulsion polymerization (SBR) - advantages and disadvantages of bulk and emulsion polymerization. Melt solution and interfacial poly-condensation

**UNIT III** **8 Hours**

**CHARACTERIZATION AND TESTING**

Characterization of polymers by Infrared Spectroscopy (IR) and Nuclear Magnetic Spectroscopy (NMR) - Thermal properties: TGA and DSC - Testing tensile strength - Izod impact - Compressive strength - Rockwell hardness - Vicot softening point - water absorption

**UNIT IV** **9 Hours**

**POLYMER PROCESSING**

Moulding: Compression - injection - extrusion and blow mouldings. Film casting - calendering. Thermoforming and vacuum formed polystyrene - foamed polyurethanes. Fibre spinning: melt, dry and wet spinning. Fibre reinforced plastics fabrication: hand-layup - filament winding and pultrusion

**UNIT V** **10 Hours**

**SPECIALITY POLYMERS**

Preparation and properties of heat resistant and flame retardant polymers. Polymers for electronic applications: liquid crystalline, conducting and photosensitive polymers – E waste management. Polymer for biomedical applications: artificial organs, controlled drug delivery, Scaffolds in tissue Engineering –waste management.

**Total: 45 Hours**

**Reference(s)**

1. V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, Polymer Science, New Age International (P) Ltd, New Delhi, 2021.
2. Joel R. Fried, Polymer Science and Technology, Prentice Hall of India (P). Ltd., 2014.
3. R. J. Young and P. A. Lovell, Introduction to Polymers, CRC Press, New York, 2011.
4. F. W. Billmeyer, Text Book of Polymer Science, John Wiley & Sons, New York, 2008.
5. Barbara H. Stuart, Polymer Analysis, John Wiley & Sons, New York, 2008.
6. George Odian, Principles of Polymerization, John Wiley & Sons, New York, 2004.

## 22OCH03 ENERGY STORING DEVICES 3 0 0 3

**Course Objectives**

- Compare the energy density of commercialized primary and secondary batteries.
- Classify the fuel cells and compare their efficiency in different environmental conditions.
- Demonstrate the various energy storage devices and fuel cells.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

**Course Outcomes (COs)**

1. Find the parameters required for operation of a cell to evaluate the capacity of energy storage devices.
2. Identify the electrodes, electrolyte and cell reactions of different types of primary, secondary batteries and infer the selection criteria for commercial battery systems with respect to commercial applications.
3. Differentiate fuel cells based on its construction, production of current and applications.
4. Compare different methods of storing hydrogen fuel and its environmental applications.
5. Classify the solar cell based on the materials used in it.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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**UNIT I** **6 Hours**

**BASICS OF CELLS AND BATTERIES**

Components - classification - operation of a cell - theoretical cell voltage - capacity - specific energy - energy density of lithium and lead acid battery - charge efficiency- charge rate - charge retention - closed circuit voltage - open circuit voltage current density - cycle life - discharge rate-over charge-over discharge

**UNIT II** **10 Hours**

**BATTERIES FOR PORTABLE DEVICES AND ELECTRIC VEHICLES**

Primary batteries: zinc-carbon - magnesium, and mercuric oxide - recycling/safe disposal of used cells. Secondary batteries: lead acid - nickel-cadmium - lithium ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide - lithium anode cell - photogalvanic cells. Battery specifications for cars and automobiles. Extraction of metals from battery materials.

**UNIT III** **10 Hours**

**TYPES OF FUEL CELLS**

Importance and classification of fuel cells: Description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells - phosphoric acid - solid oxide - molten carbonate and direct methanol fuel cells

**UNIT IV** **10 Hours**

**HYDROGEN AS A FUEL**

Sources and production of hydrogen: Electrolysis and photocatalytic water splitting. Methods of hydrogen storage: High pressurized gas - liquid hydrogen type - metal hydride. Hydrogen as engine fuel - features, application of hydrogen technologies in the future – limitations.

**UNIT V** **9 Hours**

**ENERGY AND ENVIRONMENT**

Future prospects of renewable energy and efficiency of renewable fuels - economy of hydrogen energy. Solar Cells: First, second, third and fourth generation solar cell - photobiochemical conversion cell.

**Total: 45 Hours**

**Reference(s)**

1. S.P. Jiang and Q. Li, Introduction to fuel cells, Springer, 2021.
2. M.M. Eboch, The Future of Energy: From solar cells to flying wind farms, Capstone publishers, 2020.
3. N. Eliaz and E. Gileadi, Physical electrochemistry, fundamentals, techniques and applications, Wiley, 2019.
4. J. Garche and K. Brandt, Electrochemical power sources: Fundamentals systems and applications, Elsevier, 2018.
5. A. Iulianelli and A. Basile, Advances in hydrogen production, storage and distribution, Elsevier, 2016.

## 22OMA01 GRAPH THEORY AND COMBINATORICS 3 0 0 3

**Course Objectives**

- This course comprehends the graphs as a modeling and analysis tool in computer science & Engineering
- It introduces the structures such as graphs & trees and techniques of counting and combinations, which are needed in number theory based computing and network security studies in Computer Science.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

**Course Outcomes (COs)**

1. Recognize the basic ideas of Graph and its characteristics.
2. Assess the characteristics of trees and its properties.
3. Predict the coloring of graphs and its applications in the respective areas of engineering.
4. Compute the permutations and combinations in the engineering field.
5. Demonstrate the types of generating functions and their applications in engineering.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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**UNIT I** **9 Hours**

**INTRODUCTION**

Graphs - Introduction - Isomorphism - Sub graphs - Walks, Paths, Circuits - Connectedness - Components - Euler graphs - Hamiltonian paths and circuits - Trees - Properties of trees - Distance and centers in tree - Rooted and binary trees.

**UNIT II** **9 Hours**

**TREES, CONNECTIVITY**

Spanning trees - Fundamental circuits - Spanning trees in a weighted graph - cut sets - Properties of cut set - All cut sets - Fundamental circuits and cut sets - Connectivity and separability - Network flows - 1-Isomorphism - 2-Isomorphism - Combinational and geometric graphs - Planer graphs - Different representation of a planer graph.

**UNIT III** **9 Hours**

**MATRICES, COLOURING AND DIRECTED GRAPH**

Chromatic number - Chromatic partitioning - Chromatic polynomial - Matching - Covering - Four color problem - Directed graphs - Types of directed graphs - Digraphs and binary relations - Directed paths and connectedness - Euler graphs.

**UNIT IV** **9 Hours**

**PERMUTATIONS**

Fundamental principles of counting - Permutations and combinations - Binomial theorem - combinations with repetition - Combinatorial numbers - Principle of inclusion and exclusion - Derangements - Arrangements with forbidden positions.

**UNIT V** **9 Hours**

**GENERATING FUNCTIONS**

Generating functions - Partitions of integers - Exponential generating function - Summation operator - Recurrence relations - First order and second order - Non-homogeneous recurrence relations - Method of generating functions.

**Total: 45 Hours**

**Reference(s)**

1. Narsingh Deo, Graph Theory: With Application to Engineering and Computer Science, Prentice Hall of India, 2003.
2. Grimaldi R.P., Discrete and Combinatorial Mathematics: An Applied Introduction, Addison Wesley, 1994.
3. Rosen K.H., Discrete Mathematics And Its Applications, McGraw Hil, 2007.
4. Clark J. & Holton D.A., A First Look at Graph Theory, Allied Publishers, 1995.
5. Mott J.L., Kandel A. & Baker T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 1996.
6. Liu C.L., Elements of Discrete Mathematics, McGraw Hill, 1985.

## 22OGE01 PRINCIPLES OF MANAGEMENT 3 0 0 3

**Course Objectives**

- To develop cognizance about importance of management principles.
- Extract the functions and responsibilities of managers.
- To Study and understand the various HR related activities.
- Learn the application of the theories in an organization.
- Analyze the position of self and company goals towards business.

**Programme Outcomes (POs)**

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

**Course Outcomes (COs)**

1. Students will be able to understand the basic concepts of Management.
2. Have some basic knowledge on planning process and its Tools & Techniques.
3. Ability to understand management concept of organizing and staffing.
4. Ability to understand management concept of directing.
5. Ability to understand management concept of controlling.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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**UNIT I** **9 Hours**

**INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS**

Definition of Management Science or Art Manager Vs Entrepreneur-types of managers - Managerial roles and skills Evolution of Management Scientific, Human Relations, System and Contingency approaches Types of Business organization - Sole proprietorship, partnership, Company - public and private sector enterprises - Organization culture and Environment Current Trends and issues in Management.

**UNIT II** **9 Hours**

**PLANNING**

Nature and purpose of planning - Planning process - Types of planning - Objectives - Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.

**UNIT III** **9 Hours**

**ORGANISING**

Nature and purpose – Formal and informal organization - Organization chart - Organization Structure Types - Line and staff authority – Departmentalization - Delegation of authority - Centralization and decentralization - Job Design - Human Resource – Management - HR Planning, Recruitment, Selection, Training and Development, Performance Management, Career planning and management

**UNIT IV** **9 Hours**

**DIRECTING**

Foundations of individual and group behaviour – Motivation - Motivation theories - Motivational techniques - Job satisfaction - Job enrichment - Leadership - types and theories of leadership – Communication - Process of communication - Barrier in communication Effective communication - Communication and IT.

**UNIT V** **9 Hours**

**CONTROLLING**

System and process of controlling - Budgetary and non - Budgetary control techniques - Use of Computers and IT in Management control - Productivity problems and management - Control and Performance-Direct and preventive control - Reporting.

**Total: 45 Hours**

**Reference(s)**

1. Robbins S, Management, (13th ed.), Pearson Education, New Delhi, 2017.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, Fundamentals of Management, Pearson Education, 7th Edition, 2011.
3. Robert Kreitner and Mamata Mohapatra, Management, Biztantra, 2008.
4. L. M. Prasad, Principles and Practice of Management. 7th Edition, Sultan Chand & Sons, 2007.
5. P. C. Tripathi and P. N. Reddy, Principles of Management, Fourth Edition, Tata McGraw Hill, 2008.

## 22OGE02 ENTREPRENEURSHIP DEVELOPMENT I 3 0 0 3

**Course Objectives**

- Learn the basics and scope of the Entrepreneurship
- Understand the generation of ideas of the Entrepreneurship
- Evolve the legal aspects of the business
- Learn to analyze the various business finance
- Learn the basics of the Operations Management

**Programme Outcomes (POs)**

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

**Course Outcomes (COs)**

1. Analyze the role of entrepreneurship in economic development.
2. Explain the types of ideas that to be used for entrepreneurship development.
3. Examine the legal aspects of business and its association.
4. Examine the sources of business and its analysis.
5. Analyse the different modes of operation management.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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**UNIT I** **9 Hours**

**BASICS OF ENTREPRENEURSHIP**

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

**UNIT II** **9 Hours**

**GENERATION OF IDEAS**

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractional, Reversal Method, Brain Storming, Analogies

**UNIT III** **9 Hours**

**LEGAL ASPECTS OF BUSINESS**

Contract act - Indian contract act, Essential elements of valid contract, classification of contracts, sale of goods act- Formation of contract of sale, negotiable instruments - promissory note, bills and cheques, partnership, limited liability partnership (LLP), companies act-kinds, formation, memorandum of association, articles of association.

**UNIT IV** **9 Hours**

**BUSINESS FINANCE**

Project evaluation and investment criteria (cases), sources of finance, financial statements, break even analysis, cash flow analysis.

**UNIT V** **9 Hours**

**OPERATIONS MANAGEMENT**

Importance - functions - deciding on the production system - facility decisions: plant location, plant layout (cases), capacity requirement planning - inventory management (cases) - lean manufacturing, Six sigma.

**Total: 45 Hours**

**Reference(s)**

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2005.
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2000.
3. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.

## 22OGE03 ENTREPRENEURSHIP DEVELOPMENT II 3 0 0 3

**Course Objectives**

- Evolve the marketing mix for promotion the product / services
- Handle the human resources and taxation
- Learn to analyze the taxation
- Understand the Government industrial policies and supports
- Preparation of a business plan

**Programme Outcomes (POs)**

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

**Course Outcomes (COs)**

1. Examine the strategies and plans in marketing management.
2. Analyse the cases involved in human resource management.
3. Classify the direct and indirect taxes in business.
4. Analyze the supports given by government for improving the business.
5. Examine the various steps involved in preparing the business plan.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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**UNIT I** **9 Hours**

**MARKETING MANAGEMENT**

Marketing environment, Segmentation, Targeting and positioning, Formulating marketing strategies, Marketing research, marketing plan, marketing mix (cases)

**UNIT II** **9 Hours**

**HUMAN RESOURCE MANAGEMENT**

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view)

**UNIT III** **9 Hours**

**BUSINESS TAXATION**

Direct taxation, Income tax, Corporate tax, MAT, Tax holidays, Wealth tax, Professional tax (Cases). Indirect taxation, Excise duty, Customs, Sales and Service tax, VAT, Octroi, GST (Cases).

**UNIT IV** **9 Hours**

**GOVERNMENT SUPPORT**

Industrial policy of Central and State Government, National Institute-NIESBUD, IIE, EDI. State Level Institutions - TIIC, CED, MSME, Financial Institutions

**UNIT V** **9 Hours**

**BUSINESS PLAN PREPARATION**

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis.

**Total: 45 Hours**

**Reference(s)**

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2005.
2. Philip Kotler., Marketing Management, Prentice Hall of India, New Delhi, 2003.
3. Aswathappa K, Human Resource and Personnel Management - Text and Cases, Tata McGraw Hill, 2007.
4. Jain P C., Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi, 2002.
5. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill, 2006.
6. http://niesbud.nic.in/agencies.html

## 22OGE04 NATION BUILDING, LEADERSHIP AND SOCIAL RESPONSIBILITY

**3 0 0 3**

### Course Objectives

- To understand the importance of National Integration, Patriotism and Communal Harmony
- To outline the basic awareness about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality
- To analyze the different types of responsibility role of play for the improvement of society

### Programme Outcomes (POs)

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change

### Course Outcomes (COs)

1. Understand religion-cultural diversity of the country and its impact on the lives of the people and their beliefs
2. Acquire a sense of responsibility, smartness in appearance and improve self confidence
3. Develop the sense of self-less social service for better social & community life
4. Apply the importance of Physical and Mental health and structure of communication organization and various mode of communication
5. Acquire awareness about the various types of weapon systems in the Armed Forces.

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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**UNIT I** **9 Hours**

**NATIONAL INTEGRATION**

Importance & Necessity, Factors Affecting National Integration, Unity in Diversity. Threats to National Security. Water Conservation and Rain Harvesting, Waste Management and Energy Conservation.

Leadership Capsule-Traits-Indicators-Motivation-Moral Values-Honor Code-Case Studies: Shivaji, Jhansiki Rani, Case Studies–APJ Abdul kalam, Deepa Malik, Maharana Pratap, N Narayan Murthy

Ratan Tata Rabindra Nath Tagore, role of NCC cadets in 1965 war.

**UNIT II** **9 Hours**

**PERSONALITY DEVELOPMENT AND LEADERSHIP**

Intra & Interpersonal skills - Self-Awareness- &Analysis, Empathy, Critical & creative thinking, Decision making and problem solving, Communication skills, Group Discussion – copping with stress and emotions, changing mindset, Public Speaking, Time Management, Social skills, Career counseling, SSB procedure and Interview skills.

**UNIT III** **9 Hours**

**SOCIAL SERVICE, COMMUNITY DEVELOPMENT AND ENVIRONMENTAL AWARENESS**

Basics of social service and its need, Types of social service activities, Objectives of rural development programs and its importance, NGO's and their contribution in social welfare, contribution of youth and NCC in Social welfare. Protection of children & women safety, Road/ Rail Travel Safety, New initiatives, Cyber and mobile security awareness.

Disaster management Capsule-Organization-Types of Disasters-Essential Services-Assistance-Civil Defence Organization

**UNIT IV** **9 Hours**

**HEALTH, HYGIENE AND COMMUNICATION**

Sanitation, First Aid in Common Medical Emergencies. Health, Treatment and Care of Wounds. Yoga-Introduction, Definition, Purpose, Benefits. Asanas-Padamsana, Siddhasana, Gyan Mudra, Surya Namaskar, Shavasana, Vajrasana, Dhanurasana, Chakrasana, Sarvaangasana, Halasanaetc.

Obstacle Training Contact: Obstacle training - Intro, Safety measures, Benefits, Straight balance, Clear Jump, Gate Vault, ZigZagBalance, High Wall etc.

COMMUNICATION: Basic Radio Telephony (RT) Procedure-Introduction, Advantages, Disadvantages, Need for standard- Procedures-Types of Radio Telephony Communication-Radio telephony procedure, Documentation.

**UNIT V** **9 Hours**

**ARMED FORCES AND NCC GENERAL**

Army, navy, Air force and Central armed policed forces- Modes of entry into army, police and CAPF-Naval expeditions & campaigns. History, Geography of Border / Coastal areas. EEZ maritime security & ICG. Modes of Entries in armed forces. Security challenges & role of cadets in Border management.

Aims, Objectives and org of NCC- Incentives- Duties of NCC cadets- NCC Camps: types and conduct.

**Total: 45 Hours**

**Reference(s)**

1. Lt. Dr S Rajan and Capt. Dr R Latha, NCC Master, Dream Book Publishing, 2024.
2. R. Gupta, NCC National Cadet Corps A, B & C-Certificate Examination Book, 22nd edition, Ramesh Publishing House, 2022.
3. Singh and Neeraj, A Hand Book of NCC, Kanti Prakashan Publishing, 5th edition, 2021.
4. https://nccorissa.org/old/Doc/Ncc-CadetHandbook.pdf

## 22OBM01 OCCUPATIONAL SAFETY AND HEALTH IN PUBLIC HEALTH EMERGENCIES

**3 0 0 3**

**Course Objectives**

- Students will be able to know about Occupational safety and health (OSH)
- Students will be able to discuss about risks faced by emergency responders during disease outbreaks and other emergencies
- Students will be able to create awareness on necessary strategies for managing OSH in emergency situations

**Programme Outcomes (POs)**

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change

**Course Outcomes (COs)**

1. Practice the occupational safety measures by the scientific knowledge to overcome the risks faced by emergency responders
2. Apply appropriate strategies and tools in Occupational safety and healthcare
3. Analyse common risks for safety and health in emergencies
4. Adapt appropriate occupational safety practices in chemical accidents
5. Guide Occupational safety measures in radiation incidents

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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**UNIT I** **9 Hours**

**MANAGEMENT ASPECTS**

Management system approach to occupational safety and health hazards and risks – rights, duties and responsibilities of employers and workers during outbreaks and emergencies – Emergency responders health monitoring and surveillance.

**UNIT II** **9 Hours**

**STRATEGIES AND TOOLS**

International Health Regulations, 2005 – Incident command system for managing outbreaks and emergencies – Occupational safety and health controls – Strategies for infection prevention and control

**UNIT III** **9 Hours**

**COMMON RISKS FOR SAFETY AND HEALTH IN EMERGENCIES**

Vector-borne diseases, water and food-borne diseases, Vaccine-preventable diseases – Heat stress - Slips, trips and falls - Road traffic injuries – Ergonomic hazards - Violence – Psychological stress during outbreaks and injuries

**UNIT IV** **9 Hours**

**OCCUPATIONAL SAFETY AND HEALTH IN CHEMICAL INCIDENTS**

Emergencies caused by chemical incidents – occupational safety and health hazards and risks of chemicals – Personal Protective Equipment – Decontamination of emergency response personnel – medical surveillance of emergency responders

**UNIT V** **9 Hours**

**OCCUPATIONAL SAFETY AND HEALTH IN RADIATION INCIDENTS**

Sources and scenarios of radiation incidents – guidance for protection of emergency responders - Occupational health surveillance of persons occupationally exposed to radiation in emergencies

**Total: 45 Hours**

**Reference(s)**

1. Emergency responder health monitoring and surveillance. National Response Team technical assistance document. Atlanta (GA): National Institute for Occupational Safety and Health; 2012.
2. Emergency response framework (ERF). Geneva: World Health Organization; 2013
3. Guidelines on occupational safety and health management systems, second edition. Geneva: International Labour Organization; 2009.
4. OSH management system: a tool for continual improvement. Geneva: International Labour Organization; 2011
5. OECD Environmental Outlook to 2050: the consequences of inaction. Paris: Organization for Economic Co-operation and Development; 2012.

## 22OBM02 AMBULANCE AND EMERGENCY MEDICAL SERVICE MANAGEMENT

**3 0 0 3**

**Course Objectives**

- Understand the ambulance & transport management and allied services.
- Compare the ambulance design and equipment, transportation and corporate Profit.
- Carry-out various acts governing transport management.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

**Course Outcomes (COs)**

1. Identify ambulance services, types and allied services
2. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.
3. Understand the Emergency response team, Transportation interfaces, Transportation Service Characteristics& regulatory reforms involved.
4. Identify ambulance services, types and allied services
5. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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**UNIT I** **9 Hours**

**INTRODUCTION**

Introduction-transportation ambulance types-Advanced Life Support Ambulance-Basic Life Support Ambulance-Patient Transport Ambulance-Emergency services-Ambulances-Allied services-telephone management

**UNIT II** **9 Hours**

**AMBULANCE DESIGN AND EQUIPMENT**

Design and Equipment of Ambulances -Minimum Ambulance Rescue Equipment-Emergency drugs medicines Recruitment validation Training to handle in house Ambulance emergency procedures Checklist measures Roles of paramedics, midwives, community nurses, hospice workers in emergency handling via ambulance

**UNIT III** **9 Hours**

**TRANSPORTATION REGULATION FOR EMERGENCY MEDICAL SERVICE**

Crisis Management-Anxiety & Stress Management-the Emergency response team-police assistance-Information handling & processing-Establishing customer service levels - Developing and Reporting customer service standards - Impediments to an Effective customer Service strategy - Improving customer Service Performance Transportation

**UNIT IV** **9 Hours**

**AMBULANCE PREVENTIVE MAINTENANCE**

Legal obligations Switch Console Front, Main Electrical, Patient Compartment Climate Oxygen system On board Suction system 110/12 VOLT system, Modular Body, Medical Equipment - Cot & Stretcher, safety belts-driver(s), passenger, Patients-child restraint device- incubator

**UNIT V** **9 Hours**

**THE MOTOR VEHICLE ACT**

The Motor Vehicle Act, 1988- Rules of the road Regulations 1989- Overall Dimensions of Motor Vehicles (Prescription of conditions for exemption) Rules 1991-Use of Red light on the top front of the vehicle

**Total: 45 Hours**

**Reference(s)**

1. Fawcett, "Supply Chain Management", Pearson Education India, 01-Sep-2008 - 600 pages.
2. B. Feroz, A. Mehmood, H. Maryam, S. Zeadally, C. Maple and M. A. Shah, "Vehicle-Life Interaction in Fog-Enabled Smart Connected and Autonomous Vehicles," in IEEE Access, vol. 9, pp. 7402-7420, 2021, doi: 10.1109/ACCESS.2020.3049110.
3. R. Jin, T. Xia, X. Liu, T. Murata and K. -S. Kim, "Predicting Emergency Medical Service Demand With Bipartite Graph Convolutional Networks," in IEEE Access, vol. 9, pp. 9903-9915, 2021, doi: 10.1109/ACCESS.2021.3050607.
4. Les Pringle,"Call the Ambulance",Transworld Publishers, 2010.
5. Edward J. Bardi, John Joseph Coyle, Robert A. Novack"Management of Transportation", Thomson/South-Western, 2006.

## 22OBM03 HOSPITAL AUTOMATION 3 0 0 3

**Course Objectives**

- Introduce the concepts of hospital systems and need for central monitoring
- Exemplify the power generation, utility and protection systems.
- Apply the distributed and central monitoring functions in hospital environment

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

**Course Outcomes (COs)**

1. Identify the factors in central power generating and monitoring systems
2. Analyze the sensors and actuators for the automation systems
3. Classify the equipment types and its applications.
4. Apply software tools and digital computer for monitoring of parameters and medical data handling
5. Design central monitoring station for hospitals for control and surveillance applications

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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| 4 | 1 | 2 | | | | 1 | 1 | | | | | | |
| 5 | 3 | 2 | | | | 1 | 1 | | | | | | |

**UNIT I** **9 Hours**

**AUTOMATION IN HEALTHCARE**

Introduction to automation Role of automation in healthcare Remote Patient Monitoring Maximizing resources on patient care Reducing variability, Automating clinician and patient interactions through products.

**UNIT II** **9 Hours**

**POWER GENERATION AND MEDICAL GAS PRODUCTION**

Power generator, Battery: Maintenance and troubleshooting, energy conservation and monitoring system - Automation in dryer, compressor, air conditioning, lighting, heating systems.

**UNIT III** **9 Hours**

**AUTOMATION IN PIPING**

Monitoring of flow and pressure of medical gas System Components Vacuum control units Automatic changeover system - Types of Outlets - Leakage test- Prevention and safety automation.

**UNIT IV** **9 Hours**

**INSTRUMENTATION SYSTEMS**

Optical sensors, Pressure Sensors - Ultrasonic Sensors - Tactile Sensors - Thermal sensors -Biosensor - Linear Actuators, Central monitoring station - Alarm system - Regulation and standards.

**UNIT V** **9 Hours**

**APPLICATIONS**

Business intelligence & executive dashboards - Radio-Frequency Identification (RFID)- based patient and asset tracking solutions - Tablet-based applications for bed side access to doctors/nurses - Healthcare CRM for patient relationship management - Patient kiosk, tele-health – HIS integration.

**Total: 45 Hours**

**Reference(s)**

1. Khandpur RS, Handbook of Biomedical Instrumentation, Prentice Hall of India, New Delhi, 3rd Edition, 2014.
2. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education India, Delhi, 4th Edition 2008
3. Curtis Johnson D Process Control Instrumentation Technology, Prentice Hall of India, 8th Edition 2006
4. John V. Grimaldi and Rollin H. Simonds., Safety Management, All India Travelers Book seller, New Delhi, 1989.
5. N.V. Krishnan, Safety in Industry, Jaico Publisher House, 1996.

## 22AGO01 RAINWATER HARVESTING TECHNIQUES 3 0 0 3

**Course Objectives**

- To enhance the awareness about water resources management and conservation
- To acquire knowledge about water harvesting techniques and their implementation
- To practice the design aspects of sustainable rainwater harvesting solutions for communities

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

**Course Outcomes (COs)**

1. Assess the sources, availability and challenges in water resources management
2. Assess various water harvesting systems in practice
3. Execute design considerations for comparing surface runoff harvesting methods
4. Compare the characteristics and impacts of flood water harvesting techniques
5. Evaluate various rainwater harvesting methods for groundwater recharging

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | | | | | | 3 | | | | | | |
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| 3 | 1 | 1 | 3 | | | | 2 | | | | | | |
| 4 | 1 | 2 | 3 | | | | 2 | | | | | | |
| 5 | 1 | 1 | 3 | | | | 2 | | | | | | |

**UNIT I** **8 Hours**

**WATER RESOURCES**

Global water distribution – primary and secondary sources of water – technical, social and cultural aspects; Global challenges in water and climate – water scarcity – water pollution – Indian scenario; Water resources management – public participation – integrated approach; Water governance – water sharing plans – policy, schemes and concerns

**UNIT II** **10 Hours**

**WATER CONSERVATION CHALLENGES**

Principles of water harvesting for rural and urban – collection at micro and macro levels, flow control, storage and uses; Rainwater harvesting systems – traditional and contemporary – groundwater recharge; Water resources inventory – site analysis – database collection – water allocation principles based on demand and supply; Traditional water harvesting systems – practices in India – references in old texts – reasons for their deterioration – way forward; Watershed-based approach – project planning at micro and macro levels – community participation – rain centres.

**UNIT III** **9 Hours**

**SURFACE RUNOFF HARVESTING**

Short-term and micro-level harvesting techniques for runoff – terracing and bunding – rock and ground catchments; Long-term and macro-level harvesting techniques for runoff – farm ponds – percolation ponds and nala bunds; Design considerations – site selection – selection of runoff coefficients – computation of rainwater runoff volume – hydrograph analysis – cost estimation; Design of storage structures – storage capacity – selection of component – methods of construction

**UNIT IV** **9 Hours**

**FLOOD WATER HARVESTING**

Floods – causes of urban floods and droughts – characteristics of water spread – impacts; Flood water harvesting – permeable rock dams – water spreading bunds – flood control reservoir; Design considerations – computation of flood water quantity; Trenching and Diversion Structures – types – site selection – design criteria – most economic section – design consideration of ditch system

**UNIT V** **9 Hours**

**GROUNDWATER HARVESTING**

Rooftop rainwater harvesting – recharge pit – recharge trench – tube well – recharge well; artificial recharge – gully plug – dug well – percolation tank – nala bunds – recharge shaft; Groundwater harvesting – aquifer characteristics – subsurface techniques – infiltration wells – recharge wells – groundwater dams; Design of drainage system – types – design criteria – filter design – causes of failures

**Total: 45 Hours**

**Reference(s)**


1. Theib YO, Dieter P, Ahmed YH, Rainwater Harvesting for Agriculture in the Dry Areas, CRC Press, Taylor and Francis Group, London, 2012.
2. Lancaster, Brad. Rainwater Harvesting for Drylands and Beyond, Volume 1, 3rd Edition, Rainsource Press. 2019.
3. Das M, Open Channel Flow, Prentice Hall of India Pvt. Ltd., New Delhi, 2008.
4. Michael AM, Ojha TP, Principles of Agricultural Engineering, Volume II, 4th Edition, Jain Brothers, New Delhi, 2003.
5. Suresh R, Soil and Water Conservation Engineering, Standard Publisher Distributors, New Delhi, 2014.
6. Singh G, Venkataramanan C, Sastry G, Joshi BP, Manual of Soil and Water Conservation Practices, CSWCR&TI, Dehradun, 1990.

## 22OEE01 VALUE ENGINEERING 3 0 0 3

**Course Objectives**

- To understand the concept of value engineering in order to reduce cost of product or process or service.
- To implement creative and innovative techniques using FAST diagram.
- To study benefits of Value Engineering for various industries.

**Programme Outcomes (POs)**

PO10. Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

**Course Outcomes (COs)**

1. Apply the concepts of value and value engineering to prepare a job plan
2. Analyse the cost and worth of a product/service using the principles of economics
3. Evaluate the value of a product/service to take managerial decisions
4. Apply the softskills in understanding team building, team work and report writing
5. Asses the functions and values of product/services in industries using case studies

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 5 | | | | | | | | | | 2 | 3 | | |

**UNIT I** **8 Hours**

**INTRODUCTION TO VALUE ENGINEERING**

Historical perspective of Value Engineering, Aims and objectives of Value Engineering, Concept of Value, Value Engineering concerned with Economic Value, Value Engineering Job plan.

**UNIT II** **9 Hours**

**FUNCTIONAL ANALYSIS**

Function-Cost-Worth analysis: Function Analysis System Technique (FAST); Review of principles of engineering economics

**UNIT III** **10 Hours**

**EVALUATION OF VALUE ENGINEERING**

Evaluation of function, Problem setting system, problem solving system, setting and solving management - decision - type and services problem, evaluation of value

**UNIT IV** **9 Hours**

**HUMAN ASPECTS IN VALUE ENGINEERING**

Team building; Life cycle costing; Managing Value Engineering Study; Value Engineering Report writing; Presentation Skill - Individual and Team Presentations; Implementation and follow-up.

**UNIT V** **9 Hours**

**BENEFITS OF VALUE ENGINEERING**

Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe Value Engineering Case studies in the Industries like Manufacturing; Construction; Health Care; Process.

**Total: 45 Hours**

**Reference(s)**

1. Anil Kumar Mukhopadhyaya, Value Engineering Mastermind - From Concepts to Certification, Response. Business Books from SAGE, Los Angeles / London / New Delhi / Singapore / Washington DC, 2014.
2. Anil Kumar Mukhopadhyaya, Value Engineering -Concepts, Techniques and Applications, Response Books, A Division of SAGE Publications, New Delhi / Thousand Oaks / London, 2003
3. R. D. Miles, Techniques of Value analysis & Engineering, McGraw Hill, 2000.
4. E. Midge Arthur, Value Engineering -A Systematic Approach, McGraw Hill Book Co., New York, 2000.
5. Zimmerman, Value Engineering - A Practical Approach, CBS Publishers & Distributors, New Delhi, 2000.

## 22OEE02 ELECTRICAL SAFETY 3 0 0 3

**Course Objectives**

- To provide knowledge on basics of electrical fire and statutory requirements for electrical safety
- To understand the causes of accidents due to electrical hazards
- To know the various protection systems in Industries from electrical hazards
- To know the importance of earthing
- To distinguish the various hazardous zones and applicable fire proof electrical devices

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

**Course Outcomes (COs)**

1. Analyze the basic concepts in electrical circuit and hazards involved in it.
2. Analyze the electrical hazards in the workplace and its impacts.
3. Examine the operation of various protection systems from electrical hazards.
4. Analyze the various safety procedures involved in the industries.
5. Explore the different hazardous zones in Industries and their safety measures.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 5 | 1 | 1 | | | | 2 | 1 | 2 | 1 | | | | |

**UNIT I** **9 Hours**

**INTRODUCTION**

Objectives of safety and security measures - Hazards associated with electric current and voltage - principles of electrical safety - working principles of major electrical equipment - Typical supply situation - Indian electricity act and rules - statutory requirements from electrical Inspectorate-International standards on electrical safety.

**UNIT II** **9 Hours**

**ELECTRICAL HAZARDS**

Primary and secondary hazards-shocks, burns, scalds, falls-human safety in the use of electricity- Energy leakage-clearances and insulation-classes of insulation-voltage classifications-excess energy- current surges-over current and short circuit current-heating effects of current- Lightning, hazards, lightning arrestor, - national electrical safety code ANSI.

**UNIT III** **9 Hours**

**ELECTRICAL SAFETY EQUIPMENT**

Fuse, circuit breakers and overload relays - safe distance from lines - capacity and protection of conductor joints and connections, overload and short circuit protection - earth fault protection. FRLS insulation - insulation and continuity test - system grounding - equipment grounding - earth leakage circuit breaker (ELCB) - ground fault circuit interrupter - electrical guards - Personal protective equipment.

**UNIT IV** **9 Hours**

**ELECTRICAL SAFETY OPERATION AND MAINTENANCE**

Role of environment in selection - protection and interlock - discharge rod and earthing devices - safety in the use of portable tools - preventive maintenance - installation – earthing, specifications, earth resistance, earth pit maintenance - Fire Extinguishers - CO2 and Dry Powder schemes.

**UNIT V** **9 Hours**

**HAZARDOUS AREAS**

Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe equipment-their selection for different zones-temperature classification-grouping of gases-use of barriers and isolators-equipment certifying agencies – electrical safety standards. (IS, API and OSHA standards)

**Total: 45 Hours**

**Reference(s)**

1. Fordham Cooper, W., “Electrical Safety Engineering, Butterworth and Company”, London, Third Edition, 2013.
2. “Indian Electricity Act and Rules”, Government of India.
3. “Power Engineers”, Handbook of TNEB, Chennai, 2010.
4. “Accident prevention manual for industrial operations”, N.S.C., Chicago, 1982.
5. John Cadick, P.E., Mary Capelli-Schellpfeffer, Dennis K. Neitzel, Al Winfield, “Electrical Safety Handbook”, Fourth Edition, Tata Mcgraw Hill, 2014.

## 22OCB01 INTERNATIONAL BUSINESS MANAGEMENT

**3 0 0 3**

**Course Objectives**

- To enable the students to understand the fundamentals of international business
- To provide competence to the students on making international business decisions
- To enable the students to understand the financial and promotional assistance available for exporters

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

**Course Outcomes (COs)**

1. Demonstrate the role and importance of digital marketing in today's rapidly changing business environment.
2. Discover the techniques to help organizations to utilize social media for digital marketing.
3. Analyze the key elements and campaign effectiveness of E-Mail marketing and mobile marketing.
4. Evaluate the effectiveness of a digital marketing campaign using Google Analytics.
5. Apply advanced practical skills to plan, predict and manage digital marketing campaign

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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| 3 | 3 | | | | | | 3 | | 2 | | | | |
| 4 | 3 | | | | | | 2 | | 2 | | | | |
| 5 | 3 | | | | | | 2 | | 2 | | | | |

**UNIT I** **9 Hours**

**INTRODUCTION**

Definition, Drivers of International Business, Domestic Vs. International Business, Trade and Investment Theories: Interventionist Theories, Free Trade Theories, Theories Explaining Trade Patterns: PLC Theory, The Porter Diamond, Factor Mobility Theory.

**UNIT II** **9 Hours**

**GLOBALIZATION**

Globalization: Implications, Challenges - Protectionism: Tariff Barriers, Non-Tariff Barriers- Forms of

Integration, Role of WTO and IMF in International Business, Economic, Political, Cultural and Technological Environments.

**UNIT III** **9 Hours**

**INTERNATIONAL BUSINESS STRATEGIES**

Market Entry Strategies, Multinational Strategy, Production Strategy, Marketing Strategy, Human Resource Strategy.

**UNIT IV** **9 Hours**

**FOREIGN EXCHANGE**

Foreign Exchange Market – Functions, Theories of Exchange Rate Determination, Exchange Rate Forecasting, Convertibility of Currency, Risks associated with Foreign Exchange.

**UNIT V** **9 Hours**

**EXPORTS AND ETHICS IN INTERNATIONAL BUSINESS**

Exports – Risks, Management of Exports, Regulatory frameworks, Export financing, Countertrade, Ethics – Issues, Dilemma and Theory.

**Total: 45 Hours**

**Reference(s)**

1. John D Daniels, Lee H.Radebaugh, and Sullivan, “International Business”, New Delhi: Pearson Education, 2018.
2. Charles W L Hill and Arun Kumar Jain, “International Business”, New Delhi: Tata McGraw Hill, 2017.
3. Francis Cherunilam, “International Business”, New Delhi: Prentice Hall of India, 2020.
4. Simon Collinson, Rajneesh Narula, Alan M. Rugman, “International Business”, New Delhi: Pearson Education, 2020.
5. K.Aswathappa, “International Business”, New Delhi: Tata McGraw Hill, 2020.

## 22OCE02 COST MANAGEMENT OF ENGINEERING PROJECTS

**3 0 0 3**

**Course Objectives**

- To introduce fundamental quantitative techniques, including linear programming, PERT/CPM, and optimization models, for effective cost management.
- To develop analytical skills for solving transportation and assignment problems to enhance resource allocation and cost efficiency.
- To apply learning curve theory in project planning and cost estimation to improve productivity and financial forecasting.
- To enable the use of quantitative decision-making tools for optimizing project scheduling, budgeting, and overall cost control.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required..

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

**Course Outcomes (COs)**

1. Analyze the cost concepts to support decision-making and operational control through a structured cost database.
2. Analyze stakeholder roles to optimize project performance and mitigate cost overruns.
3. Analyze project execution and cost control techniques to support strategic decision-making and optimize project financial performance.
4. Evaluate costing strategies and budgetary control techniques in the service sector.
5. Apply quantitative techniques to optimize cost management and decision-making in projects.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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| 1 | 1 | - | - | - | - | 2 | - | - | - | - | 1 | - | - |
| 2 | 1 | 2 | 2 | - | - | 2 | - | - | - | - | - | - | - |
| 3 | 1 | 2 | - | - | - | - | - | - | - | - | 2 | - | - |
| 4 | 1 | 2 | 1 | - | - | 1 | - | - | - | - | 2 | - | - |
| 5 | 1 | 2 | - | - | - | 1 | - | - | - | - | 2 | - | - |

**UNIT I** **9 Hours**

**INTRODUCTION TO COSTING CONCEPTS**

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

**UNIT II** **9 Hours**

**INTRODUCTION TO PROJECT MANAGEMENT**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.

**UNIT III** **9 Hours**

**PROJECT EXECUTION AND COSTING CONCEPTS**

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle costing.

**UNIT IV** **9 Hours**

**COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL**

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

**UNIT V** **9 Hours**

**QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT**

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost.

**Total: 45 Hours**

**Reference(s)**

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988.
3. Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011.
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003.
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.

## 22EI0XA ELEMENTS OF INDUSTRIAL AUTOMATION 1 0 0 1

**Course Objectives**

- To provide an extended overview and fundamental knowledge in the field of Industrial Automation, while building the necessary knowledge level for further specialization in advanced concepts of Industrial Automation.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Evaluate the PLC program in different applications.
2. Design a PCB based industrial automation.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
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**15 Hours**

**INDUSTRIAL AUTOMATION**

Study of advanced automation technologies: Artificial Intelligence, Machine Learning, Digital twin technology and its applications. Hands on: PLC Interfacing with VFD-Hands on: Precision Speed control of VFD using PLC Analog Cards -Hands on: Synchronization of VFD using HMI- Hands on: Level Sensors Pressure sensor to the PLC, Plant Graphic Control Interfacing Program with Monitoring systems.

**Total: 15 Hours**

**Reference(s)**

1. Dunning, Gary A. Introduction to programmable logic controllers. Cengage Learning, 2005.
2. Bolton, William. Programmable logic controllers. Newnes, 2015.

3. Rohner, Peter. Automation with programmable logic controllers. UNSW Press, 1996.
4. Adrien Bécue. Artificial intelligence and Industry 4.0: challenges and opportunities. Artificial Intelligence Review, 2021.

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## 22EI0XB SMART VISUALIZATION OF INDUSTRIAL PARAMETERS 1 0 0 1

**Course Objectives**

- To explore the smart visualization of industrial parameters.
- To Implementation of augmented reality in instrumentation and developing IoT applications.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2.Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Analyze the concepts of augmented reality and digital twin concepts.
2. Implementation of augmented reality/ digital twin concept in instrumentation monitor industrial parameter.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | - |
| 2 | - | - | 2 | 2 | 1 | - | - | - | - | - | - | - | - | 1 |

**15 Hours**

**INDUSTRIAL PARAMETERS**

Introduction to instrumentation, parameters used in industries, sensor identification, and designing, Implementation of Augmented Reality in instrumentation, development, Project development, Introduction to Internet of Things- implementation of Controllers in IoT (general) - Development of logics for simple IoT systems – Introduction to IIoT – Data transmission protocols AR Foundation- Introduction to Unity Software- Setup- Building Application - Visualizing AR planes – Creaing Placement Indicator – Scripting the placement indicator, Communication Technique IoT & Unity Communication Techniques – Implementation of Hardware Handshake Introduction & Implementation of Digital Twin:3 hours Introduction to Digital twin Concept – Industrial Application of digital Twin – Digital twin Development using AR technique Case Studies of Digital Twin: Case study 1- Case Study 2 – Case Study 3.

**Total: 15 Hours**

**Reference(s)**

1. Augmented Reality, Sean Morey, John Tinnell Parlor Press LLC, Oct 2016.
2. Digital Twin – Fundamental Concepts to Applications in Advanced Manufacturing by Surjya Kanta Pal, Debasish Mishra, Arpan Pal, Samik Dutta, Debashish Chakravarty, Srikanta Pal.

**Resource Person Details**

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## 22EI0XC AUTOMOTIVE EMBEDDED SYSTEM 1 0 0 1

**Course Objectives**

- To analyze the conceptual design of embedded systems, analog and digital designs.
- To analyze the system testing and its performance in industrial application.
- To understand the communication and testing concepts associated in embedded system development for automotive application.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Evaluate the performance of analog and digital peripherals for MSP430 MCU.
2. Evaluate the performance of embedded systems design and its development for automotive application using MSP430.
3. Analyze the signals of communication protocols in automotive clusters.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 2 | - | - | - | - | - | - | - | - | - | 1 |
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| 3 | 1 | - | 2 | - | 2 | - | - | - | - | - | - | - | 1 |

**15 Hours**

**AUTOMOTIVE EMBEDDED SYSTEM**

Architecture of an Embedded System- Embedded Hardware and Software Design - Analog control - Digital controllers - Electronic Control Units (ECU), Products Details and Product Roadmap - Automotive Instrumentation Cluster Basics - Introduction to Safety Standards (MISRA) - Understand the communication protocols used in automotive application – Software Verification and Validation - System Testing - Test Case Development from Requirements.

**Total: 15 Hours**

**Reference(s)**

1. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering, W Bolton, 3/e, Pearson Edu. Press, 2021.
2. D. Paret, Multiplexed Networks for Embedded Systems, Wiley, 2020.
3. W. Voss, A Comprehensible Guide to Controller Area Network, Copperhill Technologies Corporation, 2018.

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## 22EI0XD DATA ANALYTICS AND VISUALIZATION 1 0 0 1

**Course Objectives**

- Understanding of interoperability in healthcare analytics during the data analytics and visualization.
- Tools and techniques used in summarizing data, its collection, analysis, and processing.
- Know-how of the data interpretation and various techniques used in the process.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

**Course Outcomes (COs)**

1. Analyze the implications of artificial intelligence on extraction of complex data sets.
2. Interpret data analysis results from a visualization example.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 2 | - | - | 2 | - | - | 1 | - | - | - | - | 1 |
| 2 | - | 1 | 2 | 2 | - | 1 | 1 | - | - | - | - | - | - | - |

**15 Hours**

**DATA ANALYTICS**

Introduction to Tableau - Different Products by Tableau - Advantages of Tableau- Introduction to Data Visualization- Applications of Tableau- Companies using Tableau- Features of Tableau- Tableau Terminologies- Tableau Navigations- Tableau Design Flow- How to Connect to a File Source- Understanding of Different Data Sources- Data Source Filters- Data Types - Tableau Operators- String Functions in Tableau- Date Functions - Logical Statements - Aggregate Functions- Joins- Data Blending- Field Operator-Filter- Changing Data Type of a Field from Data Pane-Formatting- Worksheet- Line Chart- Bar Chart- Histogram- Scatter Plot- Pie Chart- Bubble chart- Tableau Forecasting- Tableau Dashboard.

**Total: 15 Hours**

**Reference(s)**

1. Trevor L. Strome (2013). Healthcare Analytics for Quality and Performance Improvement. John Wiley & Sons, Inc.
2. Kumar, R.L., Indrakumari, R., Balamurugan, B., & Shankar, A. (Eds.). (2021). Exploratory Data Analytics for Healthcare (1st ed.). CRC Press.

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## 22EI0XE AUTOMOTIVE COMMUNICATION PROTOCOLS 1 0 0 1

**Course Objectives**

- To learn the architecture of the ARM Cortex M4 microcontroller.
- To create the programming in embedded automotive communication protocols.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO11. Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Apply the comprehensive knowledge of the STM32F405 microcontroller and its peripherals.
2. Create the programming and interfacing various components and communication protocols for embedded systems development.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 2 | 3 | 2 | - | - | - | 2 | - | 1 | 1 | 2 |
| 2 | 3 | 3 | 2 | 3 | 2 | - | - | - | 2 | - | 1 | 1 | 2 |

**20 Hours**

**COMMUNICATION PROTOCOLS**

Introduction to Auto Edge Development board - introduction to STM32F405 – architecture – memory map – phase locked loop – CAN protocol – Frame Formats of CAN –message filtering- Introduction to LIN– LIN network communication - Introduction to UDS, Service ID's, NRC – Basic working of OBD - Onboard Diagnostics and the necessity of OBD in Automotive Engineering - Onboard Diagnostics Apps.

**Total: 20 Hours**

**Reference(s)**

1. STMicroelectronics. User manual STM32 value line discovery, 2010. UM0919.
2. A Review of Embedded Automotive Protocols, by Nicolas Navet, Françoise Simonot-Lion, 1st Edition, CRC Press, 2009.
3. STMicroelectronics. Programming manual: Stm32f10xxx/ 20xxx/ 21xxx/l1xxxxcortex-m3programmingmanual, March 2011.PM0056.
4. STMicroelectronics. Low & medium-densityvalueline, advancedARMbased32 bitMCUwith16to128kbflash, 12timers, ADC, DAC&8 comminterfaces, 2011.DocID16455.

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## 22EI0XF ADVANCED STM32 ARM PROGRAMMING TECHNIQUES 1 0 0 1

**Course Objectives**

- To learn the STM32 32-Bit Microcontroller and STM32 ARM I/O Programming.
- To learn STM ARM Internal Peripherals Programming and Communication Protocols.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4. Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Outline the STM32 32-Bit Microcontroller and STM32 ARM I/O Programming.
2. Outline the STM ARM Internal Peripherals Programming and CAN Communication Protocols.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 2 | 3 | 2 | - | - | - | 2 | - | - | 1 | 2 |
| 2 | 3 | 3 | 2 | 3 | 2 | - | - | - | 2 | - | - | 1 | 2 |

**5 Hours**

**INTRODUCTION TO STM32 32-BIT MICROCONTROLLER**

Introduction to Microcontroller – Von Neumann and Harvard architecture – RISC vs CSIC- Explore the STM32F series, covering its key features, architecture, functional overview, Memory organization-Memory Map, pinout, and pin descriptions. Gain insights into the electrical characteristics of STM32 integrated circuits.

**STM32 ARM I/O PROGRAMMING** **5 Hours**

Dive into GPIO and I/O programming, along with interfacing techniques for relays, optoisolators, and limit switches.

**STM ARM INTERNAL PERIPHERALS PROGRAMMING** **5 Hours**

Timers and counters, covering timer and delay generation, compare register, waveform output, timer input capture, and PWM. Explore PWM applications in electric vehicle scenarios- ADC characteristics and programming with STM32 ARM, including interfacing with position sensors- DAC applications and the programming of DAC for various functionalities.

**COMMUNICATION PROTOCOLS** **5 Hours**

CAN protocol, covering frame formats, understanding CAN nodes, signaling, bus states, bit timing calculation, and networking with transceivers. Explore the bxCAN peripheral of STM32, including self-testing modes and block diagrams- UART, its functionality, and programming aspects- SPI, its working principles, and programming with a focus on interfacing with MEMS accelerometer sensors.

**Total: 20 Hours**

**Reference(s)**

1. Embedded Systems: ARM Programming and Optimization by Jason D. Bakos, 2nd Edition, Elsevier, 2023.
2. A Review of Embedded Automotive Protocols, by Nicolas Navet, Françoise Simonot-Lion, 1st Edition, CRC Press, 2009.
3. Embedded System Design with ARM Cortex-M Microcontrollers: Applications with C, C++ and MicroPython by Cem Ünsalan , Hüseyin Deniz Gürhan , Mehmet Erkin Yücel, Springer, 2022.

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## 22EI0XG INTELLIGENT SENSOR DESIGN 1 0 0 1

**Course Objectives**

- Conceptualize the application and working principle of intelligent sensors for measuring physical and electrical parameters used in industrial automation.
- Installing, troubleshooting, and maintaining industrial automated and electrical production systems using Intelligent Sensor.

**Programme Outcomes (POs)**

PO1. Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3. Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.

PSO2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

**Course Outcomes (COs)**

1. Analyze the performance of 1D, 2D and QR code identification sensors in the span of low frequency to ultra- high frequency speed.
2. Apply the industrial parameters such as displacement, distance, pressure, level and flow using smart sensors in terms of industrial standards.
3. Analyze the rate of pollution in the industrial environment using Dust Measurement Device.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 2 | – | 2 | – | 2 | – | – | – | – | 2 | 3 |
| 2 | 3 | 3 | 2 | – | 2 | – | 2 | – | – | – | – | 2 | 3 |

**20 Hours**

**SENSOR DESIGN**

Presence Absence detection- Presence Detection - Belt conveyor with Sensors- Smart Industrial Instrumentation Level, Pressure and Flow Sensors Industry 4.0 – Working demonstration of I4.0 with JSON Commands, Motion control sensors – Encoders - Rotary/Absolute/Programmable - Identification Kit- 1D/2D Barcodes, RFID Tags Identification - Robot Cell Area Guarding Demo Kit using DeTec4 Safety Light Curtains.

Hands-on Training: 2D Vision Kit with Smart Camera- OCR Reading and Quality Inspection - 3D Vision camera -Long Distance Measurement Sensor Kit - Displacement Measurement Kit- LiDAR Scanner for Anti-collision on Mobile car - Safety Functionality Simplified - Demo Kit - Area Guarding with Safety Laser Scanner Kit - Dust Measurement Device for Continuous Emission Measurement

**Total: 20 Hours**

**Reference(s)**

1. Deepak Gupta, Victor Hugo C. de Albuquerque, Ashish Khanna, Purnima Lala Mehta, Smart sensors for industrial internet of things, Springer International Publishing, 2021.
2. Sick Sensor Materials

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