# B.Tech. (Agricultural Engineering)
# 2022 Regulations, Curriculum & Syllabi

# (Candidates admitted during Academic Year 2023-2024)

# CONTENTS                                    Page No.

## PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. Excel in academic/professional career by acquiring knowledge and skill in engineering principles involved in agriculture

II. Analyze and improve agricultural operations through farm mechanization, land and water management, post-harvest handling and energy conservation to increase yield and land use efficiency

III. Develop professionalism in management, entrepreneurship, continuous learning and follow ethics to serve the society

## PROGRAMME OUTCOMES (POs)

1.  Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2.  Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3.  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.

4.  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.

5.  Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6.  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.

7.  Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8.  Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9.  Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Recognize the need for, and have the preparation and ability to engage in independent and life- long learning in the broadest context of technological change.

## PROGRAMME SPECIFIC OUTCOMES (PSOs)

**PSO1**: Model, design, and analyze agricultural machinery and implement it to increase productivity, improve land use, and conserve agricultural inputs.

**PSO2:** Improvise technologies to minimize the crop loss from field damage during harvesting, sorting, processing, and packaging.

**PSO3:** Design improved irrigation gadgets and develop technologies for effective utilization of renewable energy in the agriculture sector.

## MAPPING OF PEOs AND POs

| PEO(s) | Programme Outcomes(s) | | | | | | | | | | | |
|:---:|:---:|:---:|:---:|:---:|:---:|:---:|:---:|:---:|:---:|:---:|:---:|:---:|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| I | X | | X | X | X | | | | X | | | |
| II | | X | X | X | X | | | X | | | | |
| III | | | | | | X | X | X | X | X | | |

<table>
<tr><td colspan="12" align="center"><b>DEPARTMENT: AGRICULTURAL ENGINEERING</b><br><b>Minimum Credits to be Earned : 165</b></td></tr>
</table>

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
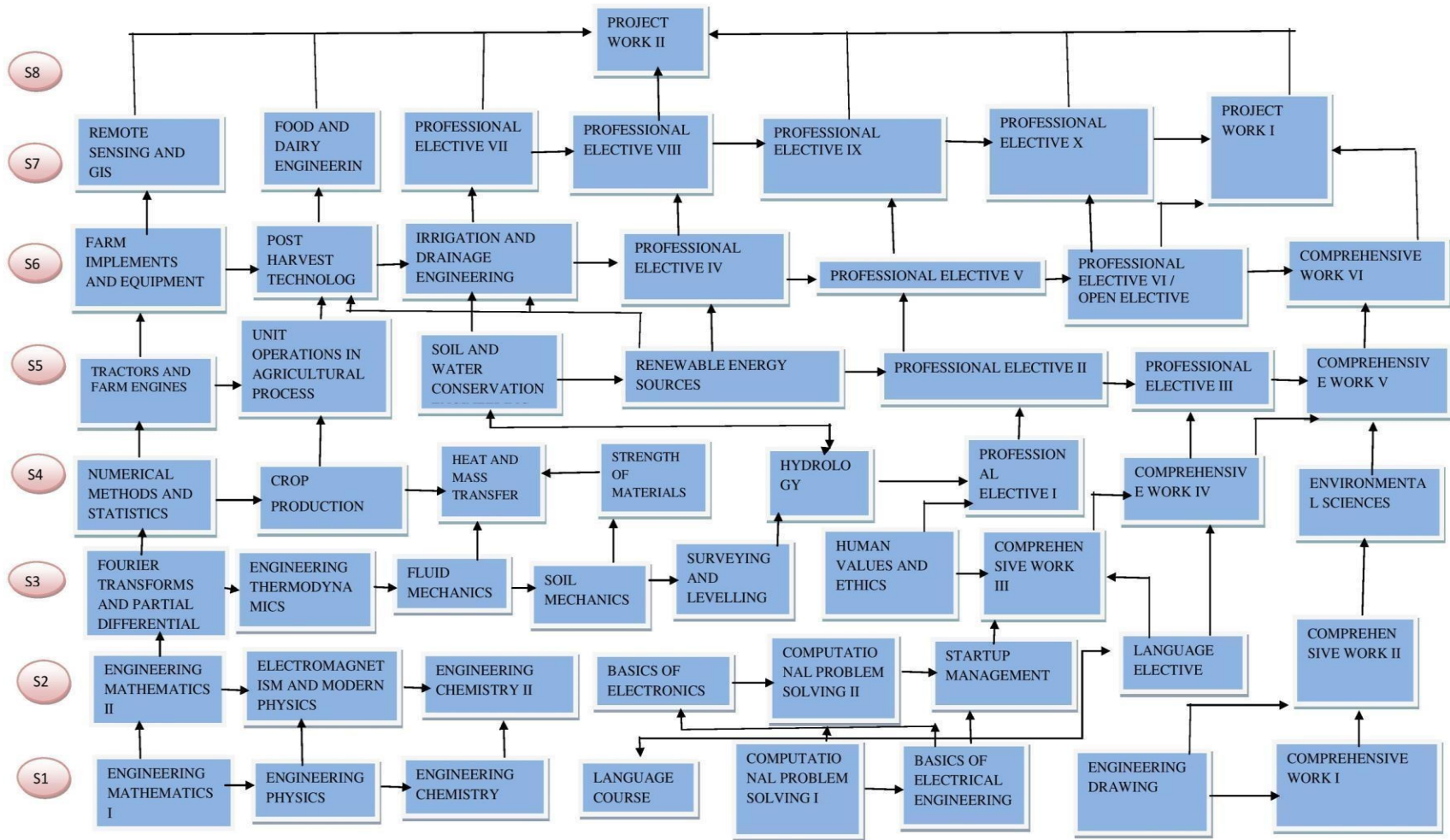
**DEPARTMENT: AGRICULTURAL ENGINEERING**
**Minimum Credits to be Earned : 165**

**I SEMESTER**

| Code No. | Course | L | T | P | C | Hours/ Week | Maximum Marks | | | Category |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | CA | ES | 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 | 100 | 0 | 100 | HSS |
| 22GE003 | Basics of Electrical Engineering | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | ES |
| 22GE005 | Engineering Drawing | 1 | 0 | 2 | 2 | 3 | 100 | 0 | 100 | EEC |
| *22HS003 | தமிழர் மரபு / Heritage of Tamils | 1 | 0 | 0 | 1 | 1 | 100 | 0 | 100 | HSS |
| | Total | 15 | 1 | 10 | 21 | 26 | - | - | - | - |

**II SEMESTER**

| Code No. | Course | L | T | P | C | Hours/ Week | Maximum Marks | | | Category |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | CA | ES | 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 |
| 22HS002 | Startup Management | 1 | 0 | 2 | 2 | 3 | 100 | 0 | 100 | ES |
| | Language Elective | 1 | 0 | 2 | 2 | 3 | 100 | 0 | 100 | HSS |
| *22HS006 | தமிழரும் தொழில்நுட்பமும் / Tamils and Technology | 1 | 0 | 0 | 1 | 1 | 100 | 0 | 100 | HSS |
| | **Total** | **15** | **1** | **10** | **21** | **26** | **-** | **-** | **-** | **-** |

\* The lateral entry students have to complete these courses during III and IV semester.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **III SEMESTER** | | | | | | | | | | | |
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours/ Week** | **Maximum Marks** | | | **Category** | |
| | | | | | | | **CA** | **ES** | **Total** | | |
| 22AG301 | Numerical Methods and Statistics | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | BS | |
| 22AG302 | Soil Science and Engineering | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | ES | |
| 22AG303 | Engineering Thermodynamics | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | PC | |
| 22AG304 | Fluid Mechanics and Machinery | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC | |
| 22AG305 | Surveying and Levelling | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | ES | |
| 22HS004 | Human Values and Ethics | 2 | 0 | 0 | 2 | 2 | 100 | 0 | 100 | HSS | |
| 22HS005 | Soft Skills and Effective Communication | 0 | 0 | 2 | 1 | 2 | 100 | 0 | 100 | EEC | |
| **Total** | | **17** | **2** | **8** | **23** | **27** | **-** | **-** | **-** | **-** | |
| **IV SEMESTER** | | | | | | | | | | | |
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours/ Week** | **Maximum Marks** | | | **Category** | |
| | | | | | | | **CA** | **ES** | **Total** | | |
| 22AG401 | Crop Production Technology | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC | |
| 22AG402 | Heat and Mass Transfer | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC | |
| 22AG403 | Strength of Materials | 2 | 1 | 2 | 4 | 5 | 50 | 50 | 100 | PC | |
| 22AG404 | Theory of Machines | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC | |
| 22AG405 | Hydrology | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | PC | |
| | Professional Elective I | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE | |
| 22HS007 | Environmental Science | 2 | 0 | 0 | 0 | 2 | 100 | 0 | 100 | HSS | |
| 22HS008 | Advanced English and Technical Expression | 0 | 0 | 2 | 1 | 2 | 100 | 0 | 100 | EEC | |
| **Total** | | **19** | **2** | **10** | **24** | **31** | **-** | **-** | **-** | **-** | |

| | | | | | | | **Maximum Marks** | | | |
|---|---|---|---|---|---|---|---|---|---|---|

**V SEMESTER**

| Code No. | Course | L | T | P | C | Hours/Week | CA | ES | Total | Category |
|---|---|---|---|---|---|---|---|---|---|---|
| 22AG501 | Tractor and Farm Engines | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22AG502 | Unit Operations in Agricultural Process | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22AG503 | Soil and Water Conservation Engineering | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | PC |
| 22AG504 | Renewable Energy Sources | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| | Professional Elective II | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | Open Elective | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22AG507 | Mini Project I | 0 | 0 | 2 | 1 | 2 | 100 | 0 | 100 | EEC |
| **Total** | | **18** | **1** | **8** | **23** | **27** | **-** | **-** | **-** | **-** |

**VI SEMESTER**

| Code No. | Course | L | T | P | C | Hours/Week | CA | ES | Total | Category |
|---|---|---|---|---|---|---|---|---|---|---|
| 22AG601 | Farm Implements and Equipment | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22AG602 | Post-Harvest Technology | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22AG603 | Irrigation and Drainage Engineering | 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 |
| 22AG607 | Mini Project II | 0 | 0 | 2 | 1 | 2 | 100 | 0 | 100 | EEC |
| **Total** | | **18** | **0** | **8** | **22** | **26** | **-** | **-** | **-** | **-** |

| VII SEMESTER | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Code No. | Course | L | T | P | C | Hours/Week | Maximum Marks | | | Category |
| | | | | | | | CA | ES | Total | |
| 22AG701 | Remote Sensing and GIS Applications | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | PC |
| 22AG702 | Food and Dairy Engineering | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 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 |
| 22AG707 | Project Work I | 0 | 0 | 4 | 2 | 4 | 60 | 40 | 100 | EEC |
| **Total** | | **17** | **0** | **8** | **21** | **25** | **-** | **-** | **-** | **-** |
| VIII SEMESTER | | | | | | | | | | |
| Code No. | Course | L | T | P | C | Hours/Week | Maximum Marks | | | Category |
| | | | | | | | CA | ES | Total | |
| 22AG801 | Project Work II | 0 | 0 | 20 | 10 | 20 | 60 | 40 | 100 | EEC |
| **Total** | | **0** | **0** | **20** | **10** | **20** | **-** | **-** | **-** | **-** |

| ELECTIVES | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| LANGUAGE ELECTIVES | | | | | | | | | | |
| Code No. | Course | L | T | P | C | Hours/Week | Maximum Marks | | | Category |
| | | | | | | | CA | ES | Total | |
| 22HS201 | Communicative English II | 1 | 0 | 2 | 2 | 3 | 100 | 0 | 100 | HSS |
| 22HSH01 | Hindi | 1 | 0 | 2 | 2 | 3 | 100 | 0 | 100 | HSS |
| 22HSG01 | German | 1 | 0 | 2 | 2 | 3 | 100 | 0 | 100 | HSS |
| 22HSJ01 | Japanese | 1 | 0 | 2 | 2 | 3 | 100 | 0 | 100 | HSS |
| 22HSC01 | Chinese | 1 | 0 | 2 | 2 | 3 | 100 | 0 | 100 | HSS |
| 22HSF01 | French | 1 | 0 | 2 | 2 | 3 | 100 | 0 | 100 | HSS |

| | PROFESSIONAL ELECTIVES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **VERTICAL I - FARM MACHINERY** | | | | | | | | | |
| 22AG001 | Human Engineering and Safety | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG002 | Design of Agricultural Machinery | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG003 | Testing and Evaluation of Farm Machinery and Equipment | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG004 | Farm Power and Machinery Management | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG005 | Hydraulic Drives and Controls | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG006 | Precision Farming Equipment | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | **VERTICAL II - SOIL AND WATER CONSERVATION ENGINEERING** | | | | | | | | | |
| 22AG007 | Building Materials, Estimation and Costing | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG008 | Groundwater, Wells and Pumps | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG009 | Protected Cultivation | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG010 | Design of Micro-Irrigation Systems | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG011 | Watershed Planning and Management | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG012 | Reservoir and Farm Pond Design | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | **VERTICAL III- AGRICULTURAL PROCESSING** | | | | | | | | | |
| 22AG013 | Refrigeration and Cold Storage | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG014 | Fruits and Vegetables Processing | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG015 | Storage and Packaging Technology | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG016 | Food Safety Management Systems | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG017 | Emerging Technologies in Food Process Engineering | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG018 | Food Process Equipment and Design | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |

| | VERTICAL IV - RENEWABLE ENERGY ENGINEERING | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 22AG019 | Bio and Thermo Chemical Conversion of Biomass | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG020 | Solar and Wind Engineering | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG021 | Energy Conservation in Agro-Based Industry | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG022 | Co-Generation and Waste Heat Recovery Systems | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG023 | Green Buildings | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG024 | Energy Storage Systems | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG025 | CDM and Carbon Trading Technology | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | VERTICAL V - CROP PRODUCTION & PROTECTION | | | | | | | | | |
| 22AG026 | Soil Fertility and Nutrient Management | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG027 | Plant Protection | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG028 | Extension Methodology and Transfer of Technology | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG029 | Agricultural Marketing | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG030 | Integrated Farming System | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG031 | Sustainable Agriculture and Food Security | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | VERTICAL VI – SMART AGRICULTURE SYSTEMS | | | | | | | | | |
| 22AG032 | Instrumentation and Control Engineering in Agriculture | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG033 | Database Management and Microprocessor Applications in Agriculture | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG034 | Data Analytics in Agricultural Systems | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG035 | Artificial Intelligence and Machine Learning for Agriculture | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG036 | Mechatronics in Agricultural Engineering | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG037 | Geoinformatics and Nano-Technology | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | VERTICAL VII - AGRI BUSINESS AND ENTREPRENEURSHIP | | | | | | | | | |
| 22AG038 | Agri Business Management and Entrepreneurship | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG039 | Agricultural Finance, Banking and Co-Operation | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG040 | Technology of Seed Processing | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG041 | Mushroom Cultivation and Vermicomposting | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |

| 22AG042 | Engineering Economy and Project Planning | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG043 | Value Addition of Indigenous Fruits and Vegetables | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AG044 | Principles of Organic Farming | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **MINOR DEGREE: SOIL AND WATER CONSERVATION ENGINEERING** | | | | | | | | | | |
| 22AGM001 | Building Materials, Estimation and Costing | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AGM002 | Groundwater, Wells and Pumps | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AGM003 | Protected Cultivation | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AGM004 | Water Harvesting Techniques | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AGM005 | Watershed Planning and Management | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22AGM006 | Reservoir and Farm Pond Design | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |

| **OPEN ELECTIVES** | | | | | | | | | | |
| Code No. | Course | L | T | P | C | Hours/Week | Maximum Marks | | | Category |
| | | | | | | | CA | ES | Total | |
| 22OCE01 | Energy Conservation and Management | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OEC01 | Basics of Analog and Digital Electronics | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OEC02 | Microcontroller Programming | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OEI01 | Programmable Logic Controller | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OEI02 | Sensor Technology | 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 |
| 22OPH01 | Nanomaterials Science | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OPH02 | Semiconductor Physics and Devices | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OPH03 | Applied Laser Science | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OPH04 | Bio-photonics | 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 |
| **ONE CREDIT COURSES** | | | | | | | | | | |
| 22AG0XA | Hydroponics Farming of Horticultural Crops | 0 | 0 | 0 | 1 | 0 | 100 | 0 | 100 | EEC |
| 22AG0XB | Energy Auditing in Industrial Sectors | 0 | 0 | 0 | 1 | 0 | 100 | 0 | 100 | EEC |

## 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

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 3 | | | | | | | | | | | 1 | | |
| 2 | 2 | 3 | | | | | | | | | | | 2 | | |
| 3 | 2 | 3 | | | | | | | | | | | 1 | | 2 |
| 4 | 3 | 3 | | | | | | | | | | | 2 | 2 | |
| 5 | 1 | 3 | | | | | | | | | | | 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 - Orhtogonality - 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, Taylors 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 decline - Exponential equations have a variable as an exponent and take the form y = abx 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

**Total: 45 + 15 (tutorial) = 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, 2014
3. S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons2020
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

**Course Outcomes (COs)**

1. Illustrate the concept and principles of energy to understand mechanical systems
2. Exemplify the types of mechanical oscillations based on vibrational energy
3. Infer the concept of propagation of energy as 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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | | | | | | 2 | | | | | 2 | | 2 |
| 2 | 2 | 1 | | | | | | 2 | | | | | 2 | | |
| 3 | 2 | 1 | | | | | | 2 | 2 | | | | 3 | | |
| 4 | 2 | 1 | | | | | | 2 | | | | | 2 | 3 | |
| 5 | 2 | 1 | | | | | | 2 | | | | | 2 | | |

**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

**UNIT II**                                                     **5 Hours**
**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 voicers - 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

**1**                                                                                                **5 Hours**
**EXPERIMENT 1**
Determination of resultant of system of concurrent coplanar forces - Parallelogram law of forces

**2**                                                                                                **5 Hours**
**EXPERIMENT 2**
Determination of moment of inertia - Torsional pendulum

**3**                                                                                                **5 Hours**
**EXPERIMENT 3**
Determination of thickness of a thin wire using interference of light - Air wedge method

**4**                                                                                                **4 Hours**
**EXPERIMENT 4**
Determination of AC frequency using Meldes apparatus

**5**                                                                                                **3 Hours**
**EXPERIMENT 5**
Determination of thermal conductivity of a bad conductor using Lees disc method

**6**                                                                                                **4 Hours**
**EXPERIMENT 6**
Wavelength of ultrasonics in a liquid medium
(ii) velocity of ultrasonic waves in the given liquid
(iii) compressibility of the given liquid using ultrasonic interferometer

**7**                                                                                                **4 Hours**
**EXPERIMENT 7**
Determination of Youngs modulus of a given material- Non-uniform bending method

**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

  Analyze the different types of bond formed during chemical reactions and its reaction thermodynamics

  Summarize different states of matter based on atomic arrangement

**Course Outcomes (COs)**

1. Understand nuclear transmutation reactions that lead to the formation of elements in the universe
2. Illustrate atomic structure of elements in the periodic table and 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. Analyze endothermic and exothermic processes and exchange of energy during chemical reactions
5. Analyze 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 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 1 | | | | | | | | | | | | | |
| 2 | 2 | 1 | | | | | | | | | | | | | |
| 3 | 2 | 1 | | | | | | | | | | | | | |
| 4 | 2 | 1 | | | | | | | | | | | | 2 | |
| 5 | 2 | 1 | | | | | | | | | | | | 1 | |

**UNIT I**                                                                                     **5 Hours**
**ORIGIN OF ELEMENTS**
Hydrogen - Elements and Sun - fusion - hypernova - supernova - dying stars - man-made elements

**UNIT II**                                                                                     **7 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

**1**                                                                                                                            **2 Hours**
**EXPERIMENT 1**
Lab safety rules and guidelines for students - OSHA Guidelines

**2**                                                                                                                            **3 Hours**
**EXPERIMENT 2**
Estimation of dissolved oxygen content in water sample(s) by Winkler's method

**3**                                                                                                                            **4 Hours**
**EXPERIMENT 3**
Determination of Fe(II) in a sample using spectrophotometer

**4**                                                                                                                            **3 Hours**
**EXPERIMENT 4**
Estimation of chromium content in water sample by volumetric analysis

**5**                                                                                                                            **3 Hours**
**EXPERIMENT 5**
Estimation of chloride present in the given water sample by argentometric method

**6**                                                                                                                            **3 Hours**
**EXPERIMENT 6**
Conductometric titration of mixture of acids

**7**                                                                                                                            **4 Hours**
**EXPERIMENT 7**
Estimation of magnesium ions in given solution by EDTA method

**8**                                                                                                                            **4 Hours**
**EXPERIMENT 8**
Preparation of salt of fatty acid by saponification process

**9**                                                                                                                            **4 Hours**
**EXPERIMENT 9**
Recrystallization of aspirin from water/ethanol

**Total: 60 Hours**

**Reference(s)**
1. Peter Atkins, Physical Chemistry, Oxford university press, 2019

2. Rose Marie Gallagher and Author Paul Ingram, Complete Chemistry Cambridge IGCSE, Oxford university press, 2020

3. P L Soni, Text book of inorganic chemistry, Chand publishers, New Delhi, 2017

4. J.D. Lee, Concise inorganic chemistry, Blackman Science Ltd, France, Wiley-India, 5th edition (Reprint), 2016

5. Gareth Price, Thermodynamics of chemical processes, Oxford university press, 2019

6. D Tabor, Gases, liquids and solids and other states of matter, Oxford University press, 2018

## 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.

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 1 | 1 | 1 | | | | | | | | | | | |
| 2 | 3 | 3 | 3 | 1 | | | | | | | | | | | |
| 3 | 2 | 2 | 2 | 1 | | | | | | | | | | | 2 |
| 4 | 2 | 2 | 2 | 1 | | | | | | | | | | | |
| 5 | 2 | 2 | 2 | 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

**Course Outcomes (COs)**

1. Express themselves in a professional manner using error-free language
2. Express in both descriptive and narrative formats
3. Understand 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 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 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 - Paralinguistic/Vocalic - 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

**Course Outcomes (COs)**

1. Interpret the behavior of electric charges in different medium using coulombs law.
2. Analyze the electric field due to different charge distributions.
3. Analyze 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. Interpret the energy conversion concepts in electromagnetic fields.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 2 | | | | | | | | | | | 2 | 2 |
| 2 | 2 | 2 | 2 | 3 | | | | | | | | | | 2 | 2 |
| 3 | 2 | 2 | 1 | 3 | | | | | | | | | | 2 | 2 |
| 4 | 2 | 2 | 1 | 2 | | | | | | | | | | 2 | 2 |
| 5 | 2 | 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.

**1**                                                       **15 Hours**
**EXPERIMENT 1**
Analyze and design of Electromechanical energy conversion system.

**2**                                                       **15 Hours**
**EXPERIMENT 2**
Develop an electrical machine and analyze its performance with supplied input of AC from 0 V to 230 V.

                                                      **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

**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.

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | | | | | | | 2 | | 2 | | | | | |
| 2 | 2 | | | | | | | 2 | | 2 | | | | | |
| 3 | 1 | | | | | | | 2 | | 2 | | | | | |
| 4 | 1 | | | | | | | 2 | | 2 | | | | | |
| 5 | 1 | | | | | | | 2 | | 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.

## 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.

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 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 aClassical 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. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL

2. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies

3. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies)

4. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)

**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

   To Summarize and apply the methodologies involved in framing the real-world problems related to fundamental principles of complex functions

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 3 | | | | | | | | | | | | | |
| 2 | 2 | 3 | | | | | | | | | | | | | |
| 3 | 2 | 3 | | | | | | | | | | | | | 2 |
| 4 | 3 | 3 | | | | | | | | | | | | | |
| 5 | 3 | 3 | | | | | | | | | | | | | |

**UNIT I**                                      **9 Hours**
**FIRST ORDER LINEAR DIFFERENTIAL EQUATIONS**
Formation of differential equations- Solutions of first order linear ODE: Leibnitzs 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 Electric flow - Mapping of complex functions

**Total: 45 + 15 (tutorial) = 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, 2/e, Pearson, 2018

3. George B. Thomas, Maurice D. Weir and Joel Hass Thomas Calculus, 13/e, Pearson Publishers, 2013

4. Erwin Kreyszig, Advanced Engineering Mathematics Wiley, 10th editi5. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017on ,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

**Course Outcomes (COs)**

1. Understand the principles and mechanism of electrostatics and current
2. Illustrate the principles and mechanism of magneto-statics
3. Classify electromagnetic waves and infer the characteristics of visible light
4. Outline the importance of theory of relativity and analyze the wave nature of particles
5. Exemplify the electrical properties of semiconductor based on the band theory

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 1 | | | | | | | 2 | | | | | | |
| 2 | 2 | 1 | | | | | | | 2 | | | | | | |
| 3 | 2 | 1 | | | | | | | 2 | | | | | | |
| 4 | 2 | 1 | | | | | | | | | | | | | |
| 5 | 2 | 1 | | | | | | | 2 | | | | | | 2 |

**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

**1**            **5 Hours**
**EXPERIMENT 1**
Determination of V-I characteristics of a solar cell

**2**            **5 Hours**
**EXPERIMENT 2**
Determination of Hall voltage of a given specimen by Hall Effect method

**3**            **5 Hours**
**EXPERIMENT 3**
Determination of wavelength of a given laser source - Grating method

**4**            **4 Hours**
**EXPERIMENT 4**
Determination of particle size using diode laser

**5**            **3 Hours**
**EXPERIMENT 5**
Determination of refractive index of a given solid medium and liquid medium

**6**            **4 Hours**
**EXPERIMENT 6**
Determination of energy loss per cycle of a ferromagnetic material using hysteresis curve

**7**            **4 Hours**
**EXPERIMENT 7**
Determination of band gap energy of a given semiconducting material

           **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.

**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. Understand the mechanism of corrosion and suggest a method to control the corrosion
4. Illustrate 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 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 1 | | | | | | | | | | | | | |
| 2 | 2 | 1 | | | | | | | | | | | | | |
| 3 | 2 | 1 | | | | | 1 | | | | | | | | 2 |
| 4 | 2 | 1 | | | | | | | | | | | | | |
| 5 | 2 | 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 - Radiocarbon dating

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

Determination of strength of hydrochloric acid in a given solution using pH meter

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

Application of calomel electrode to determine the redox potential of Fe(II) solution

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

Construct an electrochemical cell exhibiting valid output and compare its potential with the given standard cell

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

Determination of corrosion percentage of iron/steel by weight loss method

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

Determination of percentage of corrosion inhibition in iron/mild steel using a natural inhibitor

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

Electroplate copper on the given target object and estimate the amount of copper deposited at cathode

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

Determination of rate constant of acid catalyzed hydrolysis of ester

                                                                                                   **Total: 60 Hours**

**Reference(s)**

1.  Jain and Jain, Engineering Chemistry, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2013.

2.  P.H. Rieger, Electrochemistry, Second Edition (Reprint), Springer, Netherland, 2012

3.  E. McCafferty, Introduction to Corrosion Science, Springer; 2010 Edition, January 2010

4.  S. Vairam, Engineering Chemistry, John Wiley & Sons, 2014

5.  H.J. Arnikar, Essentials of Nuclear Chemistry, 4th edition, (revised) New Age International Publishers, 2011

6.  U. Hanefeld, L. Lefferts, Catalysis: An Integrated Textbook for Students, Wiley- VCH, 2017

## 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.

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 2 | 2 | 2 | | | | | | | | | | | |
| 2 | 2 | 2 | 2 | 2 | | | | | | | | | | | |
| 3 | 2 | 2 | 2 | 2 | | | | | | | | | | | |
| 4 | 2 | 2 | 2 | 2 | | | | | | | | | | | 2 |
| 5 | 2 | 2 | 2 | 2 | | | | | | | | | | | |

**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.

**Course Outcomes (COs)**

1. Understand 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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 3 | 1 | | | | | | | | | | | 1 |
| 2 | 3 | 3 | 3 | 2 | | | | | | | | | | | |
| 3 | 3 | 3 | 3 | 2 | | | | | | | | | | | |
| 4 | 3 | 3 | 3 | 2 | | | | | | | | | | | |
| 5 | 3 | 3 | 3 | 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.

**1**                                                                                          **4 Hours**
**EXPERIMENT 1**
Design and Implement a simple device to communicate basic information between two different small distance Points using wired and wireless methods.

**2**                                                                                          **6 Hours**
**EXPERIMENT 2**
Design and Implement different wave shaping Circuits using PN Junction Diodes.

**3**                                                                                          **4 Hours**
**EXPERIMENT 3**
Design and Implement Voltage Multiplier Circuit using PN Junction Diodes and Capacitors.

**4**                                                                                          **4 Hours**
**EXPERIMENT 4**
Design and Implement t a three Stage Circuit to convert 220V 50Hz AC mains supply to 12V DC supply.

**5**                                                                                          **4 Hours**
**EXPERIMENT 5**
Design and Implement a BJT Amplifier Circuit to amplify audio input signal.

**6**                                                                                          **4 Hours**
**EXPERIMENT 6**
Design and Implement Basic Logic Gates using PN Junction Diodes.

**7**                                                                                          **4 Hours**
**EXPERIMENT 7**
Design and Implement Basic Logic Gates using BJTs.
                                                                                               **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)

**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 behavior

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

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | | | | | | | 1 | 2 | 1 | | 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

**1**                                                                                           **1 Hours**

**EXPERIMENT 1**

Analysis of various business sectors

**2**                                                                                           **2 Hours**

**EXPERIMENT 2**

Developing a Design Thinking Output Chart

**3**                                                                                           **1 Hours**

**EXPERIMENT 3**

Creating Buyer Personas

**4**                                                                                           **2 Hours**

**EXPERIMENT 4**

Undertake Market Study to understand market needs and assess market potential

**5**                                                                                           **2 Hours**

**EXPERIMENT 5**

Preparation of Business Model Canvas

**6**                                                                                           **1 Hours**

**EXPERIMENT**

Developing Prototypes

**7**                                                                                           **2 Hours**

**EXPERIMENT 7**

Organizing Product Design Sprints

**8**                                                                                           **2 Hours**

**EXPERIMENT 8**

Preparation of Business Plans

**9**                                                                                           **2 Hours**

**EXPERIMENT 9**

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

**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.

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | |

**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.

**22AG301 NUMERICAL METHODS AND STATISTICS**          **3 1 0 4**

**Course Objectives**

Understand the methods to solve polynomial equations and Implement the ideas of numerical interpolation

Develop enough confidence to solve differential equations numerically

Summarize and apply the concepts of statistics in solving engineering problems

**Course Outcomes (COs)**

1. Assess the basic concepts of solving equations and able to identify the derivative and integration of functions
2. Execute the knowledge of solving various types of ordinary and partial differential equations, numerically
3. Compare the ideas of basics statistics in engineering
4. Execute the knowledge of testing of hypothesis for small and large samples in engineering problems
5. Assess the knowledge of design of experiments and control charts in the field of Engineering

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 1 | 1 | | | | | | | | | | | | | |
| 2 | 1 | 1 | | | | | | | | | | | | | |
| 3 | 2 | 2 | | | | | | | | | | | | | |
| 4 | 2 | 2 | | | | | | | | | | | | | |
| 5 | 2 | 2 | | | | | | | | | | | | | |

**UNIT I**                                                                         **10 Hours**
**NUMERICAL TECHNIQUES FOR SOLVING EQUATIONS, DIFFERENTIATION AND INTEGRATION**
Solution of algebraic and transcendental equations - Newton Raphson method - Solution of linear system of equations - Gauss elimination method – Jacobi's method for inverse matrices- Eigenvalues of a matrix by Power method -Interpolation – Lagrange's interpolation - Approximation of derivatives using interpolation polynomials-Numerical integration using Simpsons rule

**UNIT II**                                                                          **9 Hours**
**SOLUTION OF ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS**
Solution of ordinary differential equation: Fourth order Runge - Kutta method for solving first order equations - Solution of two-dimensional heat equation: Laplace's and Poisson's equations- One-dimensional heat flow equation- Solution of one-dimensional wave equation

**UNIT III**                                                                          **7 Hours**
**BASIC STATISTICS**
Mean-Median-Mode-Variance and Standard deviation -Covariance - Correlation and Regression

**UNIT IV**                                                                          **9 Hours**
**TESTING OF HYPOTHESIS**
Sampling distributions-Estimation of parameters- Statistical hypothesis-large sample tests based on Normal distribution for single mean and difference of Means-Tests based on t, Chi-square and F Distributions-Chi -square distributions (test for independent and Goodness of fit)

**UNIT V** **10 Hours**
**DESIGN OF EXPERIMENTS AND CONTROL CHARTS**
One way and two-way classifications-Completely randomized design-Randomized block design-Latin square design- 2X2 factorial design-Control Charts of Variable and Attributes

**Total: 45 + 15 (tutorial) = 60 Hours**

**Reference(s)**

1. Sankara Rao. K, Numerical Methods for Scientists and Engineers, Third Edition, Eastern Economy Edition, 2009

2. Jain M.K, Iyangar S.R.K and Jain R.K Numerical Methods For Scientific and Engineering Computation New Age International (P) Ltd , New Delhi , 2005.

3. William Navidi, Statistics for Engineers and Scientists, 2nd Edition, Tata Mcgraw Hill, 2008.

4. Richard A Johnson, Miller and Feunds Probability and Statistics for Engineers, 8thEdiion, Phi Learning Private Ltd, 2014.

5. Seymour Lipschuts, Introduction to Probability and Statistics, 1st Ediion, McGraw Hill, 2012.

**22AG302 SOIL SCIENCE AND ENGINEERING**                    **3 0 2 4**

## Course Objectives

To acquire the knowledge on engineering geology and basic geomorphic processes

To impart knowledge on applied geomorphology and hydrogeology

To gain knowledge on soil mechanics and the procedures to test the soil interns of dam and reservoir construction

## Course Outcomes (COs)

1. Assess the basic geomorphic processes
2. Apply the concepts of hydraulics in soil media
3. Assess suitable technique/procedure needed for soil conservation measures
4. Analyze the fundamental concepts of soil strength
5. Compare the methods for estimating soil stability

## Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 1 | 1 | 3 | | | | | | | | | | 1 | | |
| 2 | 2 | 2 | 3 | 2 | 2 | | 1 | | | | | | 2 | | |
| 3 | 1 | 3 | 1 | 2 | | | 1 | | | | | | 2 | | 2 |
| 4 | 1 | 3 | 2 | 1 | | | 1 | | | | | | | | 1 |
| 5 | 1 | 3 | 1 | 2 | | | | | | | | | 1 | | |

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

**PROPERTIES OF SOILS AND CLASSIFICATION**

Introduction of soil mechanics - Soil formation and nature of soils - Phase diagrams - Basic definitions and inter-relationships. Classification of soils based on BIS - Particle size distribution - analysis - Grain size distribution curves - Sedimentation analysis -Stokes law- assumptions-validity- soil structure types- Index Properties of soils - Consistency limits - Relative density. Compaction - Factors affecting compaction - Laboratory & Field Compaction methods

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

**EFFECTIVE STRESS AND PERMEABILITY**

Soil water - Various forms - Static pressure in water - Total, Neutral and Effective stress distribution in soils - Liquefaction & quicksand conditions. Flow of water through soils – Darcy's law; Assumptions and validity - Permeability - Coefficient of permeability - Factors affecting permeability - Permeability of stratified deposits of soils - Laboratory tests - Seepage analysis - Quick condition - Velocity potential and stream function - Flow net construction - Piping

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

**STRESS DISTRIBUTION AND CONSOLIDATION**

Boussinesq and Wester Guards theories of stresses due to concentrated loads - Circular, Rectangular load - Strip load - New Marks chart. Consolidation - Fundamental definitions - Spring analogy - Terzaghis one-dimensional consolidation theory - Assumptions, limitations and applications - Pre-consolidation pressure and its determination - Normally, under and over consolidated soils

**UNIT IV**                                                                                              **8 Hours**
**SHEAR STRENGTH OF SOILS**
Earth pressure at rest - active pressure - passive pressure - Rankines theory. Shear strength - Factors affecting shear strength of soils- Mohr - Coulomb theory - Measurement of shear strength parameters - Direct shear - Unconfined compression - Triaxial - Drained and un-drained conditions - Vane shear tests

**UNIT V**                                                                                                **8 Hours**
**STABILITY OF SLOPES**
Types of slopes - Failure mechanism of slopes - Total and effective stress analysis - Finite slopes - Stability analysis for purely cohesive and c-phi soils - Method of slices - Friction circle method - Taylors Stability number. Stability of earthen embankments, -Bearing Capacity of soil - Testing &Improving Bearing Capacity of soil

**1**                                                                                                    **2 Hours**
**EXPERIMENT 1**
Determination of water content of soil and specific gravity of soil

**2**                                                                                                    **4 Hours**
**EXPERIMENT 2**
Determination of Field Density by Core cutter and Sand Replacement methods

**3**                                                                                                    **4 Hours**
**EXPERIMENT 3**
Mechanical analysis of Soil Sieving

**4**                                                                                                    **4 Hours**
**EXPERIMENT 4**
Hydrometer analysis for Grain Size Distribution

**5**                                                                                                    **4 Hours**
**EXPERIMENT 5**
Determination of Atterbergs Limits of Soil Consistency

**6**                                                                                                    **4 Hours**
**EXPERIMENT 6**
Determination of Hydraulic Conductivity by Constant Permeameter, Variable Head Permeameter

**7**                                                                                                    **4 Hours**
**EXPERIMENT 7**
Proctor Compaction test of soils-Consolidation test of soils

**8**                                                                                                    **4 Hours**
**EXPERIMENT 8**
Direct Shear Test and Vane Shear Test of soils

**Total: 75 Hours**

**Reference(s)**

1. Punmia B C, Jain A K and Jain A K. 2005. Soil Mechanics and Foundations. Laxmi Publications (P) Ltd. New Delhi.

2. Ranjan Gopal and Rao A S R. 1993. Basic and Applied Soil Mechanics. Welley Easters Ltd., New Delhi.

3. Singh Alam. 1994. Soil Engineering Vol. I. CBS Publishers and Distributions, Delhi.

**22AG303 ENGINEERING THERMODYNAMICS**            **3 1 0 4**

**Course Objectives**

To study the fundamentals of thermodynamics and zeroth law

To provide the knowledge on first law of thermodynamics

To impart the knowledge on second law of thermodynamics and entropy

To study the thermodynamic properties of pure substances and its phase change processes

To learn about gas power cycles and properties of gas mixtures

**Course Outcomes (COs)**

1. Exemplify the basic concepts and zeroth law of thermodynamics
2. Apply the first law of thermodynamics to closed and open systems
3. Solve the problems related to cycles and cyclic devices using second law of thermodynamics
4. Determine the thermodynamic properties of pure substances and its phase change processes
5. Evaluate the air standard performance of heat engines and properties of gas mixtures

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 3 | 3 | | | | | | | | | | | | 3 | |
| 2 | 3 | 3 | | | | | 1 | | | | | | 2 | 3 | |
| 3 | 3 | 3 | | | | | 2 | | | | | | | 3 | |
| 4 | 3 | 3 | | | 1 | | 2 | | | | | | 2 | 3 | |
| 5 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | | | | | | 2 | 3 | |

**UNIT I**                                                                                          **8 Hours**
**INTRODUCTION AND ZEROTH LAW OF THERMODYNAMICS**
Macroscopic and Microscopic approaches, energy, heat, work. Thermodynamic system - Types, properties, functions, states, processes and cycle. Zeroth law of thermodynamics - temperature scale, perfect gas scale.

**UNIT II**                                                                                         **8 Hours**
**FIRST LAW OF THERMODYNAMICS**
First law of thermodynamics, Application of first law - Closed systems and Open systems, Thermodynamic processes in closed systems, Steady state flow processes in open systems.

**UNIT III**                                                                                        **9 Hours**
**SECOND LAW OF THERMODYNAMICS**
Limitations of first law of thermodynamics, Second law of thermodynamics - Kelvin - Planck and Clausius statements, Reversible and irreversible processes, Carnot theorem, Carnot engine, Clausius inequality, Entropy, Availability and irreversibility. Heat Engine, heat pump and refrigerator.

**UNIT IV**                                                                                   **10 Hours**
**PROPERTIES OF PURE SUBSTANCES**
Thermodynamic properties of fluids. Pure substance - Phases - Phase change processes, Steam tables and Property diagrams - (P-V), (P-T), (T-V), (T-S) and (h-s) diagrams. Ideal gas equation, Van der Waals equation and compressibility chart.

**UNIT V**                                                                                    **10 Hours**
**GAS MIXTURES AND GAS POWER CYCLES**
Thermodynamics and properties of ideal gas mixture and perfect gas mixture - Daltons law of partial pressure, Amagats law. Psychrometric properties and processes - Psychrometric chart. Air standard cycles Otto, Diesel and Dual cycles- mean effective pressure and air standard efficiency.

**Total: 45 + 15 (tutorial) = 60 Hours**

**Reference(s)**

1.  Y. Cengel and Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, 2019.

2.  P.K. Nag, Engineering Thermodynamics,Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, 2018.

3.  J.P.Holman, Thermodynamics, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi,2016.

4.  R.K. Rajput, Engineering Thermodynamics, Laxmi Publications Pvt.Ltd., New Delhi, 2017.

5.  Gordon J. Van Wylen, Richard E. Sonntag, Fundamentals of Classical Thermodynamics, December 31st 1978, John Wiley & Sons.

6.  https://onlinecourses.nptel.ac.in/ noc22-ch01.

**22AG304 FLUID MECHANICS AND MACHINERY**        **3 0 2 4**

**Course Objectives**

To impart knowledge on the fluid properties and fluid statics principles

To introduce the basic concept of fluid kinematics and dynamics.

To calculate the rate of flow and energy losses in flow through pipes and open channels.

To emphasize the concepts of boundary layer theory and the importance of dimensional analysis

To impart the knowledge of pumps and turbines

**Course Outcomes (COs)**

1.  Execute the fundamental properties of fluids and methods of pressure measurement in fluid statics
2.  Find fundamentals of fluid kinematics and dynamics and their applications in hydraulic experiments
3.  Assess the mechanisms and the factors affecting flow through pipes and open channels
4.  Apply the concept of the boundary layer, dimensional analysis, and model analysis to the fluid structures
5.  Compute the efficiency and performance of pumps and turbines

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | | 2 | | | | | 2 | | | | 2 | | 1 |
| 2 | 3 | 3 | | 2 | | | | | 2 | | | | 2 | | |
| 3 | 3 | 2 | | 2 | | | | | 2 | | | | 2 | | |
| 4 | 2 | 2 | | 2 | 1 | | | | 2 | | | | 2 | | |
| 5 | 2 | 2 | | 2 | | | | | 2 | | | | | | |

**UNIT I**                                                                                     **9 Hours**
**FLUID PROPERTIES AND FLUID STATICS**
Concept of Continuum - Properties of Fluid - Types of fluid flow -Streamline, Streak line, and path line - Pascal's Law and Hydrostatic Law, Pressure and its variation in a static fluid, Measurement of fluid pressure- Manometers- Buoyancy and meta-Centre-Stability analysis and applications.

**UNIT II**                                                                                    **9 Hours**
**FLUID KINEMATICS AND DYNAMICS**
Continuity Equation-Velocity Potential and Stream function, Bernoulli's equation, and its applications - Impulse-Momentum principle-Impact of Jet-Velocity triangle.

**UNIT III**                                                                                   **9 Hours**
**FLOW THROUGH PIPES AND CHANNELS**
Laminar and turbulent flows in circular pipes -Major and Minor losses in pipes, Darcy-Welsbach equation, Hagen-Poiseuille equation- Multi-reservoir problems, pipe network design, Types of open channel flows - Measurement of discharge in open channels: notches - Most economical channel section.

**UNIT IV**                                                                                    **9 Hours**
**DIMENSIONAL ANALYSIS AND MODEL TESTING**
Buckingham's pi-theorem and Application of theorem in fluid flow Reynolds, Froude, and Mach number and their applications in model testing - Boundary layer thickness, Momentum integral equation, Drag and lift, Separation of the boundary layer, and Methods of preventing the boundary layer separation.

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

**HYDRAULIC MACHINES**

Centrifugal pumps - Work done - Head developed - Pump output and Efficiencies - priming - minimum starting speed - performance of multistage pumps - Cavitation - methods of prevention – Pump characteristics. Classification of hydraulic turbines - Pelton wheel - Francis turbine – Kaplan and turbines - Specific speed - Performance characteristics - Selection of turbines- Turbine efficiencies

**1** **2 Hours**

**EXPERIMENT 1**

Visualize the flow using Reynolds apparatus

**2** **4 Hours**

**EXPERIMENT 2**

Verification of Bernoulli's theorem and determine the coefficient of discharge using Venturimeter

**3** **3 Hours**

**EXPERIMENT 3**

Determination of friction factor for a given set of pipes

**4** **3 Hours**

**EXPERIMENT 4**

Determine the coefficient of discharge for a rotometer and orificemeter

**5** **3 Hours**

**EXPERIMENT 5**

Determination of lift and drag force of an aerofoil

**6** **3 Hours**

**EXPERIMENT 6**

Performance test on tangential flow impulse turbine against the constant head

**7** **3 Hours**

**EXPERIMENT 7**

Performance test on Francis turbine against the constant head

**8** **3 Hours**

**EXPERIMENT 8**

Performance test on reaction (Kaplan) turbine

**9** **3 Hours**

**EXPERIMENT 9**

Performance test on a centrifugal pump.

**10** **3 Hours**

**EXPERIMENT 10**

Performance test on submersible pump/Gear pump.

**Total: 75 Hours**

**Reference(s)**

1. Yunus A. Cengel, and John M. Cimbala, Fluid Mechanics, Third edition, Mc Graw Hill Education (India) Pvt. Ltd, 2014.

2. Dr R.K. Bansal , A text book of Fluid Mechanics and Hydraulic Machines, Tenth Edition, Laxmi Publications, New Delhi, 2018.

3. Frank .M. White, Fluid Mechanics, McGraw Hill Publishing Company Ltd, New Delhi, 8th Edition. 2017

4. R.C. Hibbler, Fluid Mechanics, Pearson, First edition, 2017.

5. S.K. Som and G. Biswas, Introduction to Fluid Machines, 3rd Edition, McGraw-Hill Education, 2017.

6. https://nptel.ac.in/courses/112105183

**22AG305 SURVEYING AND LEVELLING**              **3 0 2 4**

**Course Objectives**

To acquire the knowledge on engineering geology and basic geomorphic processes

To gain knowledge on soil mechanics and the procedures to test the soil interns of dam and reservoir construction

To impart knowledge on applied geomorphology and hydrogeology

**Course Outcomes (COs)**

1. Assess the instruments required for conducting the chain survey in level and sloping ground
2. Find the area of the land by chain surveying and also can apply the necessary chain corrections
3. Compute the area and volume of earth work by simple and numerical methods
4. Find the angle between the stations by prismatic compass and conduct the plane table surveying for locating the new stations
5. Find the reduced level for all points by using dumpy level, prepare the contour map and also identify the horizontal, vertical angle using Theodolite

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 1 | 2 | 3 | | | | | | | | | | 1 | | |
| 2 | 2 | 1 | 3 | 2 | 2 | | | | | | | | 1 | | |
| 3 | 1 | 3 | 1 | 2 | | | 1 | | | | | | 1 | | |
| 4 | 1 | 3 | 2 | 2 | | | 1 | | | | | | 1 | | |
| 5 | 1 | 3 | 1 | 1 | | | 1 | | | | | | 1 | | |

**UNIT I**                                                                **9 Hours**
**PRINCIPLES OF SURVEYING**
Introduction-classification and basic principles of surveying-Types of chains, Ranging rod, Ranging- Direct and Indirect methods in chaining. Chain Surveying-Principles of chain surveying-cross staff and optical square -Steps involved in Chain Survey-Errors in measurements.

**UNIT II**                                                               **9 Hours**
**LEVELLING AND COMPASS TRAVERSING**
Levelling-Principles and theory of Levelling -Datum -Bench Marks-Temporary and Permanent Adjustments-Methods of Levelling-Theory of simple, compound, cross sectional and reciprocal levelling.Basic terminologies of Compass traversing- Prismatic and Surveyors Compass - Checking the accuracy of traverse - Errors and mistakes in Compass survey.

**UNIT III**                                                              **9 Hours**
**THEODOLITE AND TACHEOMETRIC SURVEYING**
Theodolite-Types-Temporary and Permanent adjustments-Horizontal and vertical angle measurements-Heights and distances-Reduced levels -Tacheometric surveying - Tangential and Stadia Tacheometry -Subtense bar method - Stadia constants -Anallactic lens-Tacheometric contouring.

**UNIT IV**                                                                                     **9 Hours**
**CONTOURING AND PLANE TABLE SURVEYING**
Contour -Contouring -Characteristics of contours-Methods of contouring -Contour gradient - Contour plan and map. Plane tabling - Radiation, Traversing, Orientation- Intersection and Resection.

**UNIT V**                                                                                       **9 Hours**
**MODERN SURVEYING AND COMPUTATION OF AREA**
Introduction-Total Station-Global Positioning System (GPS)-GNSS. Formulate for calculation of cross-sectional area- calculation of volume-Area computation, Mid-Ordinate rule- Average ordinate rule- Trapezoidal rules- Simpson rule and Coordinate method

**FOR FURTHER READING**
Merits and demerits of plane table surveying - Description and uses of theodolite Omitted measurements Description and uses of total station-Radial contouring - Modern Trends in surveying and advance equipment.

**1**                                                                                            **4 Hours**
**EXPERIMENT 1**
Linear measurement and Area computation by cross staff survey and plotting

**2**                                                                                            **2 Hours**
**EXPERIMENT 2**
Chain traversing of cropped area and error correction.

**3**                                                                                            **4 Hours**
**EXPERIMENT 3**
Compass Survey - radiation method-Closed compass traversing, Plotting and correction of closing error

**4**                                                                                            **2 Hours**
**EXPERIMENT 4**
Open compass traversing-Problems on Compass traversing

**5**                                                                                            **2 Hours**
**EXPERIMENT 5**
Area computation by plane table survey - radiation method

**6**                                                                                            **4 Hours**
**EXPERIMENT 6**
Plane table survey - intersection -Plane table traversing resection methods

**7**                                                                                            **2 Hours**
**EXPERIMENT 7**
Measurement of horizontal

**8**                                                                                            **4 Hours**
**EXPERIMENT 8**
Measurement of area using Total Station and GPS

**9**                                                                                                   **4 Hours**
**EXPERIMENT 9**
Dumpy level- handling - shifting- Simple levelling - temporary adjustments -Differential levelling in field-
Profile levelling


**10**                                                                                                  **2 Hours**
**EXPERIMENT 10**
Mid-ordinate rule, Average ordinate rule, Trapezoidal rule, Simpson rule and Coordinate method of finding
area
                                                                                                **Total: 75 Hours**

**Reference(s)**

1.  Punmia. B.C Surveying (Vol- I & Vol-II) Laxmi publications, New Delhi. 1991.

2.  Kanetkar, T.P. & Kulkarni, S.V., Surveying & leveling Part I, A.V.G. Prakashan, Poona 1984.

3.  Basak. V.N. 1994.Surveying and Levelling, Tata McGraw hill publications, New Delhi

4.  A.M. Michael and T.P. Ojha Agricultural Engineering (Vol-II), New Delhi

## 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.

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | | | | | | | | 3 | 2 | 1 | | | | | |
| 2 | | | | | | | | 3 | 2 | 1 | | | | | |
| 3 | | | | | | | | 3 | 2 | 1 | | | | | |
| 4 | | | | | | | | 3 | 2 | 1 | | | | | |
| 5 | | | | | | | | 3 | 2 | 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

**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. Analyze 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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | 2 | 3 | | | | | |
| 2 | | | | | | | | | 2 | 3 | | | | | |
| 3 | | | | | | | | | 2 | 3 | | | | | |
| 4 | | | | | | | | | 2 | 3 | | | | | |
| 5 | | | | | | | | | 2 | | | | | | |

**UNIT 1**                                                      **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 2**                                                      **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

**22AG401 CROP PRODUCTION TECHNOLOGY**     **3 0 2 4**

**Course Objectives**

To study about the basic principles of crop production aspects

To learn the cultivation practices of varies field crops and horticulture crops to increase the food production

To impart basic knowledge of insect pest and diseases and their losses caused to crops.

To study various methods of plant protection to get more yield in agricultural crops

**Course Outcomes (COs)**

1. Execute the concepts and principles of crop growth, climate influence, soil fertility and tillage for increase the crop productivity
2. Assess the various cultivation practices for major cereals, millets, minor millets and pulse crops, major oil seeds, cotton and sugarcane
3. Find the various cultivation practices for raising different horticultural crops such as fruits, vegetables and flower crops
4. Find the new techniques for cultivate horticultural crops, through different planting methods
5. Assess different management practices to control the groups of insects and diseases

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 1 | | | | | 2 | | 1 | | | 3 | 1 | | |
| 2 | | 3 | 1 | | 1 | | | | 1 | | | 2 | 2 | | |
| 3 | | | 1 | | | | | | | | | 1 | 2 | | |
| 4 | | 1 | 3 | | | | | | | | | | 1 | | 2 |
| 5 | | 1 | 3 | | | | | | | | | | 1 | | 1 |

**UNIT I**     **9 Hours**
**PRINCIPLES OF AGRONOMY**
Introduction and scope of agronomy - Classification of crops - Effect of different weather parameters on crop growth and development - Principles of tillage - tilth and its characteristics - Crop seasons - Methods - time and depth of sowing of major field crops - Methods and time of application of manures and fertilizers - Organic farming -Sustainable agriculture - Soil water plant relationship - crop coefficients - water requirement of crops and critical stages for irrigation - weeds and their control - crop rotation - cropping systems - Relay cropping and mixed cropping.

**UNIT II**     **9 Hours**
**AGRONOMY OF FIELD CROPS**
Package of practices for important field crops - rice - maize - sorghum - finger millet and small millets - Pulses - red gram - black gram - green gram - soybean - groundnut - gingelly and sunflower - cotton - sugarcane.

**UNIT III**     **9 Hours**
**FUNDAMENTALS OF HORTICULTURE**
Scope of horticultural - Soil and climatic requirements for fruits - vegetables and floriculture crops - improved varieties - Criteria for site selection - layout and planting methods - nursery raising - commercial varieties - hybrids - sowing and planting times and methods - seed rate and seed treatment for vegetable crops

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

**PLANTING TECHNIQUES OF HORTICULTURE**
Macro and micropropagation methods - plant growing structures - pruning and training - water requirements and critical stages - fertilizer application - fertigation - irrigation methods - Garden tools - management of orchard - seed production technique

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

**PLANT PROTECTION**
Group of insects - Diseases and weeds - Methods of control - Cultural - Physical - Chemical and Biological - Pest management in major crops - Organic way of plant protection.

**1** **3 Hours**

**EXPERIMENT 1**
Acquiring skill on the organizational setup of the agricultural farm and studying basic requirements of crop production

**2** **3 Hours**

**EXPERIMENT 2**
Studies of climatic factors on crop growth - meteorological instruments

**3** **2 Hours**

**EXPERIMENT 3**
Practicing different sowing / planting methods; fertilizers and irrigation methods

**4** **3 Hours**

**EXPERIMENT 4**
Practicing different weed management practices; cropping system in intensive or organic farming

**5** **2 Hours**

**EXPERIMENT 5**
To identify the damage symptoms of pest and diseases

**6** **2 Hours**

**EXPERIMENT 6**
Study the integrated pest and diseases management practices

**7** **4 Hours**

**EXPERIMENT 7**
Practicing cultivation operations of major cereal crops, oil seed and sugar crops

**8** **4 Hours**

**EXPERIMENT 8**
Practicing cultivation of vegetables, fruit crops, commercial flower crops and plantation crops

**9** **3 Hours**

**EXPERIMENT 9**
Practicing different techniques for seed seedling production propagation methods budding and grafting

**10** **4 Hours**

**EXPERIMENT 10**
Lawn making landscape designing.

**Total: 75 Hours**

**Reference(s)**

1. SP. Palaniappan, and S. Sivaraman. 1998. Cropping systems in the tropics- Principles and Management, New Age international publishers, New Delhi, (2nd edition), 1998.

2. P.Balasubramain and SP. Palniappan. 2001. Principles and Practices of Agronomy, Agrobios publishers, Ludhiana.

3. T. Yellamanda Reddy and G.H. Sankara Reddi. 2014. Principles of Agronomy, Kalyani publishers, Ludhiana

4. B.Chandrasekaran, B., K. Annadurai and E. Somasundaram. 2007. A Text book of Agronomy, Scientific publishers, Jodhpur.

5. N. Dhandapani and S. Uthamasamy. 2000. Integrated pest Management. TNAU Publications, Coimbatore.p.181.

**22AG402    HEAT AND MASS TRANSFER                    3 0 2 4**

**Course Objectives**

To familiarize conduction heat transfer mechanisms

To expose the mechanisms of free and forced convection

To develop the shape factor algebra for black body radiation and grey body radiation

To demonstrate the phase change heat transfer and determine the performance of heat exchanging devices

To infer diffusion and convective mass transfer

**Course Outcomes (COs)**

1. Apply the heat conduction equation to compute the rate of heat transfer in one and two - dimensional systems and composite systems
2. Assess the convection phenomena and determine the heat transfer rate in free and forced convection
3. Determine the heat transfer rate in radiation and compare the thermal performance of heat exchangers using LMTD or NTU approach
4. Execute mass transfer rate in diffusion mass transfer applications
5. Evaluate convective mass transfer process and apply mass transfer principles in food and bioprocessing

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 3 | 3 | 2 | 2 | 1 | | 2 | | | | | | | 3 | |
| 2 | 2 | 3 | 2 | 2 | 1 | | 2 | | | | | | | 3 | |
| 3 | 3 | 3 | 2 | 2 | - | | 2 | | | | | | | 3 | |
| 4 | 2 | 3 | 2 | 2 | - | | 2 | | | | | | | 3 | |
| 5 | 2 | 3 | 2 | 2 | - | | 2 | | | | | | | 3 | |

**UNIT I                                                                                     8 Hours**
**CONDUCTION**
Introduction - Steady State Conduction in one and two -dimensional systems - Composite systems - Extended surfaces

**UNIT II                                                                                    8 Hours**
**CONVECTION**
Basic concepts - Heat transfer coefficients - Boundary layers - Forced convection - External and Internal flows - correlations - Natural convection- Logarithmic Mean Temperature Difference.

**UNIT III                                                                                  11 Hours**
**RADIATION AND HEAT EXCHANGERS**
Radiation heat transfer - concept of black and grey body - monochromatic Total emissive power-Kirchhoffs law - Plancks law-Stefan-Boltzmanns law -Heat exchangers - parallel- counter and cross flow-Heat transfer efficiency using LMTD and NTU - overall coefficient of heat transfer in shell and tube heat exchanger for food products.

**UNIT IV                                                                                   10 Hours**
**INTRODUCTION TO MASS TRANSFER**
Basics of mass transfer- Fick"s laws of diffusion- mechanisms of mass transfer-Molecular diffusion, Fick"s first and second laws, steady-state and non-steady-state diffusion, diffusion in solids and liquids, diffusion coefficients.

**UNIT V**      **8 Hours**
**CONVECTIVE MASS TRANSFER**
Fundamentals of convective mass transfer, boundary layer theory, mass transfer coefficients in laminar and turbulent flow, Knudsen diffusion, dimensionless numbers, applications of mass transfer in bio and food industries.

**1**      **3 Hours**
**EXPERIMENT 1**
Determination of thermal conductivity for one dimensional steady state conduction

**2**      **3 Hours**
**EXPERIMENT 2**
Determination of heat transfer co-efficient by unsteady heat transfer

**3**      **3 Hours**
**EXPERIMENT 3**
Determination of heat transfer co-efficient by natural convection

**4**      **3 Hours**
**EXPERIMENT 4**
Determination of heat transfer co-efficient by forced convection

**5**      **3 Hours**
**EXPERIMENT 5**
Determination of Stefan-Boltzmann constant

**6**      **3 Hours**
**EXPERIMENT 6**
Determination of emissivity using emissivity apparatus

**7**      **3 Hours**
**EXPERIMENT 7**
Determination of overall heat transfer for film wise and drop wise condensation

**8**      **3 Hours**
**EXPERIMENT 8**
Determination of overall heat transfer co-efficient for a parallel and counterflow heat exchanger

**9**      **3 Hours**
**EXPERIMENT 9**
Experimentation on mass transfer

**10**      **3 Hours**
**EXPERIMENT 10**
Determination of overall heat transfer co-efficient for a fluidized bed heat transfer

     **Total: 75 Hours**

**Reference(s)**

1.  Yunus A.Cengel, Heat and Mass Transfer: Fundamentals and Application, Tata McGraw Hill publishing Company private limited, New Delhi, 6th edition, 2020

2.  J. P. Holman, Heat Transfer, Tata McGraw Hill publishing Company private limited, New Delhi, 10th edition, 2010

3.  Dutta, B.K., Heat transfer: principles and applications. 2nd Edition, PHI Learning Pvt. Ltd. 2023

4.  Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt, Principles of Heat and Mass Transfer, ISBN: 978-1-119-38291-1 October 2017

5.  R. K. Rajput, Heat and Mass Transfer, S Chand and Company, New Delhi, 2018

6.  Robert E. Treybal, Mass transfer operations. McGraw Hill Book Company, Inc., 3rd edition, 2017

**22AG403 STRENGTH OF MATERIALS**          **2 1 2 4**

**Course Objectives**

To provide knowledge about stress structures subjected to axial and thermal loads

To familiarize about two-dimensional stress systems and theories of failure.

To construct shear force, bending moment diagrams and evaluate the bending stress in beams under transverse loading

To impart knowledge on finding slope and deflection of beams and buckling of columns for different boundary conditions

To provide awareness on stresses on shafts and helical springs based on theory of torsion

**Course Outcomes (COs)**

1. Find the stress distribution and strains in regular and composite structures subjected to axial loads.

2. Evaluate the compound stresses in two dimensional systems and thin cylinders

3. Assess the shear force, bending moment and bending stresses in beams under transverse loading

4. Evaluate the slope and deflection of beams and buckling loads of columns under different boundary conditions

5. Apply torsion equation in design of circular shafts and helical springs

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 3 | 3 | 2 | 2 | | 2 | | | | 2 | | 3 | 1 | | |
| 2 | 3 | 3 | 2 | 2 | | 2 | | | | 2 | | 3 | 1 | | |
| 3 | 3 | 3 | 2 | 2 | | 2 | | | | 2 | | 3 | 2 | | |
| 4 | 3 | 3 | 2 | | | 2 | | | | 2 | | 3 | 1 | | |
| 5 | 3 | 3 | 2 | | | 2 | | | | 2 | - | 3 | 1 | | |

**UNIT I**                                                             **6 Hours**
**SIMPLE STRESS AND STRAIN**
Mechanical properties of Materials - Stress-strain curve -Factor of safety - Strain Energy and Impact Loading - Stepped and Composite bars - Axial Stresses - Thermal Stress and Volumetric Stresses - Elastic constants and their relationship.

**UNIT II**                                                             **6 Hours**
**COMPOUND STRESSES AND THIN CYLINDER**
State of stresses at a point - 2D Stress System - Plane Stress Condition - Mohr circle - Thin Cylinders - Stresses - Strain - Maximum Shear stress - Changes in dimensions and volume - Theories of Failure - Significance and Graphical Representations

**UNIT III**                                                             **6 Hours**
**SHEAR FORCE, BENDING MOMENT AND STRESSES IN BEAMS**
Beams - Types of supports - loads and beams - Shear force and Bending Moment in Cantilever - simply supported and overhanging beams - Point of contra flexure - Theory of Simple Bending, Section modulus - Bending stress and stress variation along the length and section of the beam.

**UNIT IV**                                                          **6 Hours**
**DEFLECTION OF BEAMS AND COLUMNS**
Slope and Deflection of cantilever and simply supported beams by Double integration method and Macaulay method - Theory of Columns - Slenderness ratio - End Conditions - Equivalent length - Euler and Rankine formulae.

**UNIT V**                                                            **6 Hours**
**TORSION IN SHAFT AND HELICAL SPRING**
Theory of Torsion - Stresses and Deformations in Solid and Hollow Circular Shafts - Combined bending moment and torsion of shafts - Power transmitted to shaft - Shaft in series and parallel - Close coiled helical spring - Stresses - deflection - Maximum shear stress in spring section including Wahl Factor - springs in series and parallel.

**1**                                                                **6 Hours**
**EXPERIMENT 1**
Prepare the specimen and find the hardness of the given material

**2**                                                                **3 Hours**
**EXPERIMENT 2**
Plot stress-strain curve by observing the tensile behaviour of the given specimen

**3**                                                                **3 Hours**
**EXPERIMENT 3**
Study the deflection phenomenon of the loaded beam and compare the experimental values of deflection with the theoretical values.

**4**                                                                **3 Hours**
**EXPERIMENT 4**
Subject the material to compressive loading and find its strength.

**5**                                                                **3 Hours**
**EXPERIMENT 5**
Calculate the strains in cylindrical vessels subjected to internal pressure through thin cylinder test setup

**6**                                                                **6 Hours**
**EXPERIMENT 6**
Determine the strain energy of a material subjected to impact loading

**7**                                                                **3 Hours**
**EXPERIMENT 7**
Determination of spring constant through load vs deflection curve

**8**                                                                **3 Hours**
**EXPERIMENT 8**
Experimental analysis of a bar under torsion to obtain stiffness and angle of twist

**Total: 60 + 15 (tutorial) = 75 Hours**

**Reference(s)**

1. S.S.Rattan, Strength of Materials, McGraw Hill Education (India) Private Limited, Chennai, Third Edition, 2017

2. F. P. Beer and R. Johnston, McGraw Hill Education India Private Limited, Seventh edition, 2017

3. S.S.Bhavikatti, Strength of Materials, Vikas Publishing House, New Delhi, Fourth edition, 2013

4. Egor P. Popov, Engineering Mechanics of Solids, Pearson India Education Services Pvt Ltd, New Delhi, 2015

5. William Nash and Nilanjan Malik, Strength of Materials (Schaum"s Outline Series), McGraw Hill Education, Fourth Edition, 2017

## 22AG404 THEORY OF MACHINES                                3 0 2 4

**Course Objectives**

To acquire the knowledge on mechanism and find the velocity and acceleration.

To perform force analysis and balancing of reciprocating engines.

To understand the function of flywheel and to determine basic parameters of flywheel

To determine gear ratio for simple, compound, reverted and epicyclic gear train.

**Course Outcomes (COs)**

1. Assess the characteristics of a given planar mechanism.
2. Compare vector mechanics principles to construct velocity and acceleration diagram of planar mechanisms.
3. Find the static and dynamic forces acting on the components of a reciprocating engine
4. Justify the concept of balancing of masses in rotating shafts and explain the effect of vibration
5. Compare speed and torque ratio of major gear trains.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 3 | 3 | 1 | 1 | | | | | | | | | 2 | | |
| 2 | 3 | 3 | 2 | | 2 | | | | | | | | 2 | | |
| 3 | 3 | 3 | 2 | | 2 | | | | | | | | 2 | | 1 |
| 4 | 3 | 3 | 2 | 1 | | | | | | | | | 1 | 2 | |
| 5 | 3 | 3 | 3 | | 2 | | | | | | | | 2 | 1 | |

**UNIT I**                                                    **9 Hours**
**BASICS OF MECHANISMS**
Basic concepts of mechanisms: link, joint, pair, chain, mechanism, machine and structure, degree of freedom, mobility of mechanism - Kutzbach criterion, Grashofs law - Inversions of mechanisms: Four bar and slider crank: Mechanical advantage, Transmission angle, Description of some common mechanisms: Straight line generators, dwell mechanisms, ratchets and escapements, universal Joint-Geneva mechanism.

**UNIT II**                                                   **9 Hours**
**KINEMATICS OF MECHANISMS**
Vector representation of Displacement, velocity and acceleration - Graphical method of velocity (relative velocity method) and acceleration diagrams for simple mechanisms - Coriolis component of acceleration

**UNIT III**                                                  **9 Hours**
**KINETICS OF MECHANISMS**
Static force analysis: Applied and constraint forces, Free body diagrams, Static equilibrium conditions: Two, three and four members - Static force analysis of simple mechanisms - The principle of superposition Dynamic force analysis: Inertia force and Inertia torque, D Alemberts principle, Dynamic Analysis in Four bar mechanism.

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

**BALANCING AND VIBRATION**

Balancing of Single Rotating mass by a single mass rotating in the same plane and two masses rotating in different planes - Several masses rotating in the same plane and different planes; Introduction to vibration - Types of vibration, Longitudinal, Transverse and torsional-free, forced and damped vibrations.

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

**GEARS AND GEAR TRAINS**

Law of toothed gearing Involutes and cycloidal tooth profiles Spur gear terminology and definitions Gear tooth action Interference and undercutting Problems Helical, bevel, worm, rack and pinion gears, Strain wave(harmonic) gear Gear trains: Introduction to gear correction, gear trains Speed ratio, train value, - Types of gear trains: Parallel axis gear trains, Epicyclic gear trains - Determination of gear speeds and torque using tabular method.

**1**                                                  **6 Hours**

**EXPERIMENT 1**

Determine moment of inertia of engine components

**2**                                                  **6 Hours**

**EXPERIMENT 2**

Conduct dynamic analysis for a mechanism that is used in automobiles engine

**3**                                                  **6 Hours**

**EXPERIMENT 3**

Analyze vibration in unbalanced shaft

**4**                                                  **6 Hours**

**EXPERIMENT 4**

Find torque and speed ratio of given epicyclic gear

**5**                                                  **6 Hours**

**EXPERIMENT 5**

Analyze the given four-bar mechanism for its kinematic behaviors

                                                               **Total: 75 Hours**

**Reference(s)**

1. John J Uichker and Joesph E. Shigley, Theory of Machines and Mechanism, oxford university press., United States of America., 2017

2. A Ghosh and A K Mallik. Theory of Mechanisms and Machines. East- West Press (P) Ltd. New Delhi.

3. S S. Rattan, Theory of Machines, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2019.

4. Sadhu Singh, Theory of Machines, Prentice Hall of India, New Delhi, 2011.

5. Kenneth J .Waldron and Garny L. Kinzel, Kinematics, Dynamics and Design of Machinery, John Wiley and Sons (Asia) Pvt. Ltd., New Delhi, 2007

**22AG405      HYDROLOGY                      3 1 0 4**

**Course Objectives**

> To acquire knowledge about the fundamentals of water occurrence and their exploitation
>
> To understand the hydrology of surface and ground water
>
> To understand well hydraulics so as to locate wells for the extraction of groundwater

**Course Outcomes (COs)**

1. Explain the hydrologic cycle and assess the rainfall pattern using data analysis
2. Compute initial losses including interception, evaporation, transpiration, and infiltration using analytical and empirical methods
3. Assess the runoff using analytical and empirical methods and identify the factors affecting the flow
4. Demonstrate the preparation and use of various types of hydrographs for watershed analysis
5. Determine the methods and strategies for flood flow routing

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 1 | 2 | | 1 | | 1 | 1 | | 1 | | | | 1 | | |
| 2 | 1 | 2 | 2 | 3 | | 1 | | | | | | | | | 2 |
| 3 | 3 | | 3 | 2 | | | | | | | | | 2 | | 2 |
| 4 | 2 | 2 | | 3 | | | 1 | | | | | | | | |
| 5 | | | 3 | 2 | | | 1 | | | | | | 1 | | |

**UNIT I                                                                 9 Hours**
**HYDROLOGIC CYCLE**
Hydrologic cycle - precipitation - forms - rainfall measurement - mass curve - hydrograph - mean - rainfall depth - frequency analysis of point rainfall - plotting position - estimation of missing data - test for consistency of rainfall records

**UNIT II                                                                8 Hours**
**INITIAL LOSSES**
Interception - infiltration - evaporation - evapotranspiration - estimation and measurement - geomorphology of watersheds - stream number - stream length - stream area - stream slope and Horton laws

**UNIT III                                                              10 Hours**
**RUNOFF**
Runoff - factors affecting - measurement - stage and velocity - rating curve - extension of rating curve - estimation of peak runoff rate and volume - rational method - Cook method - SCS method - Curve number method

**UNIT IV                                                                9 Hours**
**HYDROGRAPH**
Hydrograph - components - base flow separation - unit hydrograph theory - unit hydrograph of different durations - dimensionless unit hydrograph - distribution hydrograph - synthetic unit hydrograph - uses and limitations of unit hydrograph

**UNIT V** **9 Hours**
**FLOOD ROUTING**
Head water flood control - methods - retards and their location - flood routing - graphical methods of reservoir flood routing - hydrology of dry land areas - drought and its classification - introduction to watershed management and planning.

**Total: 45 + 15 (tutorial) = 60 Hours**

**Reference(s)**

1. Subramanya, K., Engineering Hydrology, Tata McGraw Hill pub Co. New Delhi, 2004
2. Raghunath, H.M., Groundwater, Wiley Eastern Ltd. Madras, 2003
3. Gurmel Singh et al.Manual of soil and water conservation practices, Oxford & IBH publishing Co. New Delhi,2005
4. Suresh, R.Land and water management principles, Standard Publishers & Distributors, New Delhi,2008
5. H.P. Garg, Advances in Solar Energy Technology Volume 2, Industrial Applications of Solar Energy, ISBN: 978-94-010-8188-7 (Print), Springer Publications., 1987.
6. Jui Sheng Hsieh, Solar Energy Engineering, Prentice Hall, London, 1986

**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

**Course Outcomes (COs)**

1. Show the importance of interdisciplinary nature of environment studies, uses and exploitation of natural resources
2. Demonstrate the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation
3. Assess the existing environmental challenges related to pollution and its management
4. Select suitable strategies for sustainable management of components of environmental science
5. Compare the impacts of population and human activities on environment

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 1 | 2 | | | | 2 | 3 | | | | | | | | |
| 2 | 1 | 1 | | | | 1 | 3 | | | | | | | | |
| 3 | 2 | 2 | | | | 3 | 3 | | | | | | | | |
| 4 | 1 | | | | | 2 | 3 | | | | | | 2 | | |
| 5 | 2 | | | | | 3 | 3 | | | | | | | | |

**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, C.P. Kaushik, Environmental Science and Engineering, 4th Multi Colour Edtion, New Age International Publishers, New Delhi, 2014

2. Raven, P. H. Hassenzahl, D.M. & Berg, L.R. 2012. Environment, 8th edition. John Wiley & Sons

3. T. G. Jr. Miller, S. Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi, 2014

4. Pepper, I. L, Gerba, C. P. & Brusseau, M. L. 2011, Environmental and Pollution Science, Academic Press

5. A. K. De, Environmental Chemistry, 7th Edition, New age international publishers, New Delhi, 2014

## 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

### Course Outcomes (COs)

1. Understand 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. Analyze 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 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | | | | | | | | | 2 | 3 | | | | | |
| 2 | | | | | | | | | 2 | 3 | | | | | |
| 3 | | | | | | | | | 2 | 3 | | | | | |
| 4 | | | | | | | | | 2 | 3 | | | | | |
| 5 | | | | | | | | | 2 | 3 | | | | | |
| 6 | | | | | | | | | 2 | 3 | | | | | |

### UNIT 1                                                                          **6 Hours**
Creative Expression - Lesson Plan 1 Persuasive Discourse -Proposals

### UNIT 2                                                                          **6 Hours**
Humor and satirical expression - Creating Business Memes - Comic Strips Stand-up Comedy Caption writing Limericks

### UNIT 3                                                                          **6 Hours**
Formal Expression - Lesson Plan 3 Organizing Subject matter - Writing Action plans, Mind-Mapping, Paragraph writing - Logical reasoning - Conditional Clause - Opening and closing sentences

### UNIT 4                                                                          **6 Hours**
Talking about plans - Action plans, Anecdotal references, order of communication/ narration, complete communication- WH – questions - Effective beginning and closing - Rhetorical questions - Appraising target audience

**UNIT 5** **6 Hours**
Research Writing = Writing - SOPs, Research Objectives, Thesis Statement, Indexing, Academic Writing, Executive Summary, Survey Questionnaires, List of References

**FURTHER READING**
Quantitative Analysis and paraphrasing of reference materials

**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. 1990, Delhi
6. English Grammar, Composition and Usage by N. K. Agrawal & F. T. Wood, Macmillan India Ltd., New Delhi

## 22AG501 TRACTOR AND FARM ENGINES 3 0 2 4

**Course Objectives**

To acquire an in-depth knowledge on farm tractors and engine systems

To acquire knowledge on test procedures to assess the performance of tractors and power tillers

To develop skills on safe and efficient use of tractors

**Course Outcomes (COs)**

1. Identify the sources of farm power, types of engines, and their functions
2. Infer various peripheral system in farm machines and their functions
3. Assess the functional components and their role in power transmission
4. Identify the hydraulic and mechanical aspects of tractors and power tillers
5. Compare the functioning and testing of tractors and power tillers

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 3 | 2 | | | 2 | | | | | | | - | 2 | | |
| 2 | 3 | 2 | | | 2 | 1 | | | | | | - | 1 | | |
| 3 | 1 | 2 | 1 | | | | | 3 | | | | | 2 | | |
| 4 | | | | | 3 | 2 | | | | | | | 2 | | |
| 5 | | | | 2 | | | | | | 3 | | | 3 | | |

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

**SOURCES OF FARM POWER AND ENGINE SYSTEM**

Sources of farm power - conventional and non - conventional energy sources; classification of tractors and IC engines; thermodynamic principles of IC engine - CI and SI; engine - functional components and their construction, working principles; measurement of indicated horse power - theoretical and numerical method; comparison between two stroke and four stroke engine cycles and CI and SI engines - valve mechanism valve timing diagram and valve clearance adjustment, air cleaning system - types of air cleaners and performance characteristics of various air cleaners; turbocharger; supercharger; emission characteristics of IC engine, biofuels in IC engine, modern trends in engine design

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

**COOLING, LUBIRCATION, FUEL SUPPLY AND ELECTRICAL SYSTEM**

Engine cooling system - necessity, types, functional components and working principle; pressurized cooling; anti - freeze solutions; lubrication system - types of lubricants and systems, theories for the application of lubricants - fluid film theory and boundary layer theory, working principle; fuel supply system - fuels, properties of fuels, calculation of air - fuel ratio and calorific value; fuel test for SI and CI engines, detonation and knocking; carburetion system - types and its functional components; fuel injection system - injection pump, their types, working principles; common rail fuel injection system; fuel injector nozzles - their types and working principle; engine governing - governor types and governor characteristics; ignition system of SI engines; electrical system - cranking of engine, battery and starting motor

**UNIT III**                                                         **9 Hours**
**TRANSMISSION SYSTEM**
Clutch - need, types, functional requirements, construction and principle of operation; gear box - gearing theory, principle of operation, types of gear box, functional requirements and calculation for speed ratio; planetary gear system, torque converter; differential system - functional components, construction, calculation for speed reduction; final drive and wheels; brake system - types, principle of operation; steering system - requirements, characteristics of steering geometry; functional components, front axle and wheel alignment, Ackerman steering geometry

**UNIT IV**                                                         **9 Hours**
**HYDRAULIC SYSTEMS AND TRACTOR MECHANICS**
Hydraulic system - principle of operation, types, main functional components, functional requirements; familiarization with the hydraulic system - automatic draft and position control; tractor power outlets - PTO, PTO standards, types and functional requirements; wheels and tyres - solid tyres and pneumatic tyres, bias ply and radial ply tyres, tyre construction and tyre specifications; tractor mechanics - forces acting on the tractor in static and dynamic mode; determination of CG of a tractor and moment of inertia of a tractor; tractor static equilibrium, tractor stability especially at turns

**UNIT V**                                                         **7 Hours**
**POWER TILLER AND TRACTOR TESTING**
Power tiller - types, application, functional components and attachments; types of tests - test procedure - need for testing and evaluation of farm tractor and power tiller; test code for performance testing of tractors and power tillers - RNAM, BIS, etc.

**1**                                                         **2 Hours**
**EXPERIMENT 1**
To study internal combustion engine components

**2**                                                         **3 Hours**
**EXPERIMENT 2**
To study four stroke cycle engines

**3**                                                         **2 Hours**
**EXPERIMENT 3**
To dismantle, clean and reassemble a dry type of air cleaner

**4**                                                         **3 Hours**
**EXPERIMENT 4**
To dismantle, clean and reassemble a wet type air cleaner

**5**                                                         **2 Hours**
**EXPERIMENT 5**
To remove, inspect and reinstall clutch assembly in a tractor
**6**                                                         **3 Hours**
**EXPERIMENT 6**
To dismantle, inspect and clean and reinstall the P.T.O shaft

**7**                                                         **3 Hours**
**EXPERIMENT 7**
Servicing and assembly of cooling system components

**8**                                                                          **2 Hours**
**EXPERIMENT 8**
Study of Gear transmission train - clutch - dismantling, inspection and reconditioning – adjustment

**9**                                                                          **2 Hours**
**EXPERIMENT 9**
Dismantling of transmission system-assembly of gear box, differential and final drive

**10**                                                                         **3 Hours**
**EXPERIMENT 10**
Brake and its adjustment-Steering system - assembly and adjustment-wheel tread adjustment

**11**                                                                         **2 Hours**
**EXPERIMENT 11**
Study of tyres, rims and balancing methods of a tractor

**12**                                                                         **3 Hours**
**EXPERIMENT 12**
Operation of tractors and power tillers

**Total: 75 Hours**

**Reference(s)**

1. Liljedahl J B and Others. Tractors and Their Power Units., CBS Publisher New Delhi

2. Michal AM and Ojha TP. Vol I. Principles of Agricultural Engineering. Jain Brothers, New Delhi

3. Jain SC and CR Rai. Farm Tractor Maintenance and Repair

## 22AG502 UNIT OPERATIONS IN AGRICULTURAL
## PROCESS ENGINEERING                 3 0 2 4

**Course Objectives**

To introduce scope, importance and key concepts of agro processing

To expose the fundamentals of various unit operations of processing industries such as evaporation, concentration, mechanical separation, size reduction equipment, etc.

Acquire the knowledge on distillation, membrane separation needed for the extraction of liquid fuels such as ethanol, methanol, etc.

**Course Outcomes (COs)**

1. Examine the evaporation process and types of evaporators for food industry
2. Analyze the principles of filtration and mechanical separation equipment
3. Identify size reduction and grinding equipment and understand the factors affecting the process
4. Identify the gas-liquid and solid-liquid equilibrium concepts and factors influencing equilibrium separation process
5. Differentiate crystallization and distillation processes and identify processing equipment

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | - | | 1 | | 1 | | | | | | | 2 | |
| 2 | | 3 | 2 | 1 | | | 1 | | | | | | | | |
| 3 | 2 | 1 | 3 | | | | 1 | | | | | | | 1 | |
| 4 | 2 | 1 | | 3 | | | 1 | | | | | | | 1 | |
| 5 | 2 | 1 | 1 | 3 | | | 1 | | | | | | | 1 | |

**UNIT I**                                                                      **8 Hours**
**EVAPORATION AND CONCENTRATION**
Unit operations in food processing - conservation of mass and energy - overall view of an engineering process- dimensions and units - dimensional and unit consistency - dimensionless ratios-evaporation - definition - liquid characteristics - single and multiple effect evaporation- types of evaporators performance of evaporators and boiling point elevation - capacity - economy and heat balance - evaporation of heat sensitive materials

**UNIT II**                                                                     **8 Hours**
**MECHANICAL SEPARATION**
Filtration - definition - filter media - types and requirements-constant rate filtration constant pressure filtration - filter cake resistance-filtration equipment - rotary vacuum filter - filter press sedimentation - gravitational sedimentation of particles in a fluid - Stokes law, sedimentation of particles in gas-cyclones - settling under sedimentation and gravitational sedimentation-centrifugal separations -   rate of separations - liquid-liquid separation - centrifuge equipment

**UNIT III** **8 Hours**
**SIZE REDUCTION AND MIXING**
Size reduction - grinding and cutting - principles of comminuting - characteristics of comminuted products - particle size distribution in comminuted products-energy and power requirements in comminuting - crushing efficiency - Rittingers, Bonds and Kicks laws for crushing-size reduction equipment - crushers - jaw crusher, gyratory crusher-crushing rolls - grinders - hammer mills-rolling compression mills - attrition, rod, ball and tube mills - construction and operation. Mixing -Characteristics of mixtures - Measurement of mixing sample size sample compositions - Particle mixing - mixing index - Rates of Mixing - mixing times - Energy Input in Mixing equipment

**UNIT IV** **11 Hours**
**CONTACT EQUILIBRIUM SEPARATION**
Contact equilibrium separation processes - concentrations - gas-liquid and solid-liquid equilibrium - equilibrium concentration relationships - operating conditions-calculation of separation in contact equilibrium processes-gas absorption - rate of gas absorption - stage - equilibrium gas absorption and equipment- properties of tower packing - types - construction - flow through packed towers-extraction - rate of extraction stage equilibrium extraction-equipment for leaching coarse solids intermediate solids - basket extractor- extraction of fine material - Dorr agitator - continuous leaching decantation systems - extraction towers- washing equipment

**UNIT V** **10 Hours**
**CRYSTALLIZATION AND DISTILLATION**
Crystallization - equilibrium -solubility and equilibrium diagram - rate of crystal growth equilibrium crystallization-crystallization equipment - classification - construction and operation-tank, agitated batch, Swenson-Walker vacuum crystallizers-distillation - binary mixtures - flash and differential distillation-steam distillation - theory - consumption - continuous distillation with rectification - vacuum distillation - batch distillation - operation and process - advantages and limitations - azeotropic distillation-distillation equipment - construction and operation - factors influencing the operation

**FOR FURTHER READINGS**
Unit operations involved in various food processing

**1** **3 Hours**
**EXPERIMENT 1**
Determination of thermal efficiency and economy of evaporator

**2** **3 Hours**
**EXPERIMENT 2**
Determination of separation efficiency of centrifugal separator

**3** **3 Hours**
**EXPERIMENT 3**
Determination of collection efficiency in cyclone separator

**4** **3 Hours**
**EXPERIMENT 4**
Determination of efficiency of liquid-solid separation by filtration
**5** **3 Hours**
**EXPERIMENT 5**
Performance evaluation of a sieve and determination of particle size of granular foods by sieve analysis

**6**                                                                                            **4 Hours**
**EXPERIMENT 6**
Determination of energy requirement in size reduction using the burr mill and pin mill

**7**                                                                                            **4 Hours**
**EXPERIMENT 7**
Determination of energy requirement in size reduction using the ball mill and hammer mill

**8**                                                                                            **3 Hours**
**EXPERIMENT 8**
Determination of mixing index for solids

**9**                                                                                            **4 Hours**
**EXPERIMENT 9**
Determination of economy and thermal efficiency of rotary flash evaporator for concentration of juice

**Total: 75 Hours**

**Reference(s)**

1. Geankoplis,C.J., Transport Process and Unit Operations, Prentice-Hall of India Private Limited, New Delhi, 1999
2. Coulson,J.M. and J.F. Richardson, Chemical Engineering, Volume I to V. The Pergamon Press, New York, 1999

**22AG503 SOIL AND WATER CONSERVATION
ENGINEERING**                                                   **3 1 0 4**

**Course Objectives**

> To acquire the fundamental understanding of soil conservation practices and erosion control structures
>
> To develop skills on water conservation and harvesting
>
> To provide knowledge on watershed development and management

**Course Outcomes (COs)**

1. Identify the causes of soil erosion, types of soil erosion and assess the total soil loss for watershed
2. Compare the agronomic and mechanical measures for controlling soil erosion
3. Design the gully control structures for controlling the landslides
4. Design the hydraulic structures for water diversion and storage
5. Infer the concepts of water harvesting with respect to land use and farming practices

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | | 2 | | 3 | | 1 | 1 | | 1 | | | | | | 1 |
| 2 | 3 | 2 | | 3 | | 1 | | | | | | | 1 | | 1 |
| 3 | 2 | | | 2 | | | | | | | | | | | 2 |
| 4 | - | 2 | | 3 | | | 1 | | | | | | | | 2 |
| 5 | | | 3 | 2 | | | 1 | | | | | | 1 | | 3 |

**UNIT I**                                                                        **10 Hours**
**EROSION TYPES AND CONTROL**
Introduction; soil erosion - causes, types and agents of soil erosion; water erosion - forms of water erosion, mechanics of erosion; gullies and their classification, stages of gully development; soil loss estimation - universal soil loss equation and modified soil loss equation, determination of their various parameters, wind erosion - factors affecting wind erosion, mechanics of wind erosion, soil loss estimation, wind erosion control measures - vegetative, mechanical measures, wind breaks & shelter belts, sand dunes stabilization

**UNIT II**                                                                        **8 Hours**
**EROSION CONTROL STRUCTURES**
Introduction; classification of structures, functional requirements of soil erosion control structures; flow in open channels-types of flow, state of flow, regimes of flow, energy and momentum principles, specific energy and specific force; hydraulic jump and its application, type of hydraulic jump, energy dissipation due to jump, jump efficiency, relative loss of energy; runoff measuring structures-Parshall flume, H - flume and weirs

**UNIT III**                                                                       **9 Hours**
**DROP SPILLWAY**
Straight drop spillway - general description, functional use, advantages and disadvantages, structural parts and functions; components of spillway, hydrologic and hydraulic design, free board and wave free board, aeration of weirs, concept of free and submerged flow, structural design of a drop spillway-loads on headwall, variables affecting equivalent fluid pressure, determination of saturation line for different flow conditions, seepage under the structure, equivalent fluid pressure of triangular load diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension

**UNIT IV**                                                                                                    **10 Hours**
**CHUTE SPILLWAY**
chute spillway general description and its components, hydraulic design, energy dissipaters, design criteria of a SAF stilling basin and its limitations, drop inlet spillway- general description, functional use, design criteria; design of diversions; small earth embankments-their types and design principles, farm ponds and reservoirs, cost estimation of structures

**UNIT V**                                                                                                       **8 Hours**
**WATER HARVESTING**
Land use capability classification; grassed water ways and their design; introduction to water harvesting techniques, Farm pond, Dry farming techniques for improving crop production

**FOR FURTHER READING**
Applications- Basic      agronomical  measures - Grassland management - watershed development wasteland development - case studies

**Total: 45 + 15 (tutorial) = 60 Hours**

**Reference(s)**

1. R. Suresh, Soil and Water Conservation Engineering, Standard Publishers & Distributors, New Delhi, 2000.

2. Ghanshyam Das, Hydrology and Soil Conservation Engineering Prentice-Hall of India Pvt Ltd., New Delhi, 2000

3. Glenn and O. Schwab, Soil and water Conservation Engineering, John Wiley and sons, New York, 1981

4. B.C., Mal, Introduction to soil and water Conservation Engineering, Kalyani Publishers, New Delhi, 2002.

5. Gurmel Singh et al, Manual of soil and water conservation practices. Oxford & IBH Publishing Co, New Delhi, 1996.

6. A.M. Michael, and T.P. Ojha, Principles of Agricultural Engineering Vol II Jain Brothers, New Delhi, 1980

## 22AG504 RENEWABLE ENERGY SOURCES     3 0 2 4

### Course Objectives

To acquire knowledge about the fundamentals of renewable energy resources

To understand the concepts and conversion systems in harnessing

To apply the above concepts in meeting the energy needs in farm

### Course Outcomes (COs)

1. Predict the energy scenario and status of renewable energy sources and production in India
2. Apply the thermal conversion technologies for agro-products
3. Determine the potential of solar energy production
4. Use wind energy conversion system to meet the energy requirements of farms
5. Demonstrate energy conversion and energy auditing for agricultural farms

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 1 | | | | 3 | 1 | 2 | | | | | | | | 1 |
| 2 | 1 | 3 | | 2 | 2 | | 2 | | | | | | | | 2 |
| 3 | 1 | 2 | 3 | 1 | 1 | | 1 | | | | | | | | 3 |
| 4 | 1 | 3 | 2 | 2 | 1 | | 2 | | | | | | | | 2 |
| 5 | 1 | 2 | 3 | 1 | 1 | | 2 | | | | | | | | 3 |

### UNIT I     10 Hours
### RENEWABLE ENERGY SOURCES
Classification of energy sources; Introduction to renewable energy sources; characterization of biomass; types, construction, working principle, Biomass Combustion Technology, Gasifiers Technology, Biomass Gasification Methods, Removal of tar and impurities from gasification, Principles of pyrolysis and methods

### UNIT II     8 Hours
### BIOCHEMICAL CONVERSION TECHNOLOGY-BIOGAS AND BIO FUELS
Importance of biofuels, Biogas technology, Biogas plants types, Microbiology of biogas production, Size and selection for Biogas plant, Biogas plant- materials and methods for Construction. Bio-Fuels and characteristics, Bio-Diesel, Bio-Diesel production processes, Bio-Ethanol Production, BEA, running of biofuel engines

### UNIT III     10 Hours
### SOLAR ENERGY CONVERSION SYSTEM
Solar radiation, insolation, Solar thermal - concentrating & non- concentrating collectors- types reflectors - solar thermal power stations principle and applications - solar stills- types- solar pond performance- characteristics applications. Basics of Solar Photovoltaics, Recent trends in solar drying-solar tunnel drier, Solar Driers, Solar PV and water pumping, Solar Water Heater

### UNIT IV     8 Hours
### WIND ENERGY CONVERSION SYSTEM
Nature of wind - wind structure and measurement - wind power laws, Wind mill - classification - power curve. Upwind and downwind systems, Wind energy conversion principles, Wind mill- aero generator, Wind mill- water pumping

**UNIT V**                                                                                                    **9 Hours**
**HYDRO AND OCEAN ENERGY CONVERSION SYSTEM AND ENERGY AUDITING**
Hydropower energy sources; hydropower types, sustainability; ocean energy conversion system, ocean thermal energy conversion system - thermodynamic efficiency - cycle type environment effect - technical difficulties; energy auditing - carbon foot print

**FOR FURTHER READING**
Energy Auditing and Management

**1**                                                                                                        **3 Hours**
**EXPERIMENT 1**
Problems on solar time, basic earth sun angles

**2**                                                                                                        **2 Hours**
**EXPERIMENT 2**
Study of radiation measuring instruments - Visit to meteorology station

**3**                                                                                                        **4 Hours**
**EXPERIMENT 3**
Solving problems on thermal losses and efficiency of flat plate collectors and concentrator

**4**                                                                                                        **4 Hours**
**EXPERIMENT 4**
Determination of thermal efficiency of natural convection and forced convection solar dryer

**5**                                                                                                        **3 Hours**
**EXPERIMENT 5**
Determination of thermal efficiency of solar still

**6**                                                                                                        **3 Hours**
**EXPERIMENT 6**
Study of photovoltaic cell characteristics

**7**                                                                                                        **3 Hours**
**EXPERIMENT 7**
Study on the performance of wind generator in the lab

**8**                                                                                                        **3 Hours**
**EXPERIMENT 8**
Performance evaluation of a SPV water pumping system

**9**                                                                                                        **3 Hours**
**EXPERIMENT 9**
Wind Energy conversion calculations for power generation

**10**                                                                                                          **2 Hours**

**EXPERIMENT 10**

Study of wind measuring instruments

                                                                                                    **Total: 75 Hours**

**Reference(s)**

1.  H. P. Garg, Treatise on Solar Energy, Vol.1 : Fundamentals of solar energy, John Wiley & sons Ltd, 1982

2.  A.John. Duffie and William A. Beckman, Solar Engineering of Thermal Processes, 4th Edition ISBN: 978-0-470-87366-3, John Wiley and Sons Ltd, 2013

3.  Jui Sheng Hsieh, Solar Energy Engineering, Prentice Hall, London

4.  H.P. Garg, Advances in Solar Energy Technology Volume 2, Industrial Applications of Solar Energy, ISBN: 978-94-010-8188-7 (Print), Springer Publications. 1987

5.  Solanki Chetan Singh, Solar Photovoltaics: Fundamentals, Technologies and Applications, Prentice- Hall Of India Pvt. Limited, 2009

6.  J.F.Manwell, J.G. McGswan and A.L.Rogers, Wind Energy Explained. Theory, Design and Application, John Wiley and Sons Ltd, 2004

**22AG507 MINI PROJECT I**                                    **0 0 2 1**

**Course Objectives**

Identify the problem statement and apply the engineering concepts to find the solution

Improve the analyzing capability of the students

Increase the exuberance in finding the solution to various problems

**Course Outcomes (COs)**

1. Formulate a real-world problem, identify the requirement, and develop the design solutions
2. Choose the technical ideas, strategies, and methodologies
3. Find 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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 1 | 1 | 2 | | | 2 | 2 | 2 | - | 1 | 1 | 1 | 1 |
| 2 | 1 | 2 | 1 | 1 | 2 | | | 2 | 2 | 2 | - | 1 | 1 | 1 | 1 |
| 3 | 1 | 2 | 1 | 1 | 2 | | | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| 4 | 1 | 2 | 1 | 1 | 2 | | | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| 5 | 1 | 2 | | | 2 | | | 2 | 2 | 2 | - | 1 | 1 | 1 | 1 |

**Total: 30 Hours**

## 22AG601 FARM IMPLEMENTS AND EQUIPMENT          3 0 2 4

**Course Objectives**

To learn about the different types of primary and secondary tillage implements, farm equipment and different ploughing methods

To know about the tools and techniques used for a wide variety of different types of farming operations and landscaping

To utilize the power tools and mounted implements with the tractor

**Course Outcomes (COs)**

1. Infer the status of farm mechanization based on technical and economic factors
2. Identify the primary tillage implements and functions
3. Compare the secondary tillage implements and functions
4. Assess the technical features and functionalities of sowing and intercultural implements
5. Select specialized farm implements including harvesters and threshers based on their test results

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 3 | 2 | 1 | 1 | | 2 | | | | | | | 1 | | |
| 2 | 3 | 1 | 1 | | 2 | 2 | | | | | | | 1 | | |
| 3 | 3 | 2 | 1 | 2 | | 2 | | | | | | | 1 | | |
| 4 | 3 | 1 | 1 | | | 2 | | | | | | | | 2 | |
| 5 | 3 | | 2 | | | 1 | | | | | | | 1 | 2 | |

**UNIT I**                                                                        **9 Hours**
**FARM MECHANIZATION**
Introduction to farm mechanization-objectives. Classification of farm machines. Tillage - objectives - methods - primary tillage implements - secondary tillage implements - animal drawn ploughs - construction. Identification and selection of machines for various operations on the farm. Hitching systems and controls of farm machinery. Types of farm implements - trailed, mounted and semi mounted implements. Calculation of field capacities and field efficiency. Calculations for economics of machinery usage, comparison of ownership with hiring of machines.

**UNIT II**                                                                       **9 Hours**
**PRIMARY TILLAGE IMPLEMENTS**
Mould board plough- attachments - mould board shapes and types. Forces acting on tillage tool- mould board plough. Disc plough - force representation on disc - Types of disc ploughs - Subsoiler, chisel plough - Rotary plough - spading machine - coir pith applicators.

**UNIT III**                                                                      **9 Hours**
**SECONDARY TILLAGE IMPLEMENTS**
Cultivators - types - construction - adjustments. Disc harrows - Bund former - ridger - leveller. Basin lister - Wetland preparation implements - puddler - cage wheel - leveller. Hitch systems - vertical and horizontal hitching of pull type and mounted implements- force analysis on trailed, mounted and semi mounted implements.

**UNIT IV** **9 Hours**
**SOWING AND INTERCULTURAL EQUIPMENT**
Crop planting - methods - row crop planting systems. Seeding machines- Devices for metering seeds - furrow openers - furrow closers - types - Types of seed drills and planters-seed drill calibration - application of fertilizers - metering devices - seed cum fertilizer drill - application of liquid fertilizers. Plant protection equipment - sprayer - classification - types - duster - types - weeders - manual, power operated - wet, dry land.

**UNIT V** **9 Hours**
**HARVESTING, THRESHING AND TESTING OF FARM IMPLEMENTS**
Combine harvester - paddy, sugarcane, maize - grains harvester - thresher - multi crop thresher - digger - tapioca, potato, onion - cotton picker, groundnut harvester - fruit harvesting equipment. Testing of primary tillage equipment - MB plough, disc, chisel and sub soiler plough. Testing of secondary tillage equipment - cultivator, rotavator, disc harrow, testing of seed cum fertilizer drill, planter, sprayer.

**1** **4 Hours**
**EXPERIMENT 1**
Operation of a tractor drawn mould board plough - adjustments - determination of field capacity

**2** **2 Hours**
**EXPERIMENT 2**
Operation of a tractor drawn disc plough - adjustments - determination of field capacity

**3** **2 Hours**
**EXPERIMENT 3**
Hitching of mounted implements to the tractor and ploughing with mounted implements

**4** **4 Hours**
**EXPERIMENT 4**
Operation of tractor drawn cultivator - adjustments- and determination of field capacity

**5** **2 Hours**
**EXPERIMENT 5**
Operation of a subsoiler - adjustments - determination of field capacity

**6** **2 Hours**
**EXPERIMENT 6**
Experiment on Calibration of seed drills

**7** **2 Hours**
**EXPERIMENT 7**
Operation of seed planter and centrifugal broadcasting device in the field

**8** **2 Hours**
**EXPERIMENT 8**
Operation and evaluation of dry land weeders and power operated weeder

**9**                                                                                                    **4 Hours**
**EXPERIMENT 9**
Dismantling, parts identification and assembly of different components of knapsack power sprayer and duster.

**10**                                                                                                   **3 Hours**
**EXPERIMENT 10**
Field-testing of rocker arm sprayer, power sprayer and boom sprayer

**11**                                                                                                   **3 Hours**
**EXPERIMENT 11**
Determination of operational cost of farm implements

**Total: 75 Hours**

**Reference(s)**

1.   Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery, CBS Publisher Delhi

1.   Michal AM and Ojha TP. Vol I. Principles of Agricultural Engineering. Jain Brothers, New Delhi.

## 22AG602 POST-HARVEST TECHNOLOGY                3 0 2 4

**Course Objectives**

To understand better the processing of cereals, pulses, oil seeds and horticultural crops

To know the physical and thermal properties of grains

To understand in-depth knowledge on the theory, methods, and equipment for the various unit operations of crop processing

**Course Outcomes (COs)**

1. Identify different engineering properties of agricultural products and assess their importance
2. Infer the working principles of grain cleaning and grading devices and select suitable equipment for cereal grains, oilseeds, and pulses
3. Assess the performance of conveying and storage systems used for agricultural products for better processing
4. Classify various methods for processing of the cereals, pulses, and oil seeds based on their properties
5. Justify the post-harvest operations for horticultural crops to increase the market value of food products

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | | | | 3 | 1 | 2 | | | | | | 1 | 2 | |
| 2 | 1 | 3 | | 2 | 2 | | 2 | | | | | | | 2 | |
| 3 | 1 | 2 | 3 | 1 | 1 | | 1 | | | | | | | 2 | |
| 4 | 1 | 3 | 2 | 2 | 1 | | 2 | | | | | | | 2 | |
| 5 | 1 | 2 | 3 | 1 | 1 | | 2 | | | | | | | 3 | |

**UNIT I**                                                    **8 Hours**
**INTRODUCTION**
Post-harvest engineering: introduction, objectives, post-harvest losses of cereals, pulses and oilseeds, importance, optimum stage of harvest. Threshing: traditional methods, mechanical threshers: types, principles and operation. Engineering properties of food materials, moisture content measurement: direct and indirect methods, moisture meters, equilibrium moisture content

**UNIT II**                                                    **10 Hours**
**CLEANING, GRADING AND DRYING**
Principles, air screen cleaners: types, adjustments. Cylinder separator, spiral separator, magnetic separator, colour sorter, inclined belt separator, length separators, effectiveness of separation and performance index. Different types of graders for cereals, pulses and oil seed crops. Drying: moisture content and water activity; Free, bound and equilibrium moisture content, isotherm, hysteresis effect, EMC determination, driving principles and theory, Thin layer and deep bed drying analysis, falling rate and constant rate drying periods, maximum and decreasing drying rate period, drying equations, Dryer performance, Different methods of drying, types of grain dryers: dryers: bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray

**UNIT III**                                                                                            **9 Hours**
**MATERIAL HANDLING AND STORAGE**
Material handling: belt conveyor, screw conveyor, chain conveyor, bucket elevators, pneumatic conveying. Direct and indirect types of damages, sources of infestation, traditional and modern types of storage structures: vertical, horizontal and underground storages, storage structure designs. Hermetic storage, controlled atmospheric storage and modified atmospheric storage.

**UNIT IV**                                                                                            **9 Hours**
**PROCESSING OF CEREALS, PULSES AND OILSEEDS**
Paddy processing: parboiling of paddy, methods, merits and demerits, dehusking of paddy: methods, merits and demerits; rice polishers: types, constructional details, polishing, layout of modern rice mill, performance evaluation of modern mills. Wheat milling, pulse milling methods. Oil seed processing, Sugarcane crushing, extraction recovery and processing of jaggery. Principles and operation: maize sheller, husker sheller for maize, groundnut decorticator, castor sheller.

**UNIT V**                                                                                             **9 Hours**
**PROCESSING OF FRUITS AND VEGETABLES**
Importance of processing of fruits and vegetables. Important characteristics and properties of fruits and vegetables for processing, cleaning and grading of fruits and vegetables. Electronic colour sorting of fruits and vegetables. Unit operation of fruit processing: blanching of fruits and vegetables, size reduction, thermal processing. Dryers for fruits and vegetables, Osmo-dehydration. Different types of packaging materials commonly used for raw and processed fruits and vegetables products, handling and transportation of fruits and vegetables, Minimal processing, Common methods of storage. Preparation of different finished products from fruits and vegetables.

**FOR FURTHER READING**
Project preparation - Solar drying of grains-agro processing industries - Value added products from agricultural products -By products utilization

**1**                                                                                                  **3 Hours**
**EXPERIMENT 1**
Determination of moisture content of grains by oven-dry method and draw the drying characteristic curves

**2**                                                                                                  **4 Hours**
**EXPERIMENT 2**
Determination of size, true density, bulk density and porosity of grains

**3**                                                                                                  **4 Hours**
**EXPERIMENT 3**
Determination of coefficient of friction and angle of repose of different grains

**4**                                                                                                  **3 Hours**
**EXPERIMENT 4**
Determination of shelling efficiency of groundnut decorticator

**5**                                                                                                  **4 Hours**
**EXPERIMENT 5**
Performance evaluation of paddy parboiling, rubber roll sheller and cone polisher

**6** **4 Hours**

**EXPERIMENT 6**
Evaluation of thermal efficiency and heat utilization factor in a grain drier


**7** **4 Hours**

**EXPERIMENT 7**
Evaluation of efficiency of a grain cleaning cum grading machine


**8** **4 Hours**

**EXPERIMENT 8**
Determining the oil content of oil seeds using Soxhlet apparatus

**Total: 75 Hours**


**Reference(s)**

1. McCabe, W.L. , J.C. Smith, and P. Harriott. Unit Operations in Chemical Engineering, 7th Edition. McGraw Hill Kogakusha Ltd, Tokyo, 2017

2. Chakraverty, A. Post Harvest Technology of cereals, pulses and oilseeds. 3rd Edition. Oxford & IBH publishing Co. Ltd., New Delhi.2019

3. Sahay, K.M. and Singh, K.K. Unit operations of Agricultural Processing. Vikas Publishing house Pvt. Ltd. New Delhi.1994

4. Earle, R.L. 2003. Unit Operations in Food Processing. Pergamon Press. Oxford. U.K.

5. Henderson, S.M., and Perry, R. L. Agricultural Process Engineering, Chapman and hall, London. 1955

6. Singh, R. Paul. and Heldman, R.Dennis. Introduction to Food Engineering. 3rd Edition. Academic Press, London. 2004

## 22AG603 IRRIGATION AND DRAINAGE ENGINEERING 　　　3 0 2 4

**Course Objectives**

To acquire a fundamental understanding of different irrigation methods

To learn about the importance of drainage in crop production and the need to control water logging and salinization

To develop skills on design of different irrigation and drainage systems

To gain the knowledge on management of irrigation and drainage systems

**Course Outcomes (COs)**

1. Assess the development and utilization of water resources in India as well as Tamil Nadu and estimate the water demands for various crops

2. Determine irrigation requirements of crops and plan the irrigation schedule for different crops considering irrigation efficiencies.

3. Compare different methods of surface irrigation and their adaptability to the specific characteristics of soil, topography and crops

4. Infer the technical features of agricultural drainage systems and design criteria for its various components

5. Design, monitor and maintain the surface and subsurface drainage systems for controlling the salinity and water logging in the agricultural area

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 3 | 2 | 2 | 1 | 1 | | | | | | 1 | | | 1 |
| 2 | 2 | 3 | 2 | 2 | 1 | 1 | | | | | | 1 | | | 2 |
| 3 | 1 | 2 | 3 | 2 | 2 | | | | | | | | | | 3 |
| 4 | 2 | 2 | 3 | 1 | | | | | | | | 2 | | | 2 |
| 5 | 2 | 1 | 3 | 2 | | | | | | | | 1 | | | 1 |

**UNIT I** 　　　　　　　　　　　　　　　　　　　　　　　　　　　　　**9 Hours**
**IRRIGATION WATER AND ITS MEASUREMENT**
Irrigation, impact of irrigation on Human Environment, some major and medium irrigation schemes of India, purpose of irrigation, sources of irrigation water, present status of development and utilization of different water resources of the country, Measurement of irrigation water, weir, notches, flumes and orifices and other methods, Economics of water resources utilization.

**UNIT II** 　　　　　　　　　　　　　　　　　　　　　　　　　　　　　**9 Hours**
**IRRIGATION REQUIREMENT**
Soil water plant relationship, soil water movement, infiltration, evapotranspiration, soil moisture constants, depth of irrigation, frequency of irrigation, water conveyance, underground pipe conveyance system, channel lining, irrigation efficiencies.

**UNIT III** 　　　　　　　　　　　　　　　　　　　　　　　　　　　　　**9 Hours**
**METHODS OF IRRIGATION**
Surface irrigation methods of water application, border, check basin, furrow and contour irrigation; sprinkler and drip irrigation method, merits, demerits, selection and design

**UNIT IV**                                                                                                                           **9 Hours**
**AGRICULTURAL DRAINAGE SYSTEM**
Drainage, objectives of drainage, familiarization with the drainage problems of the state, Surface drainage, drainage coefficient, types of surface drainage, design of open channel, sub-surface drainage purpose and benefits, investigations of design parameters, hydraulic conductivity, drainage porosity, water table etc., types and use of subsurface drainage system, Design of surface drains, interceptor and relief drains. Derivation of ellipse (Hooghoudts) and Ernsts drain spacing equations.

**UNIT V**                                                                                                                              **9 Hours**
**DESIGN OF AGRICULTURAL DRAINAGE SYSTEM AND SALT BALANCE**
Design of subsurface drainage system. Drainage materials, drainage pipes, drain envelope. Layout, construction and installation of drains. Drainage structures. Vertical drainage. Bio-drainage. Tile Drains. Drainage of irrigated and humid areas. Salt balance, reclamation of saline and alkaline soils. Leaching requirements, conjunctive use of fresh and saline waters. Economic aspects of drainage.

**FOR FURTHER READING**
GIS- concept-use of GIS for identifying the areas that need drainage-design of drainage systems based on the data obtained through remote sensing from satellites.

**1**                                                                                                                                  **3 Hours**
**EXPERIMENT 1**
Study of River basins, irrigation projects, irrigation tanks and water resources in Tamil Nadu

**2**                                                                                                                                  **3 Hours**
**EXPERIMENT 2**
Determination of soil moisture by different methods -gravimetric and tensiometer, block and neutron probe method

**3**                                                                                                                                  **3 Hours**
**EXPERIMENT 3**
Problems on duty of water - Duty and delta relationship

**4**                                                                                                                                  **3 Hours**
**EXPERIMENT 4**
Estimation of water requirement by different methods

**5**                                                                                                                                  **3 Hours**
**EXPERIMENT 5**
Estimation of Evapotranspiration

**6**                                                                                                                                  **3 Hours**
**EXPERIMENT 6**
Land Levelling Plane method from climatologically data

**7**                                                                                                                                  **3 Hours**
**EXPERIMENT 7**
Determination of irrigation efficiencies and design of basin and furrow irrigation systems

**8**                                                   **3 Hours**

**EXPERIMENT 8**

Problems on irrigation efficiencies and design of border irrigation systems

**9**                                                   **3 Hours**

**EXPERIMENT 9**

Design of Basin and Furrow irrigation Problems

**10**                                                   **3 Hours**

**EXPERIMENT 10**

Design of underground pipeline system

                                                  **Total: 75 Hours**

**Reference(s)**

1.  A.M.Michael, 2010. Irrigation - Theory and practice, Vikas publishers, New Delhi.

2.  V. Ravikumar., M.V.Ranghaswami, K.Appavu and S.Chellamuthu, 2011, Microirrigation& Irrigation Pumps, Kalyani publishers, Ludhiana

3.  Michael Raviv and J.Heinrich Lieth. ,2013, Soil less culture, Theory and Practice, Elsevier

4.  Jack Keller and Rond Bleisner 1990. Sprinkler and Trickle irrigation, Van Nostrand Reinhold, New York.

5.  P.N Modi, and S.M Seth, 2010, Hydraulics and fluid mechanics, Standard book house

**22AG607    MINI PROJECT II    0 0 2 1**

**Course Objectives**

Identify the problem statement and apply the engineering concepts to find the solution

Improve the analyzing capability of the students

Increase the exuberance in finding the solution to various problems

**Course Outcomes (COs)**

1. Formulate a real-world problem, identify the requirement, and develop the design solutions
2. Choose the technical ideas, strategies, and methodologies
3. Find 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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 1 | 1 | 2 | | | 2 | 2 | 2 | - | | 1 | 1 | 1 |
| 2 | - | - | 1 | 1 | 2 | | | 2 | 2 | 2 | - | | 1 | 1 | 1 |
| 3 | - | - | 1 | 1 | 2 | | | 2 | 2 | 2 | 2 | | 1 | 1 | 1 |
| 4 | - | - | 1 | 1 | 2 | | | 2 | 2 | 2 | 2 | | 1 | 1 | 1 |
| 5 | - | - | | | 2 | | | 2 | 2 | 2 | - | | 1 | 1 | 1 |

**Total: 30 Hours**

**22AG701      REMOTE SENSING AND GIS APPLICATIONS          2 0 2 3**

**Course Objectives**

To introduce the students to the basic concepts and principles of various components of remote sensing

To study the applications of Remote Sensing and GIS in agriculture, soil and water resources

To understand in-depth the knowledge on the theory, methods, and equipment for the various unit operations of crop processing

**Course Outcomes (COs)**

1. Compare different electromagnetic radiations and assess their applications in remote sensing systems and satellite data processing
2. Assess the methods and tools for remote sensing-based digital image processing
3. Infer the features and advantages of Geographic Information System (GIS) geospatial data analysis
4. Select various tools and techniques available for geospatial data analysis using GIS platform
5. Justify the applications of RS and GIS tools for natural resource management

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | | | 3 | | | 1 | | | | | 1 | 1 | | |
| 2 | 2 | | | 3 | | | 1 | | | | | | | | 2 |
| 3 | 1 | | 2 | 3 | | | 2 | | | | | | | 2 | |
| 4 | | | | 3 | | | | | | | | - | 3 | | 2 |
| 5 | | | | 3 | | | | | | | | 2 | 1 | | 3 |

**UNIT I**                                                                                          **6 Hours**
**BASICS OF REMOTE SENSING**
Definition of remote sensing and its components -Electromagnetic spectrum - wavelength regions important to remote sensing - Wave theory, Particle theory, Stefan-Boltzmann and Wein Displacement Law -Atmospheric scattering, absorption - Atmospheric windows - spectral signature concepts - typical spectral reflective characteristics of water, vegetation and soil. Types of platforms - orbit types, Sun-synchronous and Geosynchronous - Passive and Active sensors. Indian Space Program, Sensor characteristics LANDSAT, SPOT, ERS, IKONOS, IRS and others.

**UNIT II**                                                                                         **6 Hours**
**IMAGE INTERPRETATION AND ANALYSIS**
Types of Data Products - types of image interpretation - basic elements of image interpretation –visual interpretation keys - Digital Image Processing – Pre-processing - image enhancement techniques - multispectral image classification - Supervised and unsupervised.

**UNIT III**                                                                                        **6 Hours**
**GEOGRAPHIC INFORMATION SYSTEM**
Introduction to Maps - Definitions - Basic components of GIS - Map projections and co-ordinate system - Spatial data structure- raster, vector - Spatial Relationship - Topology - Geodatabase models- hierarchical, network, relational, object oriented models- Data Encoding methods - encoding raster data, vector data and attribute data, linking spatial and attribute data- Integrated GIS database - Digital Elevation Modelling.

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

**GEOSPATIAL ANALYSIS**

Thematic mapping - Geospatial Measurements, query analysis, buffering, overlay operations, network analysis, DEM, DSM, DTM, Interpolation – Geo-visualization - Object oriented GIS - Modern trends of GIS – Web GIS, 3DGIS, Real-time GIS.

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

**RS AND GIS APPLICATIONS**

Crop Acreage estimation - Estimation of Crop Water Requirement Crop condition - Soil mapping - classification of soil with digital numbers - soil erosion mapping- reservoir sedimentation using image processing - Water quality modeling - Drought monitoring - Cropping pattern change analysis. Application of Remote Sensing and GIS in Precision Agriculture - Monitor Crop Health.

**FOR FURTHER READING**

Microwave remote sensing SAR Technology and their application in Agriculture and Soils, forestry, hydrology and disaster management

**1** **3 Hours**

**EXPERIMENT 1**

Aerial and Satellite images interpretation - visual

**2** **3 Hours**

**EXPERIMENT 2**

Supervised classification practice

**3** **4 Hours**

**EXPERIMENT 3**

Unsupervised classification practice

**4** **4 Hours**

**EXPERIMENT 4**

Spatial data input and editing- Digitizing

**5** **4 Hours**

**EXPERIMENT 5**

Raster analysis problems - Database query

**6** **4 Hours**

**EXPERIMENT 6**

GIS applications in DEM and its analysis

**7** **4 Hours**

**EXPERIMENT 7**

GIS application in watershed analysis

**8** **4 Hours**

**EXPERIMENT 8**

GIS application in rainfall-runoff modeling

**Total: 60 Hours**

**Reference(s)**

1. Lillesand, T. M., and Kiefer, R.W., Remote Sensing and Image Interpretation, John Wiley and Sons, New York, 2000
2. P.A. Burrough, Principle of GIS for land resources assessment, Oxford Publications, 1990
3. Ian Heywood, an Introduction to GIS, Pearson Education, New Delhi, 2001
4. Basudeb Bhatta, Remote Sensing and GIS, II Edition, Oxford University Press, New Delhi, 2011
5. Floyd F.Sabins, Remote Sensing: Principles and Interpretation, III edition, Freeman and Company, New York, 1997
6. M.Anji Reddy, Textbook of Remote Sensing and Geographical Information System, 3rd Edition, BS Publications, 2008

## 22AG702      FOOD AND DAIRY ENGINEERING                3 0 2 4

**Course Objectives**

To acquire better understanding of the food concentration and thermal processing of foods

To know the physical and thermal properties of milk and different methods of milk processing and milk products

To gain knowledge on the theory, methods, and equipment for the various unit operations of dairy industry

**Course Outcomes (COs)**

1. Assess the physical, mechanical, thermal, rheological and electrical properties of food material and differentiate various thermal treatments for food products.

2. Compare food drying systems and assess their limitations in applying different food products

3. Assess the physical, chemical and thermal properties of milk and compare its processing techniques

4. Design various milk processing equipment and evaluate their performance

5. Assess non-thermal processing for various food products and application of Nanotechnology in food processing

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 3 | 1 | 2 | 1 | 1 | | | | | | 1 | | | 2 | |
| 2 | 2 | 1 | 3 | 2 | 1 | 1 | | | | | | | | 2 | |
| 3 | 1 | 2 | 3 | 2 | 1 | | | | | | 1 | | 1 | 1 | |
| 4 | 3 | 1 | 1 | 1 | 1 | 1 | | | | | | | 2 | 3 | |
| 5 | 1 | 2 | 1 | 1 | 1 | | | | | | 1 | | 1 | 3 | |

**UNIT I**                                                                                                              **9 Hours**
**BASIC PROPERTIES AND THERMAL PROCESSING OF FOODS MATERIALS**
Constituents of food and their energy values - rheological properties of food materials- texture of food materials -viscometry - Concentrations of foods - freeze concentration - membrane concentration -Thermal processing of foods - product-time-temperature relationships - cooking, blanching pasteurization techniques- UHT Processing - sterilization of solid and liquid foods- batch and continuous sterilization equipment-interaction of heat energy on food components - kinetics of microbial destruction - Preservation by retort processing - principles and applications - microwave and radio frequency heating in food processing- Canning- Aseptic packaging.

**UNIT II**                                                                                                            **9 Hours**
**DRYING AND DEHYDRATION**
Food spoilage - causes for spoilage -Moisture content - free moisture - bound and unbound moisture - equilibrium moisture content - Water activity - sorption behaviour of foods - types of dryers - drum, spray, Freeze drying, dryers-advantages and disadvantages - dehydration - methods of dehydration osmotic dehydration

**UNIT III**                                                                                              **9 Hours**
**MILK PROCESSING**
Physical, chemical, thermal and rheological properties of milk - storage tanks. Receiving handling and testing of milk - storage. Pasteurization - application- equipment - Low Temperature Long Time - High Temperature Short Time - Ultra High Temperature pasteurization, filling and packaging of milk and milk products

**UNIT IV**                                                                                              **9 Hours**
**DAIRY EQUIPMENT AND PRODUCTS**
Homogenization - theory and working of homogenizers - high pressure homogenization of milk and other food suspensions - design criteria for homogenizing equipment- cream separation principles - types of separators. Clarifiers - butter churns - ghee manufacture - equipment - whey manufacture- techniques -equipment - ice cream freezers - condensed milk - milk powder manufacturing drying equipment- milk products - paneer - casein - probiotic dairy products - kefir- milk plant sanitation requirements - Cleaning in place and its functions

**UNIT V**                                                                                              **9 Hours**
**NONTHERMAL PROCESSING AND NANOTECHNOLOGY**
Non-thermal and other alternate thermal processing in Food processing - Nanotechnology- History- fundamental concepts - tools and techniques. Nanomaterials - applications in food packaging and products, implications, environmental impact of nanomaterials and their potential effects on global economics, regulation of nanotechnology.

**FOR FURTHER READING**
Waste utilization and energy conservation in dairy industry - Utilization of whey for energy generation through bio-methanation, energy conservation opportunities in dairy industry and packaging of dry products

**1**                                                                                                    **3 Hours**
**EXPERIMENT 1**
Estimation of microbial load in food materials

**2**                                                                                                    **3 Hours**
**EXPERIMENT 2**
Estimation of thermal processing time and degree of sterilization in canned food using a batch sterilizer

**3**                                                                                                    **3 Hours**
**EXPERIMENT 3**
Measurement of fat globule size in milk and determination of homogenization efficiency

**4**                                                                                                    **3 Hours**
**EXPERIMENT 4**
Determination of the separation efficiency of cream separator

**5**                                                                                                    **3 Hours**
**EXPERIMENT 5**
Determination of water activity and construction of moisture sorption isotherm of food materials

**6**                                                                                                    **3 Hours**
**EXPERIMENT 6**
Determination of overall heat transfer coefficient for an evaporator used for concentration of milk.

**7**                                                                                                   **3 Hours**
**EXPERIMENT 7**
Experiment on osmotic dehydration of foods

**8**                                                                                                   **3 Hours**
**EXPERIMENT 8**
Determination of rehydration ratio of dehydrated foods and Experiment on food extruder and determination of thermal conductivity of food materials

**9**                                                                                                   **3 Hours**
**EXPERIMENT 9**
Estimate the microbial inactivation rate using UV treatment.

**10**                                                                                                  **3 Hours**
**EXPERIMENT 10**
Measurement and estimation of textural parameters of a solid food and properties of parboiled and raw rice

**Total: 75 Hours**

**Reference(s)**

1.  H.G.Kessler, Food Engineering and Dairy Technology, Freising, Germany, Verlag A.Kessler, 1981

2.  Norman N. Potter and Joseph H. Hotchkiss, Food Science, Fifth Edition, Food Science Text Series, 3. ISBN: 978-1-4613-7263-9 (Print) 978-1-4615-4985-7 (Online), 1995

3.  Gordon L. Robertson, Food Packaging- Principles and Practice Marcel Dekker Inc, USA, 1993

4.  Sukumar De, Outlines of Dairy: Technology, Oxford University Press, 2001

5.  Murlidhar Meghwal, Megh R. Goyal, Rupesh S. Chavan, Dairy Engineering; Advanced Technologies and their Applications, CRC Press, 2016.

**22AG707 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

## 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, 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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | 2 | 3 | 3 | 3 |
| 2 | 2 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | 2 | 3 | 3 | 3 |
| 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| 4 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| 5 | 2 | 2 | | | 2 | | | 3 | 3 | 3 | - | 2 | 3 | 3 | 3 |

**Total: 60 Hours**

**22AG801**          **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

**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, 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 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | 2 | 3 | 3 | 3 |
| 2 | 2 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | 2 | 3 | 3 | 3 |
| 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| 4 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| 5 | 2 | 2 | | | 2 | | | 3 | 3 | 3 | - | 2 | 3 | 3 | 3 |

**Total: 300 Hours**

## 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

**Course Outcomes (COs)**

1. Engage with the English language in functional contexts
2. Express in both descriptive and narrative formats
3. Understand 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 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 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, 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 FoundationBooks, 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

**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 | PO12 | 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

**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. Understand basic grammar and appropriate vocabulary in completing language tasks

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | 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

**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 | PO12 | PSO1 | PSO2 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| 1 |  |  |  |  |  |  |  |  | 3 | 3 |  |  |  |  |
| 2 |  |  |  |  |  |  |  |  | 3 | 3 |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  | 3 | 3 |  |  |  |  |
| 4 |  |  |  |  |  |  |  |  | 3 | 3 |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  | 3 | 3 |  |  |  |  |

**UNIT I**                                                              **9 Hours**
**SELF INTRODUCTION / DEMONSTRATIVS / NOUN MODIFIERS**
Introduction to 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

**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 understand short passages on familiar topics
5. Understand 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 | PO12 | 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 française, alphabets, les numéros, 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

**22AG001 HUMAN ENGINEERING AND SAFETY** 3 0 0 3

**Course Objectives**

To know about the importance of ergonomics

To design agricultural machinery, equipment, implements and tools that suits comfort for work

To know about the safety in design and operation of agricultural machinery

**Course Outcomes (COs)**

1. Assess the importance of ergonomics and its application in agriculture
2. Apply test procedures to take anthropometric data and measurement techniques
3. Design of controls and work space envelope
4. Apply the anthropometry in design of agricultural implements
5. Apply the safety standards at work place during various farm operations

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | | 3 | | | | 1 | | | | | 2 | 1 | 1 |
| 2 | 2 | 2 | | 3 | 1 | 2 | | | | | | | 2 | 2 | 2 |
| 3 | 2 | 2 | 3 | 3 | 2 | 1 | | 2 | | | | | 2 | 1 | 1 |
| 4 | 1 | 1 | | 3 | 2 | 2 | | 1 | | | | | 1 | 1 | 1 |
| 5 | 2 | | 3 | | 2 | 1 | | 1 | | | | | 1 | 2 | 2 |

**UNIT I** **8 Hours**
**ERGONOMICS**
Ergonomics- introduction- Role of ergonomics in Agriculture - Human metabolism- energy liberation in human body- Types of human metabolism- energy requirements at work - acceptable work load.

**UNIT II** **9 Hours**
**PHYSIOLOGICAL FUNCTION**
Human Skeletal system - muscle - structure and function - Physiological stress - Efficiency of work -Physical functions - Age and individual differences in physical functions- Physiological and operational criteria of physical activity.

**UNIT III** **9 Hours**
**ENERGY EXPENDITURE**
Energy expenditure of activities-keeping energy expenditure within bounds- Energy expenditure of Spraying-Weeding operations - Movements of body members- Strength and endurance of movements - Movement of body members related to Agricultural activities - Speed and accuracy of movements - Time and distance of movements - Reaction time.

**UNIT IV** **10 Hours**
**ANTHROPOMETRY**
Anthropometry - introduction - Types of data - Principles of applied anthrophometry - concept of percentile - Normal distribution - Estimating the range - Minimum and Maximum dimensions- Cost benefit analysis - applications of anthropometric data- Anthropometric consideration in tool - equipment design.

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

**HUMAN SAFETY**

Dangerous machine (Regulation) act, Rehabilitation and compensation to accident victims, Safety gadgets for spraying, threshing, Chaff cutting and tractor & trailer operation.

**FOR FURTHER READING**

Analysis of case studies on ergonomic study of different farm implements and machinery

**Total: 45 Hours**

**Reference(s)**

1. Sanders,M.S. and McComack,EJ. Human factors in Engineering and Des ign. Tata McGraw Hill, New York, 1992

2. Obome, David.J. Engieering Work. John Wiley and Sons Ltd., 1982

3. Astand, P.P. and Rodaid,K. Text book of Work Physiology, McGraw Hill Book Company,New York, 1970

4. Grandjean,E. Fitting the Track of the Man, Taylor and France Ltd., U.K.,1981

## 22AG002 DESIGN OF AGRICULTURAL MACHINERY         3 0 0 3

**Course Objectives**

To learn design considerations and their applications in agricultural tractors and machines

To understand the standards and procedures for designing of primary and secondary tillage implements

To understand the standards and procedures for calibration of seed drill, planter and tractor safety measures

**Course Outcomes (COs)**

1. Examine the design considerations of farm machinery and implements
2. Assess the factors affecting design and construction of primary tillage implements
3. Execute the design of secondary tillage implements for agricultural operations
4. Recognize the working principles and design of seed drill and planters
5. Execute the design of plant protection and harvesting equipment

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 2 | 3 | 3 | 1 | 1 | 2 | 1 | | | | 1 | 2 | | |
| 2 | 2 | 2 | 3 | 3 | 1 | 2 | 1 | | | | | | 3 | | |
| 3 | 2 | 2 | 3 | 3 | | 1 | 1 | 1 | | | 1 | | 3 | | |
| 4 | 2 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | | | | | 2 | | |
| 5 | 1 | | 3 | | | 2 | 2 | 1 | | | | | 2 | | |

**UNIT I**                                                                                   **9 Hours**
**INTRODUCTION**
Modern trends, principles, procedures, fundamentals and economic considerations for design and development of farm power and machinery systems-Design considerations, procedure and their applications in agricultural tractors & typical machines-Reliability criteria in design and its application

**UNIT II**                                                                                  **9 Hours**
**DESIGN OF PRIMARY TILLAGE IMPLEMENTS**
Design of coulters, shares, mould boards. Construction of mould board working surface- Design of landside, frog, jointer. Forces acting on plough bottom and their effect on plough balance, trailed, semi-mounted and mounted plough- Draft on ploughs, resistance during ploughing. Design disk ploughs, concave disk working tools, forces acting on disc ploughs.

**UNIT III**                                                                                 **9 Hours**
**CONSTRUCTION OF SECONDARY TILLAGE IMPLEMENTS**
Machines and implements for surface and inter row tillage, peg toothed harrow, disk harrows, rotary hoes, graders, rollers, cultivators, design of V shaped sweeps, rigidity of working tools. Rotary machines, trajectory of motion of rotary tiller tynes, forces acting, power requirement-Machines with working tools executing an oscillatory motion.

**UNIT IV**                                                                                                                    **9 Hours**
**DESIGN AND CALIBRATION OF SEED DRILL/PLANTER**
Methods of sowing and planting, machines, agronomic specifications. Sowing inter-tilled crop. Grain hoppers, seed metering mechanism, furrow openers and seed tubes. Planting and transplanting, paddy transplanters, potato planters. Machines for fertilizer application, discs type broadcasters. Organic fertilizer application, properties of organic manure, spreading machines. Liquid fertilizer distributors

**UNIT V**                                                                                                                     **9 Hours**
**DESIGN OF PLANT PROTECTION AND HARVESTING MACHINERY**
Types of sprayers- components-nozzle types-selection of nozzles- spray pattern analysis. Harvesters, reapers-combine harvesters-threshers- special equipment for harvesting and threshing - maintenance inspection for safety.

**FOR FURTHER READING**
Design of power equipment, precision farming tools, design standards                          **Total: 45 Hours**

**Reference(s)**

1.  Samuel Matz, The Chemistry and Technology of Cereals as Food and Feed, Chapman & Hall, 1992
2.  N.L.Kent and A.D.Evans, Technology of Cereals (4th Edition) Elsevier Science (Pergaman), Oxford, UK,1994
3.  D.N.Sharma, and S. Mukesh. Farm machinery design: Principles and problems. Jain brothers, 2019.
4.  H.P. Smith. Farm machinery and equipment. Read Books Ltd, 2020.
5.  C. Culpin. Farm machinery. Read Books Ltd, 2013.
6.  R. L. Norton, Design of Machinery, Tata McGraw-Hill Publishing Company Pvt Ltd., New Delhi, 2004

## 22AG003 TESTING AND EVALUATION OF FARM MACHINERY AND EQUIPMENT

**3 0 0 3**

**Course Objectives**

>   To Learn the procedure for testing of tractors and all other agricultural equipment and machinery
>
>   To understand test codes of various countries for testing farm machinery and implements
>
>   To analyze the performance of farm machinery and implements

**Course Outcomes (COs)**

1. Apply the testing procedures and standards of tractor testing
2. Analyze the performance of tillage, sowing equipment using standards
3. Test the intercultural equipment using standard procedures
4. Evaluate the performance of harvesting equipment using testing procedures
5. Apply safety standards and testing procedures for agricultural machinery and implements

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | | | | | 3 | | |
| 2 | 2 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | | | | - | 3 | | |
| 3 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | | | | 1 | 3 | | |
| 4 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | 1 | | | | | 3 | | |
| 5 | 2 | 2 | 2 | | 3 | 2 | 1 | 3 | | | | | 2 | | |

**UNIT I**  **10 Hours**
**TESTING OF AGRICULTURAL TRACTORS**
Testing and evaluation system in India - Agricultural machinery situation -Mechanization policy -future prospects - standardization efforts-type of testing systems-type of testing systems, General regulations-terminology- basic measurements, speed, fuel consumption, smoke density and power measurement-test items, specifications checking-PTO performance test-engine test, drawbar performance test-field test procedures -interpretation of results

**UNIT II**  **9 Hours**
**TESTING OF TILLAGE AND SOWING EQUIPMENT**
Testing of tillage machinery - laboratory test (hardness testing, chemical analysis) - field test (rate of work, quality of work, draft measurement, fuel consumption) - seed drill - laboratory test (seed drill calibration) - field checking and field tests

**UNIT III**  **9 Hours**
**TESTING OF INTERCULTURAL EQUIPMENT**
Testing and evaluation of weeders - types of tests for weeder - types of pesticide application equipment - terminology - types of tests for sprayers - testing methods - types of test for duster -testing methods

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

**TESTING OF COMBINE HARVESTER**

Types of grain combines - combine systems - test items - procedure for laboratory testing - materials for field test - observations during field tests - sample analysis- data analysis - summary of performance parameters - analysis of field test data

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

**SAFETY TESTING OF AGRICULTURAL MACHINERY**

Types of agricultural machinery accidents - causes of agricultural machinery accidents - technical measurements for ensuring safety - methods of safety testing- ROPS and FOPS -safety precautions

**FOR FURTHER READING**

Testing of dryers and processing machinery-Case studies                       **Total: 45 Hours**

**Reference(s)**

1.  Metha M.L., SR.Verma, K Mishra and VK Sharma. 1995. Testing and Evaluation of Agricultural Machinery, National Agricultural Technology Information Centre, Ludhiana

2.  Indian Standards Test Codes related to tractors, power tillers and agricultural implements. Ministry of Agriculture, Govt. of India

3.  ASABE. 1983. RNAM Test Codes & Procedures for Farm Machinery. Technical Series 12

4.  Nebraska Tractor Test Codes for Testing Tractors, Nebraska, USA.

## 22AG004 FARM POWER AND MACHINERY MANAGEMENT                3 0 0 3

**Course Objectives**

To analyze mechanization status in the country and management techniques for future requirements.

To apply the management concepts for farming practices

**Course Outcomes (COs)**

1. Analyses the present status of farm mechanization in India
2. Estimate the cost of machinery and cost of operation
3. Select optimal machinery for agricultural operations
4. Develop the plan for mechanization of the farm.
5. Create custom hiring centers for farming practices

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 1 | 1 | 1 | 3 | 1 | 1 | 1 | | | | | | 1 | 1 | 1 |
| 2 | 1 | 1 | 1 | 2 | - | | | | | | 3 | 2 | 1 | 1 | 1 |
| 3 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | | | 3 | 1 | 1 | 1 | 1 |
| 4 | | 1 | | 3 | | 2 | 1 | | | | 3 | | 1 | 1 | 1 |
| 5 | | 1 | | 2 | | 1 | 1 | | | | 3 | 2 | 1 | 1 | 1 |

**UNIT I**                                                                                 **9 Hours**
**FARM MECHANIZATION**
The role of farm mechanization and its relationship to productivity, employment, social and Technological change- Farm Power availability- Mechanization status in India-performance index of power source and farm machinery -Scheduling of farm operations

**UNIT II**                                                                                **9 Hours**
**COST ANALYSIS**
Farm records and inventory control - cost analysis of machinery- fixed cost and variable costs, effect of inflation on cost; Cost economics of tractor and farm machinery - land preparation, planting, intercultural, plant protection and harvesting machinery cost calculation

**UNIT III**                                                                              **10 Hours**
**MACHINERY SELECTION**
Selection of tractor and farm machinery - Matching implements for different power- computation of power requirement - optimum machinery and Replacement criteria; Break-even analysis, reliability and cash flow problems

**UNIT IV**                                                                               **8 Hours**
**FARM MACHINERY OPERATION AND MANAGEMENT**
Operations and adjustments of Land preparation, planting, intercultural, plant protection and harvesting machinery-management of machinery

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

**CUSTOM HIRING MODELS**

Establishment of CHC-operationalization - Custom hiring models - case studies of custom hiring- Custom hiring project formulation - ownership vs custom hiring services - Economic viability of custom hiring service units - Replacement of farm machinery

**FOR FURTHER READING**

Case studies on farm management systems

**Total: 45 Hours**

**Reference(s)**

1.  Mahajan M. Industrial Engineering and Production Management Dhanpet Rai and Co(P) Ltd. New Delhi. 2001

2.  Sharma D N and S.Mukesh. Farm Power and Machinery Management, Jain Brothers, New Delhi.2013.

**22AG005 HYDRAULIC DRIVES AND CONTROLS**                3 0 0 3

## Course Objectives

To assess the application of hydraulics in agricultural machinery

To design drives and controls agricultural machinery, equipment, and implements

To know about the safety in design and operation of hydraulic drives

## Course Outcomes (COs)

1. Apply the hydraulic fundamentals in design of hydraulic system and controls
2. Design pumps for hydraulic systems applied in agricultural machinery techniques
3. Develop accumulators, and circuits for hydraulic systems
4. Select the valves and create valve circuit diagrams for troubleshooting
5. Apply the safety standards for hydraulic systems

## Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 3 | 2 | 3 | | | | | | | | | 3 | | |
| 2 | 2 | 2 | 3 | 2 | 1 | | 1 | | | | | | 2 | | |
| 3 | 2 | 2 | 3 | 1 | 1 | | | | | | | | 2 | | 1 |
| 4 | 2 | 2 | 3 | 2 | 2 | 1 | | | | | | | 2 | | 2 |
| 5 | 2 | 2 | 1 | 3 | 1 | 1 | 1 | 3 | | | | | 2 | | 2 |

**UNIT I**                                                                 **9 Hours**
**INTRODUCTION**
Hydraulic Basics- Pascal's Law, Flow, Energy, Work, and Power. Hydraulic Systems, Color Coding, Reservoirs, Strainers and Filters, Filtering Material and Elements.

**UNIT II**                                                                **9 Hours**
**PUMPS**
Pump Classifications, operation, performance, Displacement, Design of Gear Pumps, Vane Pumps, Piston Pumps.

**UNIT III**                                                               **9 Hours**
**ACCUMULATORS, AND CIRCUITS**
Accumulators, Pressure Gauges and Volume Meters, Hydraulic Circuit, Fittings and Connectors. Hydraulic Actuators, Cylinders, Construction and Applications, Maintenance, Hydraulic Motors.

**UNIT IV**                                                                **9 Hours**
**VALVES**
Valves, Pressure-Control Valves, Directional- Control Valves, Flow-Control Valves, Valve. Installation, Valve Failures    and    Remedies, Valve Assembly, Troubleshooting of Valves- Hydraulic Circuit Diagrams and Troubleshooting

**UNIT V**                                                                                                                        **9 Hours**
**SAFETY AND CONTROLS**
United States of American Standards Institute (USASI) Graphical Symbols Tractor hydraulics, nudging system, ADDC. Pneumatics: Air services, logic units, Fail safe and safety systems Robotics: Application of Hydraulics and Pneumatics drives in agricultural systems, Programmable Logic Controls (PLCs)

**Total: 45 Hours**

**Reference(s)**

1. Manring, N. D. Hydraulic Control Systems: Design and Analysis of Their Dynamics. CRC Press.2001
2. Watanabe, K. Hydraulic Proportional and Servo Control Systems. CRC Press. 2003
3. Sivaraman, I. Introduction to Hydraulics and Pneumatics. CRC Press. 2015
4. Eaton Corporation. Industrial Hydraulics Manual. Eaton Corporation. 2011
5. Daines, J. R., & Nelson, C. A. Fluid Power: Hydraulics and Pneumatics. Prentice Hall. 1991

**22AG006**     **PRECISION FARMING EQUIPMENT**          **3 0 0 3**

**Course Objectives**

To learn about the fundamentals of precision farming principles and application of precision farming equipment

To practice precision farming technologies for crop cultivation

**Course Outcomes (COs)**

1. Investigate the role of sensors and electronics in precision farming
2. Analyze the principles and applications of sensors, micro controllers and actuators in precision farming equipment
3. Apply the precision farming concepts and machinery
4. Adopt site specific management system for precision farming practices
5. Analyze the application unmanned vehicles & IoT in farm operations

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | | | | | | 1 | | 1 |
| 2 | 2 | 3 | 2 | 3 | 2 | 1 | 1 | | | | | 1 | 1 | | 1 |
| 3 | 2 | 2 | 3 | 2 | 3 | 1 | 1 | 1 | | | | | 3 | | 3 |
| 4 | 1 | 2 | 3 | 2 | 3 | 1 | 1 | | | | 1 | | 2 | | 2 |
| 5 | 1 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | | | | 2 | | 3 |

**UNIT I**                                                                                     **8 Hours**
**ROLE OF ELECTRONICS IN AGRICULTURAL ENGINEERING**
Electronics in precision agriculture- Basics of precision agriculture - tools for implementation of precision agriculture. Introduction of GIS/GPS positioning system for precision farming. Use of GIS and GPS in farm machinery and equipment.

**UNIT II**                                                                                   **10 Hours**
**SENSORS, MICROCONTROLLER AND ACTUATOR FOR PRECISION AGRICULTURE**
Types of sensor- principle and concept of different sensor like ultrasonic, proximity, PIR, IR, radar, pressure, gas, temperature, moisture, strain /weight, colour sensor etc. used in agriculture. Microcontroller: Arduino, Raspberry Pi and PLC Actuator: DC Motor, Pump, linear Actuator etc. - Basic input circuits and signal conditioning systems - amplifiers and filters.

**UNIT III**                                                                                  **9 Hours**
**PRECISION FARMING CONCEPTS AND PRECISION FARMING MACHINERY**
Precision farming concepts-Map based system- Real time system - Combination Map and real time system - components of PF - Site specific management- Constraints of PF-Precision tillage, planting, intercultural, plant protection and harvesting equipment, laser guided leveller, power sprayer, straw chopper cum spreader, straw bailer, combine harvester.

**UNIT IV**                                                                                              **9 Hours**
**SITE-SPECIFIC MANAGEMENT SYSTEM**
Site-specific nutrient management- weeds management- Agro-chemicals and fertilizer management, data sources and decision making for site-specific management. Grain quality and yield. Yield monitoring and mapping, soil sampling and analysis.

**UNIT V**                                                                                               **9 Hours**
**UNMANNED VEHICLES AND IOT IN AGRICULTURE**
UAV - Drones- Types - applications - rules and regulations - Autonomous ground vehicles - Robotic platforms and unmanned agricultural vehicles- IoT - crop yield estimates-threat identification- crop insurance-pesticides spraying, environmental monitoring- protected cultivation- food quality monitoring

**FOR FURTHER READING**
Case studies on precision farming practices and equipment                          **Total: 45 Hours**

**Reference(s)**

1.  Brase, T.A. Precision Agriculture. Thomson Delmar Learning, New York.2006

2.  Hermann, J.H. Precision in Crop Farming, Site Specific Concepts and Sensing Methods: Applications and Results. Springer, Netherlands.2013.

3.  Krishna, K. R. Push Button Agriculture Robotics, Drones, Satellite-Guided Soil and Crop Management. Apple Academic Press. 2016

4.  Srivastava,A K., Carroll E.G., Roger P. R. and Dennis R.B. Engineering Principles of Agricultural Machines. American Society of Agricultural and Biological Engineers, USA.2006.

5.  Zhang, Q. Precision Agriculture Technology for Crop Farming. CRC Press, New York.2015

6.  Kepner, R.A., Bainer, R. and Berger, E.L. Principles of Farm Machinery.AVI Publ. 1978.

## 22AG007 BUILDING MATERIALS, ESTIMATION AND COSTING

**3 0 0 3**

**Course Objectives**

> To understand the fundamental knowledge on different building materials

> To impart knowledge on design of different aspects of building construction

> To learn to prepare detailed estimate and cost estimate of buildings

**Course Outcomes (COs)**

1.  Classify rocks, bricks and clay products based on their characteristics and examine the manufacturing process of bricks including moulding, drying and burning for its properties
2.  Assess the natural resources of lime, its types and timber qualities and test for water cement ratio in manufacturing Portland cement.
3.  Organize foundation, stone masonry and brick masonry and compare stone masonry and brick masonry
4.  Construct the buildings by considering dampness, mortar, foundation and concrete
5.  Find the cost estimate based on the public works department schedule rates

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | | 1 | | | 1 | | | | | | | | 2 |
| 2 | 2 | 1 | | 2 | | | 1 | | | | | | | | 2 |
| 3 | 1 | 2 | 2 | 1 | | | 3 | | | | | | | | 3 |
| 4 | 1 | 2 | 3 | | | | 1 | | | | | | | | 3 |
| 5 | 2 | 2 | 2 | | | | 1 | | | | | | | | 3 |

**UNIT I** **9 Hours**
**CONSTRUCTION MATERIALS**
Classification of rocks - Characteristics of Stones -Testing of Stones-Manufacture of Bricks - Moulding -Drying and Burning of bricks-Properties of good Brick -Classification of bricks -Clay Products- Ceramics - Tiles - Earthenware and Stoneware and uses

**UNIT II** **8 Hours**
**LIME AND CEMENT**
Lime- Natural Sources -Types of lime - Calcination-Cement -Raw materials - Water Cement Ratio. Manufacture of Portland Cement Wet and Dry process -Standard Specifications- Storage of cement -Timber - Definition - Defects in timber -Qualities of good timber

**UNIT III** **9 Hours**
**BRICK, STONE MASONRY AND FOUNDATION**
Concept of Foundation -Factors affecting Selection of Foundations -Types of soils-Subsurface Investigations - Bearing Capacity of soil -Testing & Improving Bearing Capacity of soil- Types of Foundations-Piles -Foundation in Black Cotton soil-Site Selection - General principles - classification of brick masonry-precautions in brick masonry -Stone Masonry -Comparison between Brick and Stone Masonry -Classification -General Principles and precautions in stone masonry

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

**BUILDING CONSTRUCTION**

Walls -Classification of walls - Dampness -Causes of Dampness -Methods of Preventing Dampness - Damp Proofing materials - Methods of providing Damp Proofing Materials-Mortars -Functions and Types of mortars - Concrete -Characteristics -Types and uses - Cube Strength of Concrete -Roofs - Classification - Floors -Types of Floor-Types of Plastering and Pointing -Painting and Distempering

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

**ESTIMATING AND COSTING**

PWD schedule of rates - data sheet - detailed estimate - abstract estimate - preparation of estimate market rate estimation

**FOR FURTHER READING**

Estimating and costing of farm structures- irrigation systems- farm ponds- poultry shed- dairy barn

**Total: 45 Hours**

**Reference(s)**

1. B.N. Datta, Estimation and costing. Published by the Author, Tagore Palli, Motilal Bose road, Lucknow, 2002

2. S.C Rangwala, Estimating and costing, Charotar book stall, Station road, Anand, 1991.

3. N.L. Arora and B.R. Gupta, Building construction. Sathyaprakasham, 16/7698, New market, New Rohtak road, New Delhi -5, 1995

4. B.L. Handoo and V.M. Mahajan, Civil engineering materials. Sathyaprakasam, 16/7698, New market, New Rohtak road, New Delhi-5, 1995

5. S.C. Rangwala, Building construction, Charotar publishing house, Anand, 2000

6. S.V Deodhar and Singhal, Civil engineering materials. Khanna publishers, 2B, Nath market, Naisark, Delhi - 2001

## 22AG008 GROUNDWATER, WELLS AND PUMPS                3 0 0 3

**Course Objectives**

To provide students with an understanding of the principles of groundwater and its behavior

To introduce the methods and technologies used in groundwater exploration, development, and management

To familiarize students with the design and installation of wells and pumping systems

**Course Outcomes (COs)**

1. Identify the sources and availability of groundwater in a given area
2. Design and construct wells for accessing groundwater
3. Select and operate pumps for groundwater extraction
4. Organize the water quality of groundwater resources
5. Find sustainable management practices for groundwater resources

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 1 | 3 |  | 2 |  |  |  |  |  |  |  |  |  |  | 2 |
| 2 | 1 | 2 | 3 |  |  |  |  |  |  |  |  |  |  |  | 2 |
| 3 | 1 | 2 | 3 |  |  |  |  |  |  |  |  |  |  |  | 1 |
| 4 | 1 | 3 |  | 2 |  |  | 2 |  |  |  |  |  |  |  | 2 |
| 5 |  | 1 | 2 |  |  | 2 |  | 3 |  |  |  |  |  |  | 2 |

**UNIT I**                                                                                                9 Hours
**INTRODUCTION TO GROUNDWATER RESOURCES**
Sources and availability of groundwater, groundwater exploration methods, hydrologic cycle and water budget, water quality parameters and their significance, water scarcity issues and solutions

**UNIT II**                                                                                               8 Hours
**WELLS**
Types of wells, design principles and construction methods, logging and interpretation, well development, well rehabilitation, wellhead protection, well maintenance and troubleshooting

**UNIT III**                                                                                             9 Hours
**PUMPS**
Types of pumps and their selection criteria, operating characteristics and performance evaluation, pump installation and operation, energy efficiency of pumps, pump maintenance and troubleshooting

**UNIT IV**                                                                                              9 Hours
**GROUNDWATER QUALITY**
Parameters affecting water quality, water quality standards and guidelines, water quality testing methods, interpretation of water quality data, water treatment options, safe use and disposal of water

**UNIT V**                                                               **10 Hours**

**SUSTAINABLE GROUNDWATER MANAGEMENT**

Groundwater management principles, groundwater monitoring and modeling, groundwater recharge techniques, conjunctive use of surface and groundwater resources, integrated water resources management, policies and regulations for sustainable groundwater management

**FOR FURTHER READING**

Estimating and costing of farm structures- irrigation systems- farm ponds- poultry shed- dairy barn

                                                                    **Total: 45 Hours**

**Reference(s)**

1. David Keith Todd. "Groundwater Hydrology", John Wiley & Sons, Inc. 2007

2. Bhagu R. Chahar, Groundwater Hydrology, McGraw Hill Education (India) Pvt Ltd, New Delhi, 2017

3. Subramanya K, Fluid Mechanics and Hydraulic Machines: Problems and Solutions, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2018.

4. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014

## 22AG009 PROTECTED CULTIVATION                          3 0 0 3

**Course Objectives**

To impart knowledge on the protected cultivation of vegetables, fruits and flower crops

To sensitize the students on hi-tech production technology of fruits and vegetables and flower crops

To learn and practices the various production practices of flower and other high value crops

**Course Outcomes (COs)**

1. Execute the different methods of protected cultivation practices available for vegetable crops and flowers
2. Assess the technology available for vegetable crops
3. Assess the technology available for flower crops
4. Select precision farming techniques using sensors and Geographic information systems for the crops
5. Implement the technology available for horticulture crops

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 3 | 1 | 2 | | | | | | | 1 | 2 | | |
| 2 | 2 | 3 | 3 | 1 | 2 | | | | | | | 2 | 1 | 1 | |
| 3 | 2 | 2 | 2 | 1 | 2 | | | | | | | 1 | 1 | 1 | |
| 4 | 2 | 3 | 3 | 1 | 2 | | | | | | | 1 | 2 | | 1 |
| 5 | 2 | 2 | 3 | 1 | 2 | | | | | | | 1 | 2 | 1 | |

**UNIT I**                                                                 **9 Hours**
**PROTECTED CULTIVATION AND ITS TYPES**
Importance and methods of protected culture in horticultural crops. Importance and scope of protected cultivation, different growing structures of protected culture viz., green house, poly house, net house, poly tunnels, screen house, protected nursery house. Study of environmental factors influencing greenhouse production, cladding / glazing / covering material, ventilation systems, cultivation systems including nutrient film technique / hydroponics / aeroponic culture, growing media and nutrients, canopy management, micro irrigation and fertigation systems.

**UNIT II**                                                                **9 Hours**
**PROTECTED CULTIVATION OF VEGETABLE CROPS**
Protected cultivation technology for vegetable crops: Hi-tech protected cultivation techniques for tomato, capsicum nursery, cucumber, gherkins, strawberry and melons, integrated pest and disease management, post-harvest handling.

**UNIT III**                                                               **9 Hours**
**PROTECTED CULTIVATION OF FLOWER CROPS**
Protected cultivation technology for flower crops: Hi-tech protected cultivation of cut roses, cut chrysanthemum, carnation, gerbera, asiatic lilies, anthurium, orchids, cut foliages and fillers, integrated pest and disease management, postharvest handling.

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

**PRECISION FARMING TECHNIQUES**

Concept and introduction of precision Farming: importance, definition, principles and concepts. Role of GIS and GPS. Mobile mapping system and its application in precision farming. Design, layout and installation of drip and fertigation in horticultural crops, role of commuters in developing comprehensive systems needed in site specific management (SSM), geo-referencing and photometric correction.

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

**PRECISION FARMING OF CROPS**

Sensors for information gathering, geo-statistics, robotics in horticulture, postharvest process management (PPM), remote sensing, information and data management and crop growth models, GIS based modeling, VRT, robotics and drones in agriculture Precision farming techniques for horticultural crops: Precision farming techniques for tomato, chilli, bhendi, bitter gourd, bottle gourd, cauliflower, cabbage, grapes, banana, rose, jasmine, chrysanthemum, marigold, tuberose, china aster, turmeric, coriander, coleus and gloriosa.

**FOR FURTHER READING**

Design of greenhouse roof trusses, sorting, grading and packing of fruits, vegetables and flowers, and their transportation to market.

**Total: 45 Hours**

**Reference(s)**

1. Lyn. Malone, Anita M. Palmer, Christine L. Vloghat Jach Dangeermond. Mapping out world: GIS lessons for Education, ESRI press, 2002

2. David Reed, Water, media and nutrition for greenhouse crops. Ball publishing USA, 1996

3. Adams, C.R. K.M. Bandford and M.P. Early, Principles of Horticulture, CBS publishers and distributors, Darya ganj, New Delhi, 1996

<center>**22AG010 DESIGN OF MICRO-IRRIGATION SYSTEMS**     **3 0 0 3**</center>

**Course Objectives**

To understand the basic concepts, tools, and skills used to deliver water efficiently and effectively on both a field and garden scale efficiency

To learn about the role of irrigation water in agriculture, and the environmental factors that influence the type, frequency, and duration of irrigation

To learn about the resources and essential skills needed to determine the proper timing and volume of irrigation, using both qualitative and quantitative methods

**Course Outcomes (COs)**

1. Categorize the different types of pumps and water lifting devices based on the principle, components, and working efficiency
2. Execute the working principle of centrifugal pump as well as its characteristics with efficiencies and design the centrifugal pump including impeller design, casing and other parts of pumps
3. Estimate water budgets and hydraulics used to develop irrigation schedules through micro irrigation based on crop geometry
4. Design drip and sprinkler irrigation system including, main line, sub main and laterals designs by consider pump capacity
5. Assess greenhouse irrigation system and advanced types of irrigation including lift irrigation and automation

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | | | | | 1 | | | 2 |
| 2 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | | | | | 2 | | | 2 |
| 3 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | | | | | 1 | | | 2 |
| 4 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | | | | | 1 | | | 3 |
| 5 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | | | | | 1 | | | 3 |

**UNIT I**     **9 Hours**
**TYPES OF PUMPS AND OTHER WATER LIFTING DEVICES**
Indigenous water lifts, types and their working. Types of pumps: Positive displacement and variable displacement pumps. Reciprocating pump, principle, components, single acting and double acting, work done, coefficient of discharge, slip.

**UNIT II**     **12 Hours**
**CENTRIFUGAL, SUBMERSIBLE AND TURBINE PUMPS**
Centrifugal pump: classification, principle and working, fundamental equations of centrifugal pumps, ideal, virtual and manometric heads of centrifugal pumps, net positive suction head, work done by centrifugal pump. Pump characteristics and efficiencies, priming and cavitation in centrifugal pumps, multistage centrifugal pumps. Design of impellers and casing, selection of centrifugal pumps. Submersible, Turbine pumps, Mixed flow, Axial flow, jet and Airlift pumps. Pump selection and installation, pump troubles and remedies

**UNIT III**                                                           **7 Hours**
**WATER BUDGETING AND DRIP IRRIGATION DESIGN**
Micro irrigation: classification, Irrigation scheduling, Water Budgeting with micro irrigation. Hydraulics of micro irrigation components. Valves, planning factors. Wetting pattern, crop geometries.

**UNIT IV**                                                           **10 Hours**
**SPRINKLER IRRIGATION DESIGN**
Sprinkler irrigation, components, performance. Uniformity and efficiency of sprinkler systems, sprinkler discharge. Distance of throw. Distribution pattern, application rate. Droplet size. Sprinkler selection and spacing, capacity of sprinkler system. Design of laterals, tapered. Design of Main lines, pump capacity. Operation and maintenance of the sprinkler irrigation system.

**UNIT V**                                                           **7 Hours**
**SPECIAL TYPES OF IRRIGATION**
Greenhouse irrigation system, design. Lift irrigation system: Design, subsurface drip irrigation. Soil less culture, Fertigation, Automated irrigation system and rain gun

**FOR FURTHER READING**
Project preparations: Design and draw the layout of a drip/sprinkler irrigation system for 10 acres, preparation of project proposal for the installation and commissioning of irrigation systems
                                                                     **Total: 45 Hours**
**Reference(s)**

1. V.Ravikumar and M.V.Ranghaswami, Micro irrigation and irrigation pumps. Kalyani Publishers, Ludhiana. 2011
2. Jack Keller and Rond Belisher, Sprinkler and Trickle irrigation, Van Nostrand Reinhold, New York, 1990
3. I.J. Kavassik, Engineers Guide to Centrifugal pumps, McGraw Hill Book Company, 1964
4. A.M.Michael, Irrigation theory and practice, Vikas publishers, New Delhi, 2010
5. L.J. James, Farm Irrigation System Design, John Wiley & Sons, 1988

## 22AG011 WATERSHED PLANNING AND MANAGEMENT

**3 0 0 3**

**Course Objectives**

To acquire knowledge about the principles of watershed development activities

To understand the hydrological responses of a watershed and its control measures

To investigate the applicability of hydrological models for watershed conservation

**Course Outcomes (COs)**

1. Assess the watershed characteristics for their classification and prioritization
2. Execute the watershed planning activities based on the inventory and scope
3. Find the needs, methods and implementation strategies of watershed management projects
4. Assess the watershed responses for suggesting suitable control measures
5. Organize the selection of hydrologic models for watershed management

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | | | | | 3 | | | | | | | | | 3 |
| 2 | | | | | | 3 | 2 | | | | | | | | 3 |
| 3 | | | | | | 2 | 3 | | | | | | | | 3 |
| 4 | 1 | 2 | 3 | | | 1 | 2 | | | | | | | | 3 |
| 5 | 1 | | | | 3 | | 2 | | | | | | | | 3 |

**UNIT I**     **9 Hours**
**WATERSHED CHARACTERISTICS**
Watershed-Concept and objectives - watershed classifications - land use and capabilities - watershed delineation - toposheets - codification - watershed priorities - Indian scenario - watershed issues

**UNIT II**     **9 Hours**
**WATERSHED PLANNING**
Watershed resources inventory - land use data - hydrologic data - planning principles - watershed development plan - planning process - scope and objectives - step wise process - implementation strategy - monitoring and evaluation system

**UNIT III**     **9 Hours**
**WATERSHED MANAGEMENT**
Project proposal formulation - action plan - watershed economics - runoff management - temporary and permanent soil conservation structures - water conservation practices - participatory watershed management - watershed based rural development - national programs on watershed management - Government of India guidelines

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

**WATERSHED RESPONSES**

Estimation of water yield - analysis of overland flow and rain water harvesting - assessment and management perspectives - development of recharge structures - estimation of soil erosion - measurement and controls - estimation of sediment yield - measurement and controls - watershed prioritization - index based models - morphometric analysis

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

**WATERSHED MODELS**

Hydrologic modelling - basic principles - objectives and scope - classification of watersheds models - empirical - conceptual - physical based - selection of watershed model - suitability - model assessment - sensitivity analysis - major watershed models - governing equations - software tools - working principles - exercises to expertise

**FOR FURTHER READING**

GIS for watershed management; Case studies in watershed development projects; decision support system for watershed management

**Total: 45 Hours**

**Reference(s)**

1. Ghanashyam Das, Hydrology and Soil Conservation engineering, Prentice Hall of India Private Limited, New Delhi, 2000

2. Suresh R, Land and water management principles, Standard Publishers & Distributors, New Delhi, 2008

3. K. Palanisami, V. N. Sharda and D. V. Singh, Water management in the Hill regions -Evidences from field studies. Bloomsbury Publishing India Pvt. Ltd, 2013

4. Das M, Saikia MD, Watershed management, PHI Learning, 2013

5. Brooks KN, Ffolliott PF, Magner JA, Hydrology and the Management of Watersheds, Wiley- Blackwell, Ames, IA, USA, 2013

**UNIT IV**                                                                                          **9 Hours**
**CONSTRUCTION OF EARTHEN DAM**
Earthen dam - staking for construction - construction methods and specifications - considerations in implementation - checking with compliance standards - sealing methods -considerations in maintenance - monitoring evaluation and protection - extension and training - miscellaneous aspects - water quality considerations - seepage and evaporation reduction measures - runoff inducement methods

**UNIT V**                                                                                           **9 Hours**
**ECONOMIC ANALYSSI OF FARM POND AND RESERVOIR**
Estimation of earthwork - cost analysis - initial investment - variable cost - annual returns - present worth analysis - economic indicators - net present value - benefit cost ratio - internal rate of return - Payback period
**FOR FURTHER READING**
Other water harvesting structures - Appurtenant structures - design of dam components
                                                                                          **Total: 45 Hours**

**Reference(s)**

1. Murthy, V.V.N. and Jha. M. K. (2011). Land and Water Management Engineering. Kalyani Publication.
2. Garg, S. K. (2011). Irrigation Engineering and Hydraulic Structures. Khanna Publishers
3. Theib YO, Dieter P, Ahmed YH, Rainwater Harvesting
4. Agriculture in the Dry Areas, CRC Press, Taylor and Francis Group, London, 2012
5. Suresh R, Soil and Water Conservation Engineering, Standard Publisher Distributors, New Delhi, 2014

## 22AG013 REFRIGERATION AND COLD STORAGE    3 0 0 3

**Course Objectives**

To interpret principles of operation of different Refrigeration & Air conditioning systems

To understand the types of compressors and expansion devices and their applications

To combine the parameters involved in design of the various air conditioning systems

**Course Outcomes (COs)**

1. Execute the principles and practice of thermal comfort
2. Analyze the vapor compression and heat-driven refrigeration systems
3. Apply the knowledge on psychrometric chart for designing heating and refrigeration units
4. Find various types of air conditioning systems and their application in food industry
5. Evaluate applications and make design calculations of Heating, Ventilation and Air conditioning systems

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | 2 | 1 | 1 | | | | | | | | 1 | 1 | 1 |
| 2 | 1 | 2 | 2 | 2 | 1 | | | | | | | | | 1 | 1 |
| 3 | 2 | 3 | 2 | 1 | 1 | | | | | | | | 1 | 1 | 1 |
| 4 | 1 | 3 | 2 | 2 | 1 | | | | | | | | 3 | 1 | 1 |
| 5 | 2 | 2 | 3 | 1 | 1 | | | | | | | | 2 | 2 | 2 |

**UNIT I** 10 Hours
**REFRIGERATION PRINCIPLES AND COMPONENTS**
Refrigeration principles - refrigeration effect coefficient of performance units of refrigeration - refrigeration components - compressor - classification - principle and working - condensors - types - construction principle and working - refrigerants properties classification comparison and advantages - effect on environmental pollution

**UNIT II** 8 Hours
**VAPOUR COMPRESSION AND VAPOUR ABSORPTION CYCLE**
Simple vapour compression cycle - T-S diagram - p-h chart- vapour compression system-different types-vapour absorption cycle simple and practical vapour absorption system- advantages- ideal vapour absorption system- Electrolux refrigerator Lithium bromide refrigeration-construction and principle

**UNIT III** 9 Hours
**APPLIED PSYCHROMETRY**
Principle and properties of psychrometry- Representation of various psychrometric processes on psychrometric chart and their analysis, by-pass factor, sensible heat factor- room sensible heat facto-equipment sensible heat factor- grand sensible heat factor- apparatus dew point- ventilation and infiltration- energy efficiency ratio- Use of psychrometric charts- Cooling and heating load calculations

**UNIT IV**                                                                                    **8 Hours**
**AIR CONDITIONING SYSTEM**
Air conditioning systems-equipment used-classification-comfort and Industrial air conditioning system- winter-summer and year- round air conditioning system- unitary and central air conditioning system- application of refrigeration and air conditioning-domestic refrigerator and freezer refrigerated trucks- ice manufacture- cold storage-freeze drying

**UNIT V**                                                                                    **10 Hours**
**APPLICATIONS OF REFRIGERATION IN FOOD PROCESSING AND PRESERVATION**
Cooling and heating load estimation, cold storage design, types of cooling plants for cold storage. Insulation properties and types of insulation material- Cold storage for milk, meat, fruits, vegetables, poultry and marine products. Refrigerated Transport, Handling and Distribution, Cold chain, refrigerated product handling, order picking, refrigerated vans, refrigerated display

**Total: 45 Hours**

**Reference(s)**

1. C. P. Arora, Refrigeration and Air Conditioning, Tata McGraw Hill Publishing Company Private Limited, New Delhi, 2008

2. Langley and C. Billy, Refrigeration and Air conditioning, Ed. 3, Engle wood Cliffs (NJ), Prentice Hall of India, New Delhi, 2009

3. Roy J. Dossat, Principles of Refrigeration, Pearson Education, New Delhi, 2007

4. N. F Stoecker and Jones, Refrigeration and Air Conditioning, Tata McGraw Hill, New Delhi, 2008

5. Manohar Prasad, Refrigeration and Air Conditioning, Wiley Eastern Ltd., 2007

6. 6. J. B Hains, Automatic Control of Heating & Air conditioning, Tata McGraw Hill Publishing Company Private Limited, 2005

## 22AG014 FRUITS AND VEGETABLES PROCESSING          3 0 0 3

**Course Objectives**

Implement specific post-harvest handling technique for storage and transport of fruits and vegetables

Apply preservation techniques to produce value added fruits and vegetable products

Learn the industrial scale processing and preservation methods to extend the shelf life of fruit and vegetable commodities

**Course Outcomes (COs)**

1. Identify suitable storage methods for storage of fruits and vegetables
2. Compare various preservation methods of fruits and vegetables
3. Assess the optimum conditions for preservation by drying and dehydration
4. Infer the mechanisms and practices of minimal processing fermentation
5. Identify suitable methods for canning and bottling of processed food products

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | | | | 2 | | | | | | | | 1 | |
| 2 | 2 | | | 2 | | | | | | | | | | 2 | |
| 3 | 2 | 1 | | 1 | | | | | | | | | | 2 | |
| 4 | 2 | 1 | | 2 | | | | | | | | | | 2 | |
| 5 | 2 | | | 2 | | | | | | | | | | 2 | |

**UNIT I**                                                            **9 Hours**
**HARVESTING, HANDLING AND STORAGE OF FRUITS AND VEGETABLES**
Fruits and vegetables- classification- nutritional profile - Harvesting of fruits and vegetables - maturity indices - Post-harvest physiology - handling - precooling and storage - Storage under ambient condition-low temperature storage - chilling, frozen storage- chilling injury- freeze burn- Controlled atmosphere storage- Modified atmosphere storage - concepts and methods - gas composition - Changes during storage

**UNIT II**                                                           **9 Hours**
**PRESERVATION OF FRUITS AND VEGETABLES BY VALUE ADDITION**
Methods of fruit and vegetable preservation - Processing using sugar- Preparation of jam- jelly- marmalade-squash- RTS- crush- nectar- cordial- fruit bar- preserves- candies and carbonated- fruit beverages- Processing using salt - Brining - Preparation of pickles- chutney and sauces, ketchup- Machinery involved in processing of fruits and vegetables products

**UNIT III**                                                          **9 Hours**
**PRESERVATION BY DRYING AND DEHYDRATION**
Drying and dehydration - Types of driers - Solar- cabinet- fluidized bed drier-spouted bed drier- heat pump drier-vacuum drier and freeze drier - Applications- Preparation of product- Changes during drying and dehydration-Problems related to storage of dried and dehydrated products

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

**MINIMAL PROCESSING AND FERMENTATION**

Primary processing and pack house handling of fruits and vegetables; Peeling, slicing- cubing- cutting and other size reduction operations for fruits and vegetables- Minimal Processing of Fruits and Vegetables- Preservation by fermentation - wine- vinegar- cider and sauerkraut

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

**CANNING AND BOTTLING**

Canning - principles- types of cans - preparation of canned products - packing of canned products - spoilage of canned foods- Bottling of fruit and vegetable- Precautions in canning operations- General considerations in establishing a commercial fruit and vegetable cannery- machineries involved in canning and bottling unit

**FOR FURTHER READING**

Toping of sugar/salt- Hybrid drier- safe level of irradiation- solid state fermentation- layout of fruit/vegetable canning unit

**Total: 45 Hours**

**Reference(s)**

1. R.P. Srivastava and S. Kumar, Fruit and Vegetable Preservation: Principles and Practices, Third Edition, CBS Publishers & Distributors-New Delhi, 2002

2. A. Chakraverty, A.S. Mujumdar, G.S.Vijaya Raghavan and H.S. Ramaswamy, Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. CRC Press, USA, 2003

3. Girdhari Lal, G. S.Siddappa and G.L. Tandon, Preservation of Fruits and Vegetables, Indian Council of Agricultural Research, New Delhi, 2009

4. D.K. Salunkhe, and S.S. Kadam, Handbook of Fruit Science and Technology: Production, Composition and Processing, Marcel Dekker, New York, 1995

5. K.Sharma, Stevan J.Mulvaney and Syed S.H. Rizvi, Food Process Engineering-Theory and Laboratory equipments, John Wiley & Sons, New York, 2000

## 22AG015 STORAGE AND PACKAGING TECHNOLOGY 3 0 0 3

**Course Objectives**

To study about the different storage structures

To learn about the different packaging materials and various methods of packaging to improve the shelf life of the products

To understand the concepts of Controlled Atmosphere Storage and Modified Atmosphere Packaging

To learn about the equipment used for packaging

**Course Outcomes (COs)**

1. Assess the knowledge on storage environment and storage structures
2. Recognize the importance of packaging and Acquaint with the equipment used for packaging apply
3. Determine the principles of controlled atmosphere storage and modified atmosphere packaging
4. Differentiate various canning systems and their application in food industry
5. Apply the knowledge to choose suitable flexible packaging film and the sealing technique for processed foods

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | | | | 1 | | | | | | | | 3 | |
| 2 | 2 | 2 | 3 | | | 1 | | | | | | | | 3 | |
| 3 | 2 | 2 | 3 | - | | 1 | | | | | | | | 3 | |
| 4 | 2 | 2 | 3 | 1 | | 1 | | | | | | | | 3 | |
| 5 | 2 | 3 | 2 | | | | | | | | | | | 3 | |

**UNIT I** **11 Hours**
**STORAGE ENVIRONMENT AND STORAGE STRUCTURES**
Factors affecting shelf life of food material during storage- Interactions of spoilage agents with environmental factors as water- oxygen- light- pH and general principles of control of the spoilage agents-Difference between food infection- food intoxication and allergy. Fumigation Processes for bag storage piles- Rural storage structures- Bag Storage and its Design- Parameters and types of storage structure- Bulk Storage in silos and large Bins Construction of Silos- Problems of Silo storage- relative Costs of Silo and Bag Storage- Quality Changes and remedial measures of Grains during storages- Design considerations and heat load calculation of cold storage

**UNIT II** **7 Hours**
**INTRODUCTION TO PACKAGING**
Introduction Protection of Food products major role and functions of food packaging Effect of environmental factors- mechanical forces and biological factors on food quality and shelf life- Estimating the shelf life requirement accelerated storage studies- Tests on packaging materials Mechanical strength (Tension- notch and tearing strengths)- Gas and water vapour transmission rates

**UNIT III** **10 Hours**
**CONTROLLED ATMOSPHERE STORAGE AND MODIFIED ATMOSPHERE PACKAGING**
Introduction and concept of CA Storage Equipment for creating- maintaining and measuring controlled atmosphere - Biochemical aspects of CA storage - Static & Dynamic CA- Fruit Ripening- Hypobaric and Hyperbaric Storage- Effects of concentrations of compositional gases on Fruits and vegetables- MAP-Film - Coating types- Permeability- Gas Flushing, Perforation- Absorbents- Humidity- Temperature- Chilling Injury- Shrink wrapping- Vacuum Packing- Modified Interactive Packaging- Minimal Processing- Equilibrium Modified Atmosphere Packaging- Effect of scavengers

**UNIT IV** **10 Hours**
**CANNING**
Metal Cans and Glass Bottles as Packaging- Types of Metallic cans- Basics of Canning operations- Can closures- Glass jars and Bottles in food packaging- Design features and applications- Sterilization of bottles- advantages and problems- Bottle and jar closures- different types of caps and liners used- Can double seam can seam formation and defects- Metal caps for bottles and jars applications- Plastics used and their Specific applications - Polyethylene (LDPE and HDPE)- Cellulose- Polypropylene- Polyesters- Polyvinylidene Chloride -PVDC Diofan, Ixan and Saran- Polyvinyl chloride- Copolymers their applications- Closing and sealing of Rigid plastic containers Seal types

**UNIT V** **7 Hours**
**FLEXIBLE FILMS PACKAGING**
Formation of Films and pouches- Co-extruded films and Laminates applications- Filling and Sealing of pouches and flexible plastic containers- Pouch form fill seal machines- Rigid and Semi rigid plastic packaging- Fabrication methods Thermo forming- Blow moulding- Injection moulding- Extrusion Blow moulding applications- Laminated Paper board Cartons- Fibre Board and Corrugated Card Board packaging - applications- Nano packaging and smart packaging- Printing on packages- Bar codes- Nutrition labeling and legislative requirements

**FOR FURTHER READING**
Active packaging and Oxygen scavenging- applications of Modified atmosphere packaging- Vacuum and Inert Gas Packaging- Transport systems or technology for CAS and MAP
**Total: 45 Hours**

**Reference(s)**

1. Samuel Matz, The Chemistry and Technology of Cereals as Food and Feed, Chapman & Hall, 1992
2. Ruth H. Matthews: Pulses Chemistry, Technology and Nutrition Mercel Dekker Inc., USA,1989
3. Gordon L. Robertson, Food Packaging- Principles and Practice Marcel Dekker Inc, USA, 1993
4. Donald Downing, Complete Course in Canning (3 Volumes) CTI Publications Inc, USA, 1996

**22AG016** **FOOD SAFETY MANAGEMENT SYSTEMS** **3 0 0 3**

**Course Objectives**

Introduce the concept of food hygiene, importance of safe food and laws governing it

Learn common causes of foodborne illness - viz. physical, chemical and biological and identification through food analysis

Understand food inspection procedures employed in maintaining food quality

**Course Outcomes (COs)**

1. Analyse the sources of food spoilage and food toxicants.

2. Assess the food quality evaluation methods.

3. Execute the food inspection procedures to evaluate the food quality

4. Select the National and International Food laws and regulations.

5. Evaluate the quality control measures in food processing industry and marketing centres

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | | 1 | | | | 3 | | 2 | | | | 2 | | 2 | |
| 2 | | 3 | | | | 3 | 1 | | 2 | | | 1 | | 2 | |
| 3 | | 3 | | | | | | 1 | 1 | 1 | | 1 | | 1 | |
| 4 | 3 | | | | 2 | | | | | | | 1 | | 1 | |
| 5 | 2 | 2 | 2 | | | 1 | | | 1 | | | 3 | | 1 | |

**UNIT I** **9 Hours**
**FOOD SAFETY**
Food safety - General principles of food safety. Characterization of food Hazards - physical, chemical and biological. Food spoilage and food borne infection hazards-sources of food spoilage and microorganisms- microbial problems in food safety-food toxicants and food poisoning - prevention. Cross contamination, Limits for pesticide and metal contamination of food. Adulteration, Food additives- types- usage, permissible limits, concept of safe food.

**UNIT II** **9 Hours**
**FOOD QUALITY AND QUALITY EVALUATION OF FOODS**
Food Quality - its need and its role in Food Industry. Food Quality and Quality Attributes-Classification of Quality Attributes and their role in food Quality. Quality Assessment of Food materials -Fruits, vegetables, cereals, legumes, dairy products, meat, poultry, egg and processed food. Sensory Evaluation of Food Quality. Requirements for conducting Sensory Evaluation, Methods of Sensory Evaluation and Evaluation cards, Different methods of Quantitative descriptive analysis.

**UNIT III** **9 Hours**
**QUALITY CONTROL**
Objectives, Importance and Functions of Quality Control, Quality control specifications, training of food technologists for quality control, implementation of standards and specifications. Quality control, principles of quality control - raw material control, process control, finished product inspection, process control, quality problems and quality improvement techniques- mechanization, future of quality control, Total quality management. Objective/Instrumental analysis of Quality Control.

**UNIT IV**            **12 Hours**
**NATIONAL AND INTERNATIONAL FOOD LAWS AND STANDARDS**
Standards for food packaging and labelling - FSSAI, Bureau of Indian Standards (BIS), Agricultural Grading and Marketing (AGMARK), The Agricultural and Processed Food Product Export Development Authority (APEDA), MPEDA. Food and Drug Administration Act (FDA), International Organization for Standards (ISO) and its implication, Generally recognized as safe (GRAS), European Council (EU), Codex Alimentarius Commission (CAC), Total Quality Management (TQM), Good Manufacturing Practices (GMP), Good Agricultural Practices(GAP), and Good Hygienic Practices (GHP) , GMP, Hazard Analysis Critical Control Point (HACCP), FSMA, Legal Metrology Rules, Food Safety Standards for Organic foods, GFSi, HALAL and KOSHE.

**UNIT V**            **6 Hours**
**QUALITY CONTROL MEASURES IN INDUSTRIAL AND MARKETING CENTRES**
Quality control system in storage, Quality control aspects in food industries, Importance of quality control in marketing of Food products - domestic and export markets. International standards for export and quarantine requirements for export of Agricultural and Horticultural produce.

           **Total: 45 Hours**

**Reference(s)**
1. Manoranjan Kalia, Food analysis and Quality control, Kalyani Publishers, Ludhiana, 2002.
2. Mehta, Rajesh and J. George, Food Safety Regulation Concerns and Trade: The Developing Country Perspective, Macmillan, 2005.
3. P.A. Luning, F. Devlieghere and R. Verhe, Safety in the agri - food chain, Wageningen Academic Publishers, Netherland, 2006.
4. Leo and M.L. Nollet, Handbook of food analysis - Methods and Instruments in applied food analysis, Marcel Dekker Inc., 2004.
5. J. Andres Vasconcellos,Quality Assurance for the Food Industry: A Practical Approach,1st Edition,2003.
6. V Ravishankar Rai, Jamuna A Bai,Food Safety and Protection 1st Edition,CRC Press,2017

**22AG017 EMERGING TECHNOLOGIES IN FOOD
PROCESS ENGINEERING**

**3 0 0 3**

**Course Objectives**

> To understand the different emerging technologies in processing food
>
> To familiarize about the equipment used for the processing of foods by emerging technologies
>
> To understand about alternate thermal and non-thermal processing techniques

**Course Outcomes (COs)**

1. Identify the methods of high pressure processing and pulsed electric field processing
2. Infer the features and applications of pulsed electric field processing
3. Compare various methods of food irradiation
4. Assess the mechanisms and applications of various non-thermal processing techniques
5. Select suitable thermal processing technique for food processing

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 2 | 3 | 1 | 2 | 1 | | | | | | | | 1 | |
| 2 | 2 | 1 | 2 | 1 | 3 | 2 | | | | | | | | 2 | |
| 3 | 2 | 2 | 3 | 2 | 2 | 1 | | | | | | | | 2 | |
| 4 | 2 | 2 | 3 | 2 | 2 | 1 | | | | | | | | 2 | |
| 5 | 2 | 2 | 3 | 2 | 2 | 1 | | | | | | | | 3 | |

**UNIT I** **9 Hours**
**HIGH PRESSURE PROCESSING**
Principles- Mechanism and applications of high pressure processing to food systems- High pressure processing of salads- meats and sea foods- fruits and fruit products- Effect of high pressure on microorganisms- enzymes- textural and nutritional quality of foods- Other applications of high pressure processing- High Pressure Freezing- principles and equipment- types of high pressure freezing process- microbiological and enzymatic inactivation after high pressure freezing

**UNIT II** **8 Hours**
**PULSED ELECTRIC FIELDS PROCESSING**

Principles- Mechanism- PEF treatment systems- Main processing parameters- PEF technology- Equipments- Applications- Mechanisms of microbial and enzyme inactivation- PEF processing of solid foods- liquid foods and beverages- Food safety aspects of pulsed electric fields

**UNIT III** **8 Hours**
**FOOD IRRADIATION**
Introduction- Fundamentals of food Irradiation- Type and sources of radiation- dosimetry- mode of action of ionizing radiation Direct and indirect effect- radiation effect on food constituents- Dose requirement for different products and regulations

**UNIT IV**                                                                                                                      **14 Hours**
**ALTERNATIVE NON THERMAL PROCESSING TECHNIQUES**
High intensity pulsed light technology- principles of PLT technology- Technological aspects of PLT- Effects of PLT technology on microorganisms and food quality- Ultrasound Processing- Principle of ultrasound-Fundamentals- Ultrasound as a processing and food preservation tool- Effect of ultra sound on properties of foods-Applications of ultrasound in microbial inactivation- assisted drying- extraction- osmotic dehydration- detection of foreign bodies-filtration and freezing- challenges in ultrasound processing. Radio frequency electric fields-Introduction- radio frequency electric fields equipment- effect of radio frequency electrical field on inactivation of microorganisms

**UNIT V**                                                                                                                          **6 Hours**
**ALTERNATIVE THERMAL PROCESSING TECHNIQUES**
Microwave heating and microwave drying- Microwaves- dielectric properties of foods- thermal properties of foods- Recent developments in microwave heating- combined microwave-vacuum drying- microwave freeze-drying-applications- Radio-frequency processing- Introduction-dielectric heating, Radio- Frequency applications for heating and drying

**FOR FURTHER READINGS**
Preservation methods for food product to extend shelf life                                               **Total: 45 Hours**

**Reference(s)**

1. Emerging Technologies for Food Processing. Da-Wen Sun (Ed), Academic Press, 1st Edition, 2005

2. Novel Food Processing Technologies. M. P. Cano, M. S. Tapia, and G. V. BarbosaCanovas, CRC Press, 1st Edition, 2004

3. Maria Laura Passos, Claudio P. Ribeiro, Innovation in Food Engineering: New Techniques and Products, CRC press, 2010

4. Howard Q. Zhang, Gustavo V. Barbosa-Canovas, V. M.Balasubramaniam, C. Patrick Dunne, Daniel F. Farkas, James T. C. Yuan, Nonthermal Processing Technologies for Food, 2000

**22AG018  FOOD PROCESS EQUIPMENT AND DESIGN**          **3 0 0 3**

**Course Objectives**

Impart knowledge on basic principles of designing equipment for food processing

Become familiar with design and manufacture of storage tanks, pulpers, heat exchangers, driers etc.

Provide an idea about devising cold storage units, freezers etc.

**Course Outcomes (COs)**

1. Analyze the process parameters of equipment and design pressure vessels, storage tanks and pulpers
2. Select the suitable products and materials for designing heat exchangers and evaporator
3. Design and analyze the performance of dryers and extruders
4. Estimate the cooling load of cold storage and design a cold storage for fruits and vegetables
5. Analyze and determine the parameter for designing size reduction and conveying equipment

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 3 | | 2 | 1 | | 1 | | | 1 | | | | | 1 | |
| 2 | 3 | | 2 | | | | | | | | 1 | | | 2 | |
| 3 | 3 | | 2 | 1 | | | | | | | 2 | | | 1 | |
| 4 | 2 | | 2 | | | 1 | 1 | - | | | 2 | | | 2 | |
| 5 | 2 | | 2 | | | 2 | | | | | | | | 2 | |

**UNIT I**                                                                     **9 Hours**
**DESIGN OF PRESSURE VESSELS, STORAGE TANKS AND PULPER**
Introduction to design - principles and selection of food processing equipment - design of pressure vessels - design aspects of storage tanks, design of sterilizers and process vats - design of pulper - design considerations - materials of construction - installation and operation.

**UNIT II**                                                                    **9 Hours**
**DESIGN OF HEAT EXCHANGERS AND EVAPORATORS**
Design of heat exchangers - plate heat exchanger, shell and tube heat exchangers - materials of construction - installation and operation - design of single effect evaporators - applications -multiple effect evaporators-entrainment separators-installation and maintenance

**UNIT III**                                                                   **9 Hours**
**DESIGN OF DRYERS AND EXTRUDERS**
Design of dryers - cabinet dryer, fluidized bed dryer, heat pump dryer, foam mat dryer - freeze dryer - Spray dryer - design considerations, installation, operation and maintenance - design considerations of food extruders - single and twin screw extruders - installation, operation and maintenance of food extruders

**UNIT IV**                                                                    **9 Hours**
**DESIGN OF COLD STORAGE AND FREEZERS**
Design of cold storage - estimation of cooling load - construction, operation and maintenance of cold storage -design consideration for controlled atmospheric storage and modified atmospheric storage of perishables - design of freezers - types of freezers - design considerations - construction and operation-design of frozen storage

**UNIT V** **9 Hours**
**DESIGN OF SIZE REDUCTION AND CONVEYING EQUIPMENTS**
Design consideration of size reduction equipment- installation and maintenance-design consideration of material conveying equipment- belt conveyor- screw conveyor - bucket elevator- pneumatic conveyor

**Total: 45 Hours**

**Reference(s)**

1. P.S. Phirke, Processing and conveying equipment design, Jain Brothers, New Delhi, 2004

2. M.V. Joshi and V.V. Mahajani, Process Equipment Design (3rd edition), New India Publishing Agency, New Delhi, 2004

3. Jasim Ahmed and Mohammad Shafiur Rahman (Editors), Handbook of Food Process Design, John Wiley and Sons, Ltd., U.K., 2012

4. Kennath. J. Valentas and R.Paul Singh (Editors), Handbook of Food Engineering Practice, CRC Press, London, 1997

5. Zacharias B. Maroulis and George D. Saravacos, Food Process Design, Marcel Dekker, Inc. U.S.A, 2003

**22AG019 BIO AND THERMO CHEMICAL CONVERSION**
**OF BIOMASS** 3 0 0 3

**Course Objectives**

To acquire knowledge on the biomass characteristics and biochemical conversion technologies of biomass for energy generation

To learn thermochemical conversion technologies for converting biomass into energy

To understand the cogeneration system and waste heat recovery

**Course Outcomes (COs)**

1. Assess the basics of biomass characteristics and supply chain management of biomass
2. Organize the biochemical conversion technologies of biomass for energy generation
3. Select the principles of the combustion process for converting biomass into energy
4. Analyze thermochemical conversion technologies of biomass for energy generation
5. Organize the basics of cogeneration and CDM technologies

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | 3 | 2 | 3 | | | | | | | | | | 2 |
| 2 | 1 | 2 | 1 | 3 | 1 | | 1 | | | | | | | | 3 |
| 3 | 3 | 1 | 2 | 2 | 3 | | 1 | | | | | | | | 2 |
| 4 | 2 | 3 | 1 | 3 | 2 | | 1 | | | | | | | | 3 |
| 5 | 1 | 2 | 1 | 3 | 2 | | 1 | | | | | | | | 3 |

**UNIT I** 9 Hours
**BIOMASS CHARACTERIZATION**
Biomass - types - biomass conversion process - fuel from biomass - Photosynthesis - Terms and units used in biomass production - Biomass characterization - physical - chemical and thermal - energy release - Supply chain Management - harvesting - collection - transportation and processing - Importance - Briquetting - types of equipment - Factors affecting - Pelletizing.

**UNIT II** 11 Hours
**BIOCHEMICAL CONVERSION**
Biochemical degradation - Feedstock for biogas production - Process involved - Factors affecting biogas production - Types of biogas plants - Construction details - Operation and maintenance - Utilization of biogas - Slurry handling - utilization and enrichment - high-rate bio methanation process - landfills - Bioethanol - feedstock - process - utilization - composting - methods machinery - Economics of biofuels

**UNIT III** 9 Hours
**THERMOCHEMICAL CONVERSION BY COMBUSTION**
Thermochemical degradation - stoichiometric air requirement - Combustion process - chemistry of combustion - combustion zones - emissions - Co-firing of biomass - types - Direct - Indirect and Parallel - Wood burning stoves - types - operation - Incinerators - Types - Combustion of wastes and MSW

**UNIT IV**                                                       **9 Hours**
**THERMOCHEMICAL CONVERSION BY GASIFICATION AND PYROLYSIS**
Biomass gasification - chemistry of gasification - types of gasifiers - Gas cleaning - conditioning - utilization of producer gas - emissions - commercial gasifier - Pyrolysis - product recovery - types - biochar - bio-oil - operation recovery

**UNIT V**                                                       **7 Hours**
**COGENERATION AND WASTE HEAT RECOVERY**
Cogeneration technology - cycles - topping - bottoming - problems - applications - waste heat recovery - heat pipe - heat wheel - Recuperator - Economizer - Carbon cycle - Carbon sequestration - Types -benefits - CDM Concept - CDM Technologies - Carbon Emission Reduction

                                                                 **Total: 45 Hours**

**Reference(s)**

1. Khoiyangbam. R.S, Kumar. S, Gupta.N, Biogas Technology: Towards Sustainable Development. India, Energy and Resources Institute, 2011.

2. Sergio C. Capareda, Introduction to Biomass Energy Conversions, CRC Press, 2014.

3. C.Higmen and M.Vander Burgt, Gasification, Elsevier Science, USA, 2003

4. Ashok Pandy, Thallada Baskar, M.Stocker and Rajeev Sukumaran (Editors), Recent advances in Thermochemical conversion of Biomass. Elsevier Publications, 2015

5. Robert C Brown, Christian Steven (Editors), Thermochemical Processing of Biomass: Conversion into Fuels, chemical and powder, Wiley Eastern Publishers, 2011

6. K.C. Khandelwal and S.S. Mahdi, Biogas Technology, Tata McGraw Hill Pub. Co. Ltd., New Delhi,1986

## 22AG020 SOLAR AND WIND ENGINEERING    3 0 0 3

**Course Objectives**

To learn about the fundamental aspects of solar energy availability, solar energy conversion technologies

To understand the fundamental aspects of wind energy availability and wind power generators

To acquire knowledge on alternate sources of energy such as geothermal energy, wave energy, tidal energy, OTEC energy, fuel cells, and energy storage

**Course Outcomes (COs)**

1. Assess the basics of solar energy and solar thermal energy conversion technologies and compare direct mode and indirect mode solar dryers
2. Organize the principles and applications of solar thermal power stations, solar pond, and solar stills
3. Find the wind power laws and calculate the torque and power characteristics of wind energy
4. Design wind mills and test the units for certification
5. Assess the principles of geothermal energy, wave energy, tidal energy, OTEC energy, fuel cells and analyze their applications

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 1 | 3 | 2 | 3 | | 1 | | | | | | | | 3 |
| 2 | 1 | 2 | 1 | 3 | 1 | | 1 | | | | | | | | 3 |
| 3 | 3 | 1 | 2 | 2 | 3 | | 1 | | | | | | | | 3 |
| 4 | 2 | 3 | 1 | 3 | 2 | | 1 | | | | | | | | 2 |
| 5 | 1 | 2 | 1 | 3 | 2 | | 1 | | | | | | | | 3 |

**UNIT I**                                                                                  **9 Hours**
**SOLAR ENERGY RADIATION AND NON-CONCENTRATING COLLECTORS**
Solar constant - Solar Radiation Types - Geometry - measurement - Pyranometer - Pyrheliometer -Greenhouse Effect - Flat Plate Collector - transmittance - absorptance - Energy Balance Equation - collector efficiency - absorber plate - types - selective surfaces - Solar Dyer - Direct - Indirect and Combined Mode - Application.

**UNIT II**                                                                                 **9 Hours**
**SOLAR CONCENTRATING COLLECTORS AND PV TECHNOLOGY**
Line-focusing and point-focusing concentrators - parabolic trough - parabolic dish - heliostat field with central receiver - Fresnel lenses - compound parabolic concentrator - Sun tracking mechanisms - Solar Still - Types - Uses - Solar Pond - characteristics - application - Photovoltaics types - Mono - Poly - Thin Film - Mono PERC - Bifacial PERC - characteristic - load estimation batteries inverters operation system controls - Module mounting structure - Tracking system - module cleaning system - PV - powered water pumping system sizing.

**UNIT III**                                                                                **9 Hours**
**WIND MAPPING ANALYSIS AND CHARACTERISTICS OF WIND**
Nature of wind - the origin of wind - Energy in a moving object - Power in the wind - Power absorption by a turbine - Wind speed variation - Velocity and Power duration curve - Wind Resource Assessment - Aerodynamic Force - Lift and Drag Coefficient - Aerofoil - tip speed ratio - torque and power characteristics - Betz coefficient.

**UNIT IV** **9 Hours**
**WIND ENERGY CONVERSION SYSTEM**
Wind Turbines Classification - Upwind and Downwind Turbine - Savonius and Darrieus Turbine - Propeller Wind Turbine - Wind Turbine Components - Rotor - Drivetrain - Gearbox - Brake - Generator - Nacelle - Yaw System - Tower - Standalone system - grid system - batteries - Wind energy storage - wind farms - wheeling and banking - testing and certification procedures.

**UNIT V** **9 Hours**
**ALTERNATE ENERGY SOURCES**
Ocean energy - offshore and onshore ocean energy conversion technologies - OTEC principles - open and closed cycles - Tidal energy - high and low tides - tidal power - tidal energy conversion -Geothermal energy - resources - classification and types of geothermal power plants - Nuclear energy - reactions - fusion - fission - hybrid reactors - Fuel cell - principle and operation - classification and types - Energy storage - pumped hydro and underground pumped hydro - compressed air – battery - flywheel - thermal.

**Total: 45 Hours**

**Reference(s)**

1. Rai.G.D, Non-Conventional Energy Sources, Khanna Publishers, New Delhi, 2018.

2. Rao.S., Parulekar.B.B, Energy Technology Non-Conventional, Renewable & Conventional, Khanna Publishers, New Delhi, 2015.

3. Ahmad Hemami, Wind Turbine Technology, Cengage Learning, New Delhi, 2012.

**22AG021   ENERGY CONSERVATION IN AGRO-BASED INDUSTRY**                    **3 0 0 3**

**Course Objectives**

> To learn about the basic process carried out in various Agro-based Industries
>
> To learn the different aspects of energy auditing in the Food Industry
>
> To know about the energy saving opportunities in existing food processing facilities

**Course Outcomes (COs)**

1. Find the energy resources based on sources and purposes
2. Organize the types of energy audits in production agriculture for rural living and the scope of energy conservation
3. Assess the energy-efficient machinery systems and analyze the technologies and methods for the conservation of energy resources
4. Find the factors affecting energy conservation and analyze the energy economics, pricing, and incentives for energy conservation
5. Assess the energy audit in agricultural fields for comparative studies

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | 2 | 1 | | | | | 1 | | | 1 | | | 2 |
| 2 | 1 | 2 | 1 | | | | | | | | | - | | | 3 |
| 3 | 1 | 2 | 1 | | | | | | | | | 3 | | | 3 |
| 4 | 1 | 2 | 1 | | | | | | | | | 3 | | | 2 |
| 5 | 1 | 2 | 1 | 3 | 2 | | 1 | | | | | | | | 2 |

**UNIT I**                                                                                           **12 Hours**
**ENERGY MANAGEMENT**
Defining Energy Management - the need for Energy Management - Energy management techniques - the importance of Energy Management - managing Energy consumption - Energy Audit and Types -and Energy Audit Instruments - understanding Energy costs - benchmarking - Energy performance - matching energy use to requirements optimizing the input - fuel and energy substitution - material and Energy balance diagrams - Energy pricing - Energy and Environment and Energy Security.

**UNIT II**                                                                                           **10 Hours**
**ENERGY CONSERVATION IN AGRO-BASED INDUSTRY**
Energy Conservation in the Indian industrial sector - Energy saving potential in the industry - boiler - furnaces - air compressors - refrigeration systems - heat exchangers - heat pumps - turbines - electric drives - pumps - cooling towers - fans - and blowers - Energy Conservation in agriculture sector - Energy Conservation opportunities in pumps used in agriculture sector - summary.

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

**ENERGY-SAVING OPPORTUNITIES IN EXISTING FOOD PROCESSING**

Facilities Energy Consumption pattern - Energy Conservation in Grains and Oilseeds Milling Facilities - Sugar and Confectionary Processing Facilities - Fruit and Vegetable Processing Facilities -Dairy Processing Facilities - Meat Processing Facilities - Bakery Processing Facilities.

**UNIT IV**                                                                                         **8 Hours**

**FOOD PROCESSING WASTES AND UTILIZATION**

Concepts of Anaerobic Digestion of Food Processing Wastes - Fermentation of Food Processing Wastes into Transportation Alcohols - Bio-diesel Production from Waste Oils and Fats -Thermochemical Conversion of Food Processing Wastes for Energy Utilization.

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

**WASTE HEAT RECOVERY**

Waste Heat Recovery and Thermal Energy Storage in Food Processing Facilities - Novel Thermodynamic Cycles Applied to the Food Industry for Improved Energy Efficiency

**Total: 45 Hours**

**Reference(s)**

1. Umesh Rathore," energy management", Kataria publications, 2 nd ediiton,2014.

2. G Harihara Iyer, Green Building Fundamentals, Notion press.com, 2022

3. Guidebooks for National Certification Examination for Energy Manager/Energy Auditors Book-1, General Aspects

4. Umesh Rathore, "energy management", Kataria publications, 2nd ediiton, 2014

5. L.Wang, Energy Efficiency and Management in Food Processing Facilities, CRC Press, 2009

## 22AG022 CO - GENERATION AND WASTE HEAT RECOVERY SYSTEMS 3 0 0 3

### Course Objectives

To acquire knowledge on the various seed production and processing technologies

To impart knowledge on seed testing and the methods

To impart knowledge about seed certification, legislation, and industries in India

### Course Outcomes (COs)

1. Assess the principles of cogeneration and analyze thermodynamic power cycles
2. Evaluate the performance of cogeneration systems
3. Find the cogeneration technologies based on steam turbines, gas turbines and IC engines
4. Organize the issues and applications of cogeneration technologies
5. Analyze the waste heat recovery systems, economic analysis, and environmental consideration

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 1 | 3 | 2 | 3 | 2 | | 1 | | | | | | | 2 |
| 2 | 2 | 3 | 2 | 1 | 3 | 1 | | 2 | | | | | | | 3 |
| 3 | 1 | 2 | 3 | 3 | 1 | 3 | | 3 | | | | | | | 3 |
| 4 | 3 | 3 | 1 | 3 | 3 | 1 | | 1 | | | | | | | 2 |
| 5 | 1 | 3 | 2 | 2 | 2 | 1 | | 2 | | | | | | | 2 |

**UNIT I** **9 Hours**
**INTRODUCTION**
Cogeneration principles and definition - thermodynamics power cycle analysis - Rankine and Brayton cycles-topping and bottoming cycles

**UNIT II** **9 Hours**
**COGENERATION SYSTEMS**
Performance indices of cogeneration systems - Cogeneration systems based on steam turbine - gas turbine - combined cycle and IC engines - Cogeneration systems based on Stirling Engines

**UNIT III** **9 Hours**
**APPLICATIONS OF COGENERATION**
Cogeneration Applications in various industries like Cement - Sugar Mill - Paper Mill - Textile - Sizing of waste heat boilers - Performance calculations - Part load characteristics selection of Cogeneration Technologies - Financial considerations - Operating and Investments - Costs of Cogeneration - Impacts of cogeneration plants-fuel- electricity

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

**WASTE HEAT SOURCES**

Selection criteria for waste heat recovery technologies - Recuperators - Regenerators - Economizers - Plate Heat Exchangers - Waste Heat Boilers-Classification - Location - Service Conditions - Design Considerations - Unfired combined Cycle - supplementary fired combined cycle - fired combined cycle applications in Industries - fluidized bed heat exchangers - heat pipe exchangers - Heat pumps - types- design

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

**COST ANALYSIS AND ENVIRONMENTAL IMPACT OF COGENERATION SYSTEMS**

Economic analysis of cogeneration and waste heat recovery systems - Regulatory and financial framework for cogeneration and waste heat recovery systems - Environmental considerations - mitigation of harmful emissions from energy production - conversion and utilization technologies- control of air - water and ground pollution

**Total: 45 Hours**

**Reference(s)**

1. J.F Harrington and J.E Douglas, "Seed storage and packaging application", NSC, New Delhi, 1963

2. J.E Douglas, "Seed Production Mannual", National Seeds Corporation and Rockfeller Foundation, New Delhi, 1969

3. J.E Douglas, "Seed Certification Mannual", National seeds corporation, New Delhi, 1970

4. R.L Agrawal, A text book on "Seed Technology", Oxford & IBH Publication, Co Pvt Ltd, New Delhi-1992

5. L.O Copeland and M.B Mc Donald, "Principles of Seed Science and Technology", Chapman and Hall, New York, 1995

**22AG023        GREEN BUILDINGS                    3 0 0 3**

**Course Objectives**

To imbibe the basics of green buildings and to learn guidelines for the development and certification of green designs.

To identify various areas of implementing strategies for green design in projects to enhance the built environment.

To impart knowledge on site selection, waste management, water, and energy efficiency, and indoor environmental quality of green buildings

**Course Outcomes (COs)**

1. Execute the concept of green buildings and its certification
2. Assess the site selection criteria and water management in green buildings
3. Analyze the energy efficiency and use of renewable energy in green buildings
4. Select appropriate green building material and analyze waste management strategies
5. Find indoor environmental quality in green buildings

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | 3 | 2 | 3 | 2 | | | | | | | | | 1 |
| 2 | 2 | 3 | 2 | 1 | 3 | 1 | | | | | | | | | 2 |
| 3 | 1 | 2 | 3 | 3 | 1 | 3 | | 1 | | | | | | | 2 |
| 4 | 3 | 3 | 1 | 3 | 3 | 1 | | 1 | | | | | | | 1 |
| 5 | 1 | 3 | 2 | 2 | 2 | 1 | | 1 | | | | | | | 1 |

**UNIT I                                                                                                                        9 Hours**
**CONCEPT OF GREEN BUILDINGS AND ITS CERTIFICATION**
Introduction to Green Buildings - Definition of green buildings and sustainable development - typical features of green buildings - benefits of green buildings towards sustainable development - green building rating systems - GRIHA - IGBC and LEED - overview of the criteria as per these rating systems.

**UNIT II                                                                                                                      9 Hours**
**SITE SELECTION AND WATER CONSERVATION AND EFFICIENCY**
Site selection and planning - Criteria for site selection - preservation of landscape - soil erosion control - minimizing urban heat island effect - maximizing comfort by proper orientation of building facades - daylighting - ventilation - Water conservation and efficiency - Rainwater harvesting methods for roof and non-roof - reducing landscape water demand by proper irrigation systems -water-efficient plumbing systems - water metering - wastewater treatment - recycle and reuse systems

**UNIT III** **9 Hours**
**ENERGY EFFICIENCY AND USE OF RENEWABLE ENERGY IN GREEN BUILDINGS**
Energy Efficiency - Environmental impact of building constructions - Concepts of embodied energy - operational energy and life cycle energy - Methods to reduce operational energy - Energy-efficient building envelopes - efficient lighting technologies - energy-efficient appliances for heating and air conditioning systems in buildings - zero ozone-depleting potential (ODP) materials - wind and solar energy harvesting - energy metering, and monitoring - the concept of net zero buildings.

**UNIT IV** **9 Hours**
**WASTE MANAGEMENT AND BUILDING MATERIALS USED IN GREEN BUILDINGS**
Building materials - Methods to reduce embodied energy in building materials - Use of local building materials - Use of natural and renewable materials like bamboo - timber - rammed earth and stabilized mud blocks - use of materials with recycled content such as blended cement - pozzolana cement - fly ash bricks - vitrified tiles - materials from agro and industrial waste - reuse of waste and salvaged materials Waste Management - Handling of construction waste materials - separation of household waste - on-site and off-site organic waste management.

**UNIT V** **9 Hours**
**INDOOR ENVIRONMENTAL QUALITY**
Indoor Environmental Quality for Occupant Comfort and Wellbeing - Daylighting - air ventilation - exhaust systems - low VOC paints - materials and adhesives and building acoustics - Heating and cooling - Codes related to green buildings - NBC - ECBC - ASHRAE - UPC.

**Total: 45 Hours**

**Reference(s)**

1. IGBC Green Homes Rating System, Version 2.0., Abridged reference guide, 2013, Indian Green Building Council Publishers.
2. GRIHA version 2015, GRIHA rating system, Green Rating for Integrated Habitat Assessment.
3. Alternative building materials and technologies by K.S. Jagadish, B.V. Venkatarama Reddy and K.S. Nanjunda Rao.
4. Mike Montoya, Green Building Fundamentals, Pearson, USA, 2010
5. Charles J. Kibert, Sustainable Construction, Green Building Design and Delivery, John Wiley & Sons, New York, 2008.
6. 8Regina Leffers, Sustainable Construction and Design, Pearson, Prentice Hall, USA, 2009

**22AG024     ENERGY STORAGE SYSTEMS            3 0 0 3**

**Course Objectives**

To understand the necessity of different energy storage systems

To study details of various energy storage systems along with applications

Enabling to identify the optimal solutions to a particular energy storage application/utility

**Course Outcomes (COs)**

1. Execute need of energy storage systems
2. Find knowledge pertaining to various ways of thermal energy storage, its analysis and use
3. Find knowledge pertaining to various ways of chemical energy storage, its analysis and use
4. Assess knowledge pertaining to various ways of electromagnetic and mechanical energy storage, its analysis and use
5. Assess knowledge pertaining to various ways of electrochemical energy storage, its analysis and use

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 3 | 1 | 2 | 1 | | | | | 1 | | | 1 | | | 2 |
| 2 | 1 | 2 | 1 | | | | | | | | | | | | 2 |
| 3 | 1 | 2 | 1 | | | | | | | | | 3 | | | 1 |
| 4 | 1 | 2 | 1 | | | | | | | | | 3 | | | 1 |
| 5 | 1 | 2 | 2 | 2 | 2 | 1 | | | 1 | | | 3 | | | 1 |

**UNIT I**                                                                                                    **9 Hours**
**OVERVIEW OF ENERGY STORAGE SYSTEMS**
Energy storage systems overview - Scope of energy storage - needs and opportunities in energy storage - Technology overview and key disciplines - comparison of the time scale of storages and applications - Energy storage in the power and transportation sectors - Importance of energy storage systems in electric vehicles - Current electric vehicle market.

**UNIT II**                                                                                                   **9 Hours**
**THERMAL ENERGY STORAGE SYSTEMS**
Thermal storage system - heat pumps - hot water storage tank -solar thermal collector - application of phase change materials for heat storage-organic and inorganic materials - efficiencies and economic - evaluation of thermal energy storage systems

**UNIT III**                                                                                                  **9 Hours**
**CHEMICAL ENERGY STORAGE SYSTEMS**
Chemical storage system - hydrogen - methane - concept of chemical storage - application of chemical energy storage system - advantages and limitations of chemical energy storage - challenges and future prospects of chemical storage systems.

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

**ELECTROMAGNETIC AND MECHANICAL ENERGY STORAGE SYSTEMS**

Electromagnetic storage systems - double-layer capacitors with electrostatically charge storage - superconducting magnetic energy storage (SMES) - concepts - advantages and limitations of electromagnetic energy storage systems - Mechanical-Pumped hydro - flywheels and pressurized air energy storage

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

**ELECTROCHEMICAL STORAGE SYSTEMS**

Indoor Environmental Batteries - Working principle of battery - primary and secondary (flow) batteries - battery performance evaluation methods - major battery chemistries and their voltages- Li-ion battery & Metal hydride battery vs lead-acid battery - Supercapacitors - Working principle of the supercapacitor - types of supercapacitors- cycling and performance characteristics - the difference between battery and supercapacitors - Introduction to Hybrid electrochemical supercapacitors

**Total: 45 Hours**

**Reference(s)**

1. Energy Storage,Technologies and Applications by Ahmed Faheem Zobaa, InTech.

2. Fundamentals of Energy Storage by J. Jensen and B. Sorenson, Wiley-Interscience, New York

3. Handbook of battery materials by C. Daniel, J. O. Besenhard,Wiley VCH Verlag GmbH & Co. KgaA

4. Electric & Hybrid Vehicles by G. Pistoia, Elsevier B. V.

5. Thermal energy storage: Systems and Applications by Dincer I. and Rosen M. A., Wiley pub.

6. Energy Storage: Fundmentals, Materials and Applications, by Huggins R. A., Springer

## 22AG025 CDM AND CARBON TRADING TECHNOLOGY          3 0 0 3

**Course Objectives**

    To know the basics and importance of clean development mechanism (CDM)

    To monitor CDM for sustainable development and know about carbon credit

    To know the concept of carbon trading

**Course Outcomes (COs)**

1.  Identify the effects of greenhouse gas emission and explain the responsibilities of countries in GHG emission

2.  Infer the Kyoto Protocol and develop clean development mechanism (CDM) projects

3.  Assess the features of CDM and employ monitoring and auditing techniques on CDM projects

4.  Compare the guidelines for small-scale and Land Use, Land Use Change, and Forestry (LULUCF) CDM projects

5.  Classify the alternate techniques for lowering the carbon emission

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | 2 | 1 | | | | | 1 | | | 1 | 1 | | 2 |
| 2 | 1 | 2 | 1 | | | | | | | | | | | | 2 |
| 3 | 1 | 2 | 1 | | | | | | | | | 3 | | | 3 |
| 4 | 1 | 2 | 1 | | | | | | | | | 3 | | | 3 |
| 5 | 1 | 2 | 2 | 2 | 2 | 1 | | | 1 | | | 3 | | | 1 |

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

**GREEN HOUSE GASES AND ENVIRONMENTAL CHANGE**

Global Environmental Changes - United nations framework convention on climate change-United (UNFCC)-ozone layer depletion -land degradation-air and water pollution-sea-level rise-loss of biodiversity-climatic change problem GHG emissions by different countries-developing country responsibilities - India"s Greenhouse gas emissions - Conference of parties

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

**KYOTO PROTOCOL AND CDM PROJECTS**

Kyoto protocol and clean development mechanism-CDM and cooperative mechanism-CDM overview administration -participation-CDM institutions-procedures CDM project cycle-project design and formulation - eligibility-additionally. Approval of (DNA) Designated National Authority - Validation and registration-monitoring-validation and certification through the source of Certified Emission Reduction (CER)

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

**TYPES AND FEATURES OF CDM**

Types of CDM topologies -project activity -small-scale CDM project categories- access station and cater station projects - PDO- project design document -General description of project activity-baseline methodology-monitoring methodology-auditing period-technical aspects

**UNIT IV** **9 Hours**
**MONITORING OF CDM**
Monitoring and verification-verification process principles of verification-report preparation-pitfalls - Joint implementation (JI)-institutions and procedures-guidelines-JI or small-scale projects-JI Land Use - Land Use Change and Forestry (LULUCF) projects

**UNIT V** **9 Hours**
**SUSTAINABLE ENERGY DEVELOPMENT**
Low carbon technologies-low carbon building-alternative approaches-energy efficiency projects-sustainable energy policy concepts-mitigating energy-related GHG emissions through renewable energy-carbon trading
**Total: 45 Hours**

**Reference(s)**

1. CDM Manual for project developers and policy makers-UNFCCC Publication, 2007
2. Myungkyoon Lee, Information and Guide Book - the UNEP project CD4CDM-UNEP publication, June 2004.
3. MyungKyoon Lee, Baseline Methodologies for clean Development Mechanism Projects- A Guide Book-Vol.1, UNEP publication, 2005
4. Aukland L, Bass S, Hug S, Landell Mals N, Tipper R, Laying the Foundations for clean Development, Preparing the Land use sector London, 2002
5. Carbon sequestration in dryland soils, World Soil Resources report No.102, Food and Agriculture Organization, Rome,2004

| 22AG026 | SOIL FERTILITY AND NUTRIENT MANAGEMENT | 3 0 0 3 |

## Course Objectives

- To enhance the knowledge on soil fertility and soil formation processes.
- To impart knowledge on essential nutrients and its movements in soil-plant.
- To study the transformation of nutrients and its formation and functions.
- To study the manures and fertilizers application for the improvement of soil fertility.
- To analyze the soil and plant samples for better crop production.

## Course Outcomes (COs)

1. Determine the classification of soil and land capability, soil erosion and its control
2. Assess the functions and nutrients supply from soil to plant
3. Find nutrient transformation in relation to soil-plant systems
4. Determine the manure and fertilizers for crop production
5. Check the soil fertility by conducting the soil tests using different methods

## Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | - | 1 | - | | | | 2 | | 1 | | | 3 | 1 | | |
| 2 | | 3 | 1 | | 1 | | | | 1 | | | 2 | 2 | | 1 |
| 3 | | | 1 | - | | | | | | | | 1 | 1 | | 2 |
| 4 | | 1 | 3 | | | | | | | | | | 2 | | 1 |
| 5 | | 1 | 3 | | | | | | | | | | 2 | | 3 |

**UNIT I**                                                                                               **10 Hours**
**SOIL AS A NATURAL RESOURCE**
Definition of Soil-Soil Fertility and Soil Productivity-soil formation process-soil & land capability classification-soil acidity and alkalinity-        soil erosion and its control- soil organisms-organic matter-modern views of humus formation -Plant Growth & Response Curves-liebig's law of minimum-Mitscherlich's law.

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

**BASIC SOIL-PLANT RELATIONSHIPS**
Essential plant nutrients- Definition of macro and micro nutrients -Functions and deficiency symptoms- Hidden hunger-  Beneficial elements -Criteria of essentiality of elements- Luxury consumption of nutrients-SUPPLY OF NUTRIENTS FROM organic matter-movement of ions from soils to roots -Mass flow-diffusion-root interception-nutrient mobility in soil- ion absorption by plants.

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

**NUTRIENT TRANSFORMATION IN RELATION TO SOIL-PLANT SYSTEMS**
The functions and forms of N, P, K in soil -Biological N2 fixation - losses of nitrogen from soils-leaching -denitrification- forms of P in soil- P sources- Factors affecting K availability- sulfur, calcium and magnesium-cycle-forms and functions in plants.

**UNIT IV**                                                                                                         **8 Hours**

**MANURES AND FERTILIZERS**

Definition- characteristics of manure -classification-sustainable agriculture- composts-methods of composting-organic farming-LEISA-fertilizer-classification-recommendations in agriculture crops -Calculation and application of fertilizers in soil -Nano fertilizer-soil testing and its importance.

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

**SOIL FERTILITY EVALUATION AND MAINTENANCE OF SOIL HEALTH**

Characteristics of a healthy soil -Measure of soil health-soil health indicators-soil health report-problem soils -Plant analysis- total analysis, rapid tissue test, enzyme test, DRIS method and critical levels of nutrients in plants-problem due to excessive use of chemical fertilizers-crop residue management.

**FOR FUTHRE READING**

Agricultural productivity and environmental quality-economics of nutrient use-soil and water pollution- Study of soil profile- identification of different soil types- interpretation of soil and water test data.

**Total: 45 Hours**

### Reference(s)

1. John L.Halvin, Samuel.L.Tisdale, Werner.L.Nelson, James.D.Beaton, Soil fertility and fertilizers, an introduction to nutrient management, Eighth edition, PEARSON India education services, 2017.
2. Dilip Kumar Das, Introductory Soil Science, 3rd Edition, Kalyani Publishers, Ludhiana, 2013.
3. T.D. Biswas and S.K. Mukherjee, Text Book of Soil Science, 2nd Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2001.
4. Indian Society of Soil Science, Fundamentals of Soil Science, ISSS Publication, IARI, New Delhi, 2012.
5. E-Course Indian council of Agricultural Research.

**22AG027**     **PLANT PROTECTION**     **3 0 0 3**

## Course Objectives

To impart basic knowledge of insect pest and diseases and their losses caused to crops

To study various methods of plant protection to get more yield in Agricultural and Horticultural crops

To gain knowledge on pest & diseases management in horticultural crops

## Course Outcomes (COs)

1. Identify various groups of insect pests and diseases of crops and their symptoms of damage
2. Assess the different crops damaged by insects and diseases
3. Compare the various methods of pest management to increase crop yield
4. Classify the plant protection machineries
5. Infer integrated pest and disease management in organic and inorganic farming

## Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | | | 1 | 3 | | | | | | | | 3 | 1 | | |
| 2 | | | 2 | 1 | 1 | | 2 | 1 | | | 2 | 3 | 1 | | |
| 3 | | | 2 | 2 | 2 | | 2 | 1 | 2 | | | 3 | 1 | | 1 |
| 4 | | | 2 | 2 | 2 | | 2 | | 2 | 1 | | 3 | 2 | | 1 |
| 5 | | | | 2 | 1 | | 2 | 2 | 2 | | | 2 | 2 | | 2 |

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

**GROUPS OF INSECTS AND DISEASE**

Sucking pests, borer pests, soil pests, Vectors, Rodent pests and their symptoms of damage- Fungal bacterial and viral pathogens causing crop diseases

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

**AGRICULTURE AND HORTICULTURE CROP PESTS**

Insect pests of agricultural crops - rice, pulses, cotton, sugarcane - Horticultural crops - coconut, fruits, vegetables, and flower crops affected by various pests and disease - Storage insects - distribution, host range, bio-ecology, injury, integrated management of important insect pest

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

**METHODS OF CROP PROTECTION**

Cultural, physical, mechanical, legal, biological, chemical and biotechnological methods of crop protection, IPM, Organic farming - Organic production requirements; Biological intensive nutrient management-organic manures, vermicomposting, green manuring

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

**PLANT PROTECTION APPLIANCES**

Different machineries available for spraying and soil application on annual and perennial crops and maintenance of machineries

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

**PESTICIDE HAZARDS AND MANAGEMENT**

Pesticide residues in consumable crop parts by way of application of pesticides and fungicides, methods of decontamination of toxic chemicals, organic healthy way of crop protection

**FOR FURTHER READING**

Mode of spread of pest and diseases, prophylactic measures to manage pests - mode of action of pesticides, complex problems in plant protection

**Total: 45 Hours**

**Reference(s)**

1. Dhandapani, N and S.Uthamasamy 2000. Integrated pest Management. Tnau Publications, Coimbatore.p.181

2. Ragupathy. A and R. Ayyasamy 2003. A Guide on crop pests. Namrutha publications, Madananadapuram, Porur, Chennai 16.p.368

3. Justin. K.2004. Crop protection. TNAU, Petchipaarai, kanyakumari Dt.p.379

4. David, B.V. and T. kumaraswami 1975. Elements of Economic Entomology. Popular Book Depot, Chennai-600034.p.507. 16. 2003

**22AG028    EXTENSION METHODOLOGY AND TRANSFER OF TECHNOLOGY    3 0 0 3**

**Course Objectives**

To familiarize with proper communication techniques

To expose the students to different extension teaching methods

Utilizing all the electronic media for transfer of technology

**Course Outcomes (COs)**

1. Find the way to communicate in proper channel
2. Organize the various extension teaching methods and communication gadgets
3. Execute the use of electronic media for transfer of technology
4. Execute the way of strengthen to build experiential learning
5. Determine to able to participate in all extension activities

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 1 | 1 | 1 | 1 | | 1 | 2 | | 2 | 3 | | 1 | 1 | | |
| 2 | | | | 1 | | | 2 | | 3 | 2 | | 1 | 1 | | |
| 3 | 1 | | | 1 | 3 | 2 | | | 3 | | | 2 | 1 | | 1 |
| 4 | | | | 1 | 2 | 1 | | 2 | | 3 | | 1 | 1 | | |
| 5 | | | | 1 | 2 | | | | 2 | 3 | | 2 | | | 1 |

**UNIT I** 9 Hours
**COMMUNICATION**
Communication meaning, definition, types; Communication models - Aristotle, Shanon-Weaver, Berlo, Schramm, Leagans, Rogers & Shoemaker elements and their characteristics; Barriers in communication - Transfer of technology - meaning and concepts - Systems of transfer of technology - Knowledge Generating System - Knowledge Disseminating System - Knowledge Consuming System

**UNIT II** 9 Hours
**EXTENSION TEACHING METHODS**
Extension teaching methods, meaning, definition, functions, classification - individual, group, mass contact methods- merits and demerits; Audio aids, Visual aids and Audio-Visual aids, definition, classification, purpose, planning, selection, combination, use; Training, definition, types, training functions of FTC, KVK, EEI, MANAGE, NAARM

**UNIT III** 9 Hours
**E-EXTENSION**
e-Extension, Community Radio, Internet, cyber cafes, video and teleconferencing, Interactive Multimedia Compact disk, Agri portals, Information Kiosks, Kisan Call Centre, Mobile phone, Expert System, Village Knowledge Centre, DEMIC, consultancy clinics, Geographical Information System; Agricultural journalism, definition, principles, importance, ABC of news, types of news

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

**EXPERIENTIAL LEARNING, SYSTEMS THINKING**

Experiential Learning, concept, three types of learning: Scientia, Techne & Praxis; Kolbs Cycle; Systems Thinking: concept, importance, Hard System vs Soft System, Four World Views; Modelling the Farm System: production system, human activity system, marketing system, natural resource system, management system, Supra systems

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

**PARTICIPATORY EXTENSION, DIFFUSION OF INNOVATIONS**

Participatory Extension Approaches: RRA, PRA; Diffusion of Innovations: definition, elements; Innovation: definition, attributes; Adoption: meaning, steps in adoption process, adopter categories, factors influencing adoption of innovations; Consequences of innovations

**FOR FURTHER READING**

The Challenger case study: Bhopal Gas Tragedy: The Three Mile Island and Chernobyl case studies: Fundamental Rights, Responsibilities and Duties of Indian Citizens: Sample code of ethics like IETE, ASME, ASCE, IEEE, Institution of Engineers India, Indian Institute of Materials Management

**Total: 45 Hours**

**Reference(s)**

1. Berlo, D.K. 1960. The Process of Communication. Holt, Rinehart and Winston, New York

2. Dass, R. 1981. Appropriate Technology - Percepts and Practices Vintage Press Inc., New York

3. Ray, G.L. 1991. Extension Communication and Management. Kalyani Publishers, Kolkata

4. Mike W Martin and Roland Schinzinger, Ethics in Engineering, 4th edition, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, 2014

5. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi, 2012

6. R S Naagarazan, A text book on professional ethics and human values, New age international (P) limited, New Delhi, 2006

**22AG029      AGRICULTURAL MARKETING                3 0 0 3**

**Course Objectives**

To expose the students to know about marketing the Agricultural products from the point of production to the point of consumption / utilization

To import knowledge on marketing strategies and functions

To possess the knowledge on export and import market functioning system

**Course Outcomes (COs)**

1. Identify the market conduct and functions
2. Compare with various market channels and prices
3. Assess marketing institutions with various parameter
4. Assess the agricultural products trading
5. Implement the product prices and risk management

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 1 | 1 | 1 | 3 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | | |
| 2 | | 1 | 1 | 3 | 2 | 1 | | 1 | 2 | 3 | 2 | 1 | | 2 | |
| 3 | | 1 | 2 | 2 | 3 | 1 | | 2 | 2 | 2 | | 2 | 1 | | |
| 4 | | 1 | 2 | 3 | 2 | | | 1 | 2 | 2 | 2 | 1 | | 2 | |
| 5 | | 1 | 1 | 2 | 3 | 1 | | 1 | 2 | 2 | 2 | 1 | 1 | | |

**UNIT I                                                                                        9 Hours**
**MARKET STRUCTURE CONDUCT AND PERFORMANCE**
Components: Dynamics of Market Structure, Agricultural Marketing and Economic Development, Marketing Functions and their Classification, Marketing Agencies: Producers, Middlemen, Retailers, Commission Agents, Brokers, Advertising Agency: Marketing Institutions

**UNIT II                                                                                       9 Hours**
**MARKETING CHANNELS, MARKETING COST, MARKETING EFFICIENCY AND MARKET INTEGRATION**
Marketing Channels: Factors affecting Marketing Channels; Marketing Channels for various products, Innovative Marketing Channels, Market Integration: Types, Marketing Cost in India, Reducing Marketing Cost, Relationship of Farmers Price and Consumers Price

**UNIT III                                                                                      9 Hours**
**COOPERATIVE AGRICULTURAL MARKETING INSTITUTIONS**
Functions: Types, Single Commodity Multi Commodity, Multi purpose, Multi commodity Structure; Membership: Sources of Finance, Functioning, Cooperative Processing, NAFED, NCDC, NDDB, TANFE

**UNIT IV**      **9 Hours**
**EXTERNAL TRADE IN AGRICULTURAL PRODUCTS**
Trade Policy for Agriculture: Share of Agricultural Products in Total Imports and Exports of India, Changes in India"s Agricultural Export Basket, Recent Policies on Trade, GATT: The General Agreement on Trade and Tariffs, World Trade Organization

**UNIT V**      **9 Hours**
**AGRICULTURAL PRICES AND RISK MANAGEMENT**
Commission for Agricultural Costs and Prices: Price Policy, risks-minimization of risk, Future Trading, Dangers of Forward Market, Contract Farming and Contract Marketing
**FOR FURTHER READING**
Case studies on regulated markets for agricultural commodities

                                                             **Total: 45 Hours**

**Reference(s)**

1. Acharya S.S and N.L. Agarwal. 2012. Agricultural marketing in India. Oxford and LBH publishing co. Pvt. Ltd., New Delhi

2. Agricultural Marketing in Tamil Nadu, Department of Agricultural Marketing, Government of Tamil Nadu, Chennai, 2000

3. Khols, R.L. and Damey, Marketing of Agricultural Products, McMillan Company, New York, 1972

4. Wader, L.K. 2013.Text Book of Agricultural Marketing and Cooperation. ICAR New Delhi

**22AG030     INTEGRATED FARMING SYSTEM   3 0 0 3**

**Course Objectives**

To study about the basic principles of farming system aspects.

To learn the sustainable farming practices of varies IFS models to increase the food production.

To impart basic knowledge of different IFS units in farming system

To study various resource management strategies in farming systems.

To learn about different resource recycling for effective crop production.

**Course Outcomes (COs)**

1. Implement the concepts and principles of farming systems and IFS models to increase the crop productivity.
2. Assess the various sustainable farming practices for raising different farming methods.
3. Find the different IFS components in farming system.
4. Determine the resource management strategies in farming for effective utilization.
5. Assess the various resource recycling and residue management methodologies.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | | | | | | 1 | | | | | | 1 | | |
| 2 | | 2 | 1 | | 1 | | 1 | | 1 | | | | 1 | | |
| 3 | | | 1 | | | | | | | | | 1 | | | 2 |
| 4 | | 1 | 3 | | | | | | | | | | | 1 | |
| 5 | | 1 | 3 | | | | | | | | | | 1 | | |

**UNIT I**                                                                                                    **9 Hours**
**FARMING SYSTEMS**
Farming systems - Principles - scope of Integrated Farming system - evaluation indicators of integrated farming system - Integrated farming system models for different agro eco-systems - LEISA concepts and principles. Cropping systems for different agro climatic zones of India and Tamil Nadu - Crop diversification and intensification in farming system.

**UNIT II**                                                                                                   **9 Hours**
**SUSTAINABLE FARMING PRACTICES**
Design of heat exchangers - plate heat exchanger, shell and tube heat exchangers - materials of construction - installation and operation - design of single effect evaporators - applications -multiple effect evaporators- entrainment separators-installation and maintenance

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

**COMPONENTS OF IFS**

Integrated Farming system - various components of IFS. Study of different units: dairy, goat, poultry, fishery, mushroom, sericulture and biogas as allied sectors. Carbon foot-printing and greenhouse gas emission - Simulation models for intercropping.

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

**RESOURCE MANAGEMENT**

Resource use efficiency and optimization techniques - Resource management under IFS - Improving resource use efficiency in agriculture - Cost reduction strategies in crop production - cropping system, farming system and dry farming - Non-monetary inputs and low cost technologies - Labour management

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

**RESOURCE RECYCLING**

Resource recycling - Residue management - crop and livestock - Conservation agriculture - principles, concept and scope- Sustainable Agriculture - flow of energy in different farming systems

**Total: 45 Hours**

## References

1. Devasenapathy, P., T. Ramesh and B. Gangwar 2007.Efficiency indices for agriculture management research. New India Publishing agency, Delhi.
2. Jayanthi, C. Devasenapathy, P and C. Vennila. 2007. Farming Systems. Principles and practices. Satish Serial Publishing House.Delhi.
3. Jayanthi, C., N. Sakthivel, N. Sankaran and T.M. Thiyagarajan. 2003. Integrated Farming system – A Path to Sustainable Agriculture. TNAU Publication.
4. Palaniappan, SP and K. Sivaraman.1996. Cropping systems in the tropics - Principles and management. New Age International (P) Ltd., New Delhi.
5. S.C. Panda. 2003. Cropping and Farming Systems. Agrobios Publishers. Jodhpur.

**22AG031    SUSTAINABLE AGRICULTURE AND FOOD SECURITY        3 0 0 3**

**Course Objectives**

To study the importance of sustainable agriculture for the growing population, various resources required and their sustainability

Importance of science, food security and ecological balance

**Course Outcomes (COs)**

1. Implement the need for sustainable agriculture and land utilization
2. Assess the need for irrigation potential and water resource sustainability
3. Demonstrate organic farming and different sustainable agricultural practices
4. Analyze the ecological balance in food production and nutritional food security
5. Determine the policies and programs for sustainable agriculture and food security

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 2 | | | | 1 | | | | | | | 1 | 1 | |
| 2 | 2 | 2 | 3 | | | 1 | | | | | | | | 1 | 2 |
| 3 | 2 | 2 | 3 | 1 | | 1 | | | | | | | 2 | | |
| 4 | 2 | 3 | 2 | | | | | | | | | | | 2 | |
| 5 | 2 | | | | | | 2 | 3 | | | | | 1 | 2 | 1 |

**UNIT I                                                                         9 Hours**
**LAND RESOURCE AND ITS SUSTAINABILITY**
Sustainable agriculture- definition, concept, goals; factors affecting ecological balance- land degradation, water and air pollution, global warming, impact and amelioration Sustainable agriculture- problems and its impact on agriculture, indicators of sustainability, adaptation and mitigation, conservation agriculture strategies in agriculture. Land Resources of India - Population and land, Land utilization, Net Area Sown, changes in cropping pattern, land degradation

**UNIT II                                                                        9 Hours**
**WATER RESOURCE AND ITS SUSTAINABILITY**
Rainfall forecasting - adequacy of rainfall for crop growth - rainfall, drought and production instability - irrigation potential - available, created and utilized - river basins; watersheds and utilizable surface water - utilizable water in future - ground water and surface water

**UNIT III                                                                       9 Hours**
**SUSTAINABLE AGRICULTURE**
Agro ecosystem - impact of climate change on agriculture, effect on crop yield, effect on soil fertility - food grain production at state level - indicators on sustainable food availability - indicators of food production sustenance - natural farming principles - sustainability in rain-fed farming - organic farming: principles and practice - sustainable agriculture practice: natural farming, alternative farming, integrated farming

**UNIT IV                                                                        9 Hours**

**FOOD PRODUCTION AND FOOD SECURITY**
Performance of major food crops over the past decade - trends in food production - decline in total factor productivity growth - demand and supply projections - impact of market force - rural land market - emerging water market - vertical farming; food security - concepts and definitions, agriculture and food security, nutrition and health urbanization and food security, food system and food security; sustainable food security indicators and index - indicator of sustainability of food security - path to sustainable development

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

**POLICES AND PROGRAMMES FOR SUSTAINABLE AGRICULTURE AND FOOD SECURITY**
HEIA, LEIA and LEISA and its technique for sustainability, integrated farming system - historical background, objectives and characteristics, components of IFS and its advantages; Food and crop production policies - agriculture credit policy - crop insurance - policies of natural resource use - policies for sustainable livelihoods - virtual water and trade - sustainable food security action plan - macroeconomic policies employment and cash income, markets and food prices

**FOR FURTHER READING**
Precision Agriculture, Integrated Farming System, Bio-farms, Global Positioning System, Geographic Information System, Site Specific Nutrient Management for nutrient and irrigation management practices

**Total: 45 Hours**

**Reference(s)**

1. B. K. Desai and Pujari, B.T. Sustainable Agriculture: A vision for future, New India Publishing Agency, New Delhi, 2007

2. Saroja Raman, Agricultural Sustainability: Principles, Processes and Prospects, CRC Press, 2013

3. Sithamparanathan, J., Rengasamy, A., Arunachalam, N. Ecosystem principles and sustainable agriculture, Scitech Publications, Chennai, 1999

4. Gangadhar Banerjee and Srijeet Banerji, Economics of sustainable agriculture and alternate production systems, Ane Books Pvt Ltd., 2017

5. M. S. Swaminathan, Science and sustainable food security, World Scientific Publishing Co., Singapore, 2010

6. Mohan, S., Nair, P.K.R., Long, A.J. 2007. An Assessment of Ecological Diversity in Homegardens: A Case Study from Kerala State, India. Journal of Sustainable Agriculture. Volume 29, Issue 4: 135-153

## 22AG032    INSTRUMENTATION AND CONTROL
## ENGINEERING IN AGRICULTURE                 3 0 0 3

### Course Objectives

To expose students with electrical and electronic components used in the analytical instruments

To learn and understand the principles and operation of different instrumentation techniques

To understand the basic concepts of open loop and closed loop control systems

To understand the concept of frequency domain analysis

To understand the concept of stability of a system

### Course Outcomes (COs)

1. Organize the function of electrical and optical component in analytical instruments and their calibration
2. Execute the spectroscopic techniques to identify, estimate and characterize analytes
3. Organize the thermal behaviour of materials using thermal analysis
4. Develop a mathematical model of a physical system and compute the transfer function using Block diagram reduction technique and Signal flow graph
5. Assess the performance of first and second order system and compute the steady state error for different test signals

### Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | | | | | | 1 | 1 | |
| 2 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | | | | | | 1 | | |
| 3 | 1 | 3 | 3 | 1 | 1 | 1 | 2 | | | | | | | | 1 |
| 4 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | | | | | | 2 | | |
| 5 | 2 | 3 | 3 | 1 | 2 | 1 | 1 | | | | | | | | |

**UNIT I**                                                                                                    **9 Hours**
**INTRODUCTION**
Basic concepts of measurement system configuration. Concept of accuracy, precision error, resolution repeatability bias, calibration, range; Performance characteristics of Instruments- Zero, first and second order instrument systems and their response to different input signals (step, ramp etc) Specification and testing of dynamic response

**UNIT II**                                                                                                   **9 Hours**
**INSTRUMENT FOR VARIOUS USES**
Different types of measuring instruments, their working principles, construction features, measurement of level, flow, temperature, pressure, vacuum, force, torque, power, displacement, vibration, acceleration, pH, colour, viscosity, surface tension and composition. Indicating and recording type instruments, digital displays, transmitting and telemetering devices

**UNIT III**                                                                                                  **9 Hours**
**INTRODUCTION TO CONTROL SYSTEM**
Control system characteristics, purpose disturbances and stability Feed back and feed forward control strategies. Modelling the Dynamic and Static Behaviour of Process-Mathematical modelling for physical process control, state variables and state equations, modelling difficulties and considerations. Input-output models block diagram, degree of freedom, process controllers action, P, PI, PID controllers, final control system

**UNIT IV** **9 Hours**
**ANALYSIS OF DYNAMIC BEHAVIOUR**
Linearization of systems, Deviation variables, Application of Laplace transform in mathematical modelling of process control. Transfer function; Transfer function matrix. for processes having multiple outputs, Poles and zeros of transfer function

**UNIT V** **9 Hours**
**QUALITATIVE ANALYSIS OF RESPONSE OF SYSTEM**
Design of Feed Back System Block diagram, stability analysis, frequency response root locus analysis, Routh"s criteria, Nyquist plots and Bode diagrams. Control Systems for Various Uses Electronic pneumatic, hydraulic control system and their application in Farm machinery, food processing industry aquaculture, milk processing
**Total: 45 Hours**

**Reference(s)**

1. Doeblin, D.O. "Measurement Systems; Application and Design". McGraw Hill, 1984
2. Considine T..M. "Process/Industrial Instruments and ControlsÃ,Â· Handbook", McGraw Hill 1993
3. Fribance, A.E. "Industrial Instrumentation Fundamentals", McGraw Hill, 1962
4. Coughanowr, D.R. "Process Systems Analysis and Control", McGraw Hill, 1991
5. Patranabis. D. "Principles of Industrial Instrumentation", Tata McGraw Hill, 1995
6. Patranabis, D. "Principles of Process Control", Tata McGraw Hill, 1995

**22AG033**      **DATABASE MANAGEMENT AND MICROPROCESSOR**      **3 0 0 3**
                 **APPLICATIONS IN AGRICULTURE**

**Course Objectives**

    To learn data models, conceptualize and depict a database system using ER diagram

    To understand the internal storage structures in a physical DB design

    To know the fundamental concepts of transaction processing techniques

    Impart knowledge on the methods of interfacing 8085 and 8086 microprocessors with various peripheral devices

**Course Outcomes (COs)**

1. Impart knowledge on the methods of interfacing 8085 and 8086 microprocessors with various peripheral devices
2. Assess to master the basics of SQL and construct queries using SQL
3. Organize the modes of operations of I/O interface devices
4. Develop programs using the register set and instruction set of Programmable Interrupt Controller 8259A
5. Develop programs using the register set and instruction set of Programmable Interrupt Controller 8259A

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 1 | 2 | 1 | 2 | 1 | | | | | | | | 1 |
| 2 | 1 | 2 | 3 | 2 | 2 | 1 | 1 | | | | | | | | 1 |
| 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | | | | | | | | 2 |
| 4 | 3 | 3 | 2 | 1 | 2 | 1 | 2 | | | | | | | | 1 |
| 5 | 1 | 2 | 3 | 1 | 1 | 2 | 1 | | | | | | | | 2 |

**UNIT I**                                                                                                      **9 Hours**
**INTRODUCTION**
Purpose of Database system - Views of data - data models, database management system three schema architecture of DBMS, components of DBMS, E/R Model - Conceptual data modelling -motivation, entities, entity types, attributes, relationships, relationship types, E/R diagram notification, examples.

**UNIT II**                                                                                                     **9 Hours**
**RELATIONAL MODEL**
Relational Data Model - Concept of relations, scheme-instance distinction, keys, referential integrity and foreign keys, relational algebra operators, SQL - Introduction, data definition in SQL, table, key and foreign key definitions, update behaviors. Querying in SQL, notion of aggregation, functions group by and having clauses, embedded SQL

**UNIT III**                                                                                                    **9 Hours**
**DATABASE DESIGN**
Dependencies and Normal forms, dependency theory - functional dependencies, Armstrong"s Axioms for FD"s, closure of a set of FD"s, minimal covers, definition of 1NF, 2NF, 3NF and BCNF, decompositions and desirable properties of them, algorithms for 3NF and BCNF normalization, 4NF, and 5NF

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

**PERIPHERAL DEVICES AND I/O INTERFACING**

Programmable interrupt controller 8259A: Architecture and Signal description of 8259A - Command words of 8259A - operating models of 8259A - The Keyboard/Display controller 8279: Architecture and Signal Description of 8279 - Modes of Operations of 8279 - DMA Controller 8257: Internal Architecture and Signal Descriptions of a 8257 - DMA Transfers and Operations

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

**MICROCONTROLLER**

Architecture of 8051 - Signal descriptions of 8051 - Register Set of 8051 - Memory Addressing - External I/O Interfacing -Addressing modes of 8051 - Instruction set of 8051

**FOR FURTHER READING**

Introduction to Parallel, Distributed and oriented databases -Introduction to MySQL and PHP

**Total: 45 Hours**

**Reference(s)**

1. A. Silberschatz, Henry F. Korth, and S. Sudharshan, "Database System Concepts", 5th Ed, Tata McGraw Hill, 2006

2. C. J. Date, A. Kannan and S. Swamynathan, "An Introduction to Database Systems" 8th ed, Pearson Education, 2006Raghu Ramakrishnan, "Database Management Systems", Thrid Edition, McGraw Hill, 2003

3. S. K. Singh,"Database Systems Concepts, Design and applications", First Edition, Pearson Education, 2oo6

4. Mohamed Ali Mazidi, Janice Gillispie Mazidi, The 8051 microcontroller and embedded systems, Pearson education, 2009.

**22AG034      DATA ANALYTICS IN AGRICULTURAL SYSTEMS      3 0 0 3**

**Course Objectives**

Familiarize with the fundamentals of data science and related concepts

Acquaint the students with the knowledge to construct complex statistical models, assess the fit of such models to the data, and apply the models in real-world contexts

Apply quantitative modelling and data analysis techniques to the solution of real world business problems, communicate findings, and effectively present results using data visualization techniques

**Course Outcomes (COs)**

1. Select the Implement data science fundamentals and apply them to day-to-day business and industrial needs
2. Assess appropriate probability and statistical tests using R
3. Execute supervised and unsupervised algorithms in the data analysis process
4. Design the mathematical models for data analysis and also perform mining in text data
5. Construct the visualization models using Tableau and d3.js tools

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 1 | 2 | 1 | 3 | 2 | 2 | | | | | | | | 1 |
| 2 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | | | | | | 1 | | 1 |
| 3 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | | | | | | 1 | | 2 |
| 4 | 3 | 2 | 1 | 2 | 3 | 3 | 1 | | | | | | 1 | 1 | 1 |
| 5 | 2 | 3 | 2 | 1 | 1 | 2 | 3 | | | | | | | | 2 |

**UNIT I                                                                                        7 Hours**
**INTRODUCTION TO DATA SCIENCE**
Data Science Fundamentals, Exploring data engineering pipelines, Applying data science and data warehousing to business and industry

**UNIT II                                                                                       9 Hours**
**INTRODUCTION TO PROBABILITY AND R**
Introduction to Probability, Conditional Probability, Random Variable, Statistical Modelling, Probability Distribution, R Introduction, Data Structures in R, Working with Data in R

**UNIT III                                                                                   10 Hours**
**SUPERVISED AND UNSUPERVISED LEARNING**
Linear Regressions, Classification- Decision Tree, Naive Bayes, K-Nearest Neighbors, Clustering- Identifying Clusters, K-Means Clustering, Hierarchical Clustering

**UNIT IV                                                                                    10 Hours**
**MATHEMATICAL MODELLING**
Association Rule Mining, Time Series Analysis, Dimensionality Reduction, Principal Component Analysis, Linear Discriminant Analysis, Sentiment Analysis on text data

**UNIT V** **9 Hours**
**VISUALIZATION TOOLS**
Introduction to Visualization - Types of visualizations, working with Tableau, Creating views in Tableau, using d3.js for data visualization
**FOR FURTHER READING**
Data Analysis using Python, Natural Language Processing, Google Charts.

**Total: 45 Hours**

**Reference(s)**

1. Lillian Pierson, Data Science for Dummies, John Wiley,2015
2. Garrett Grolemund, Hadley Wickham, R for Data Science, O Reilly in January 2017.
3. Andrie de Vries, Joris Meys, R For Dummies, John Wiley and Sons, 2012
4. Jiawei Han, Micheline Kamber, Jian Pei, Data Mining: Concepts and Techniques, Elsevier Inc., 2012.
5. David Baldwin , Mastering Tableau, Packt Publishing, 2016.

| 22AG035 | **ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FOR AGRICULTURE** | **3 0 0 3** |

## Course Objectives

To impart artificial intelligence principles, techniques and its history

To introduce basic concepts and techniques of Machine Learning

To assess the applicability of AI and ML in Agriculture

## Course Outcomes (COs)

1. Use basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation and learning.
2. Implement machine learning algorithms to agricultural datasets for problem-solving
3. Select appropriate unsupervised learning models to address specific challenges in agriculture
4. Select and implement appropriate supervised learning models to address specific challenges in agriculture
5. Assess comprehensive pest management strategies, integrating AI-based approaches for pest detection, monitoring, and control and use of ML for agricultural applications

## Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 3 | 2 | | 2 | 3 | | | | | | | | | | 1 |
| 2 | 3 | 2 | | 2 | 3 | | | | | | | | | | 1 |
| 3 | 3 | 2 | | 2 | 3 | | | | | | | | | | 1 |
| 4 | 2 | 2 | | 2 | 3 | | | | | | | | 2 | 2 | 2 |
| 5 | 2 | 2 | 1 | 2 | 3 | 1 | 1 | 1 | 1 | | 1 | | 2 | | 3 |

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

**INTRODUCTION TO AI - INTELLIGENT AGENT AND UNINFORMED SEARCH**
Introduction – Foundations of AI – History of AI – The state of the art – Risks and Benefits of AI -Intelligent Agents – Nature of Environment – Structure of Agent – Problem Solving Agents -Formulating Problems – Uninformed Search – Breadth First Search – Dijkstra's algorithm or uniform-cost search – Depth First Search – Depth Limited Search

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

**INTRODUCTION TO MACHINE LEARNING**
Need for Machine Learning, Machine Learning Explained, and Machine Learning with respect to agriculture, Types of Machine Learning. Challenges of Machine Learning, Machine Learning process, Machine Learning applications.

**UNIT III**                                                                                       **8Hours**

**UNSUPERVISED LEARNING**
Unsupervised Learning – Principle Component Analysis – Neural Network: Fixed Weight Competitive Nets – Kohonen Self-Organizing Feature Maps – Clustering: Definition – Types of Clustering – Hierarchical clustering algorithms – k-means algorithm

**UNIT IV**                                                                                        **8 Hours**

**SUPERVISED LEARNING**
Neural Network: Introduction, Perceptron Networks – Adaline – Back propagation networks -Decision Tree: Entropy – Information gain – Gini Impurity – classification algorithm – Rule based Classification – Naive Bayesian classification – Support Vector Machines (SVM)

**UNIT V**                                                     **12 Hours**
**APPLICATION OF AI AND ML FOR AGRICULTURE**
Application of AI and ML for agriculture - Disease Classification - Pest detection and monitoring - Integrated pest management using AI - Early warning systems for pest outbreaks and Detection in Plants - Species Recognition in Flowers - Precision Farming - Use of ML For Portable Proximal Soil And Crop Sensors - Soil And Crop Image Processing - Digital Soil Mapping - General Overview - Digital Soil Mapping With Continuous Variables and Categorical Variables

**Total: 45 Hours**

**Reference(s)**

6. Peter Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data, First Edition, Cambridge University Press, 2012

7. Jason Bell, Machine learning Hands on for Developers and Technical Professionals, First Edition, Wiley, 2014

8. Ethem Alpaydin, Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series, Third Edition, MIT Press, 2014

9. Stuart J. Russell, Peter Norvig, Artificial Intelligence - A Modern Approach, Third Edition, Pearson Publishers, 2015.

10. Dheepak Khemani, A first course in Artificial Intelligence, McGraw Hill Education Pvt Ltd., New Delhi, 2013

11. Ric, E., Knight, K and Shankar, B. 2009. Artificial Intelligence, 3rd edition, Tata McGraw.

**22AG036      MECHATRONICS IN AGRICULTURAL ENGINEERING     3 0 0 3**

**Course Objectives**

Develop a comprehensive understanding of mechatronics principles and their application in agricultural engineering

To learn about mechatronics systems and equipment used in agricultural engineering

To Analyze and design mechatronics solutions for agricultural engineering problems

Develop critical thinking and problem-solving skills in the context of mechatronics in agricultural engineering

**Course Outcomes (COs)**

1. Assess the mechatronic design approach to develop integrated systems in the field of agricultural engineering
2. Design the effective interfacing, instrumentation, and control systems for mechatronic applications in agricultural engineering
3. Assess the principles of Microprocessor based controllers and Microelectronics
4. Organize various control systems and their application in agricultural engineering
5. Execute the knowledge to choose suitable robot used for the agriculture purpose

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 2 | | | | 1 | | | | | | | | | 2 |
| 2 | 2 | 2 | 3 | | | 1 | | | | | | | 1 | | 3 |
| 3 | 2 | 2 | 3 | 1 | | 1 | | | | | | | | | 2 |
| 4 | 2 | 2 | 3 | 1 | | 1 | | | | | | | 2 | | 3 |
| 5 | 2 | 3 | 2 | | | | | | | | | | | 2 | 2 |

**UNIT I**                                               **9 Hours**
**INTRODUCTION**
Definition of mechatronics, measurement system, control systems, microprocessor-based controllers, mechatronics approach. Sensors and transducers, performance terminology, Displacement, Position & Proximity Sensors, photo-electric transducers, flow transducers, optical sensors and transducers

**UNIT II**                                               **9 Hours**
**MICROPROCESSOR CONTROL**
System interfacing, instrumentation, and control systems. Input/output signals of a mechatronic system, signal conditioning, microprocessor control, microprocessor numerical control, microprocessor input/output control.

**UNIT III**                                             **9 Hours**
**MICROPROCESSOR BASED CONTROLLERS AND MICROELECTRONICS**
Introduction to microelectronics, digital logic, overview of control computers, microprocessors and microcontrollers, programmable logic controllers, digital communications

**UNIT IV**                                             **9 Hours**
**TECHNOLOGIES OF ROBOT**
Sub systems, transmission system (Mechanics), power generation and storage system, sensors, electronics, algorithms and software. Servo motor drives types and applications. Stepper motor and its concept. Industrial robots: Classification and sub systems. Defining work space area

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

**APPLICATION OF ROBOTS IN AGRICULTURE**

Harvesting and picking, weed control, autonomous mowing, pruning, seeding, spraying and thinning, phenotyping, sorting and packing. Utility platforms. Use of different agro bots in agriculture.

**FOR FURTHER READING**

System modelling & control, Mathematical Models, Engineering Systems, Electro-mechanical & Hydraulic-mechanical Systems

**Total: 45 Hours**

**Reference(s)**

1. Alciatore DG and Histand MB. 2002. Introduction to Mechatronics and Measurement System. McGraw Hill Pvt Limited, New Delhi.

2. Robert HB. 2002. Mechatronic Hand Book. CRC Press.

3. Shakhatreh and Fareed. 2011. The Basics of Robotics. Lahti University of Applied Sciences Machine and Production Technology

4. Wolfram, Stadler. 1995. Analytical Robotics and Mechatronics. McGraw Hill Pvt Limited, New Delhi.

5. Bolton, W. 2010. Mechatronics. Pearson Education Asia

**22AG037    GEOINFORMATICS AND NANO- TECHNOLOGY        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

**Course Outcomes (COs)**

1. Organize the origin and advance of nanomaterials and its classification
2. Compare the different types of methods adopted for synthesizing nanomaterials
3. Assess the characterization techniques for analyzing nanomaterials
4. Execute 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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 3 | 2 | 2 | 1 | | | | | | | 1 | 1 | |
| 2 | 2 | 2 | 1 | 1 | 2 | 3 | | | | | | | | 2 | |
| 3 | 2 | 1 | 2 | 1 | 2 | 2 | | | | | | | | 2 | |
| 4 | 3 | 1 | 3 | 1 | 3 | 2 | | | | | | | 1 | 1 | |
| 5 | 2 | 3 | 1 | 2 | 2 | 3 | | | | | | | 1 | 2 | 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 cascade laser - quantum efficiency of semiconductor nanomaterials

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

**NANOMACHINES AND NANODEVICES**

Microelectromechanical systems (MEMS) and Nanoelectromechanical systems (NEMS)-fabrication, actuators-HEMT devices: structure, fabrication, principle, types and applications - organic LED: basic processes, carrier injection, exactions, optimization - organic photovoltaic cells- single electron transistor- particulate and geometrical nanomagnets - spintronics

**Total: 45 Hours**

**Reference(s)**

1. Willam A. Goddard, Donald 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, Aulice Scibioh M, "Fuel cells: Principles and Applications", University Press, 2009.

## 22AG038   AGRI BUSINESS MANAGEMENT AND ENTREPRENEURSHIP    3 0 0 3

**Course Objectives**

To study about the concept and importance of agri-business system

To develop the management competencies required by student in the field of Agriculture to establish and support profitable agribusiness in a competitive global business environment

The ability to use effectively business management techniques in an international environment

**Course Outcomes (COs)**

1. Analyses agribusiness situations, formulate strategies, implement plans and manage strategic change
2. Execute how organizations adapt to an uncertain environment and identify techniques managers use to influence and control the internal environment
3. Analyze the process of managements four functions: planning, organizing, leading, and controlling
4. Analyze the various structure and technologies of the agribusiness sector to develop the business in the competitive marketing
5. Implement the systematic process to elect and ability to discern distinct entrepreneurial traits

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 |  | 1 |  |  |  |  |  | 1 | 2 |  | 3 |  |  | 1 |  |
| 2 |  | 2 | 1 |  | 1 |  |  |  | 1 |  | 1 |  |  |  | 1 |
| 3 |  | 1 | 2 |  |  |  | 3 | 3 |  |  | 1 |  |  | 1 |  |
| 4 |  | 1 | 2 |  |  |  |  |  |  |  |  |  |  | 1 |  |
| 5 |  | 2 | 1 | 1 |  |  |  | 2 |  |  |  |  |  |  | 1 |

**UNIT I**                                                                 **9 Hours**
**AGRIBUSINESS MANAGEMENT**
Concept - components of agribusiness - forms of agribusiness firms. Management - concept - functions of management - managerial roles and skill-Mintzbergs- required at various levels of management.

**UNIT II**                                                                 **9 Hours**
**MANAGEMENT FUNCTIONS**
Planning - steps and types of plans. Organizing - basis for Departmentation - Staffing - human resource planning process - Directing - techniques of direction. Coordination and control - types.

**UNIT III**                                                                **9 Hours**
**FUNCTIONAL AREA - I**
Operations management - planning and scheduling - supply chain management in agribusiness - Human resource management - job analysis, recruitment and selection process

**UNIT IV**                                                                 **9 Hours**
**FUNCTIONAL AREA - II**
Marketing Management - market segmentation, consumer buying behaviour and marketing mix - Financial management - concept and financial planning for agribusinesses

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

**ENTREPRENEURSHIP**

Entrepreneur - entrepreneurship - types, characteristics and process - Innovation, business incubation and financing entrepreneurs.

**FOR FURTHER READING**

Market survey for understanding client needs and satisfaction - Pricing methods for small agribusinesses

**Total: 45 Hours**

**Reference(s)**

1. Subba Reddy, S. and P. Raghu Ram. 2011. Agricultural Finance and Management. Oxford & IBH. New Delhi.

2. Muniraj, R. 1987. Farm Finance for Development. Oxford & IBH. New Delhi.

3. Lee, W.F., M.D. Boehlje, A.G. Nelson and W.G. Murray. 1998. Agricultural Finance.Kalyani Publishers. New Delhi

4. Patnaik, V.E. and A.K. Roy. 1988. Cooperation and Cooperative Management. Kalyani Publishers, Ludhiana.

**22AG039     AGRICULTURAL FINANCE, BANKING AND CO-OPERATION     3 0 0 3**

**Course Objectives**

To study the various methods of agriculture finance

To reconstruct the policies and of co-operative so that it can bring about economic development of people

**Course Outcomes (COs)**

1. Create a confidence in the preparation and use of business accounts
2. Compute an opportunity to prepare, as part of their final management project, a thorough analysis of a business situation
3. Implement the marketing linkages with centre to increase employment opportunities and generating income
4. Execute Co-operation Philosophy and Principles as part of revitalizing cooperative credit
5. Predict the financial inclusion and exclusion with assessment of crop losses.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | | | | | | | | | | 3 | | 1 | | |
| 2 | 2 | 1 | | | | 1 | | | | | 3 | | | 1 | |
| 3 | 3 | 2 | | | | 1 | 2 | | | | 2 | | 1 | | |
| 4 | 2 | 1 | | | | 1 | | | | | 3 | | 1 | | 1 |
| 5 | 2 | 1 | | | | 1 | | | | | 3 | | | 1 | |

**UNIT I**                                                                                                    **9 Hours**
**AGRICULTURAL FINANCE - NATURE AND SCOPE**
Agricultural Finance: Definition, Importance, Nature and Scope - Agricultural credit: Meaning, Definition, Need and Classification - Sources of credit - Role of institutional and non - institutional agencies - Rural indebtedness-Consequences of rural indebtedness Development of rural credit in India

**UNIT II**                                                                                                   **9 Hours**
**FARM FINANCIAL ANALYSIS**
Principles of Credit - 5Cs, 3Rs and 7 Ps of Credit - Project Cycle and Management - Preparation of bankable projects / Farm credit proposals - Feasibility - Time value of money-Compounding and Discounting - Appraisal of farm credit proposals - Undiscounted and Discounted measures - Repayment plans - Farm Financial Statements- Balance Sheet, Income Statement and Cash Flow Statement - Financial Ratio Analysis

**UNIT III**                                                                                                  **9 Hours**
**FINANCIAL INSTITUTIONS**
Institutional Lending Agencies - Commercial banks- Nationalization, Agricultural Development Branches-Regional Rural Banks, Lead bank, Scale of finance - Higher financial institutions- RBI, NABARD, AFC, ADB, World Bank and Deposit Insurance and Credit Guarantee Corporation of India - Microfinance and Its role in poverty alleviation - Self-Help Groups - Non-Governmental Organizations - Subsidized farm credit, Differential Interest Rate (DIR), Kisan Credit Card (KCC) Scheme - Relief Measures and Loan Waiver Scheme and Know Your Customer (KYC)

**UNIT IV**                                                                                                    **9 Hours**
**CO-OPERATION**
Co-operation: Philosophy and Principles - History of Indian Co-operative credit movement: Pre and Post-Independence periods and Co-operation in different plan periods - Co-operative credit institutions -Two tier and three tier structure, Functions-provision of short term and long term credit, Strength and weakness of co-operative credit system, Policies for revitalizing co-operative credit - Successful co-operative credit systems in Gujarat, Maharashtra, Punjab, etc. - Special Co-operatives: LAMPS and FSS- Objectives, role and functions - National Cooperative Development Corporation (NCDC) and National Federation of State Cooperative Banks Ltd. (NAFSCOB): Objectives and functions

**UNIT V**                                                                                                     **9 Hours**
**BANKING AND INSURANCE**
Meaning, Importance and Types - Central bank- RBI - functions - Credit control - Objectives and Methods: CRR, SLR and Repo rate - Credit rationing - Dear money and cheap money - Financial Inclusion and Exclusion: credit widening and credit deepening monetary policies. Credit gap: Factors influencing credit gap - Non- Banking Financial Institutions (NBFI) - Assessment of crop losses, Determination of compensation - Crop Insurance Schemes - Livestock Insurance Schemes - Agricultural Insurance Company of India Ltd (AIC)
**FOR FURTHER READING**
Role of technology in finance and banking sector in India
                                                                                                    **Total: 45 Hours**

**Reference(s)**

1. Subba Reddy, S. and P. Raghu Ram. 2011. Agricultural Finance and Management. Oxford & IBH. New Delhi.

2. Muniraj, R. 1987. Farm Finance for Development. Oxford & IBH. New Delhi.

3. Lee, W.F., M.D. Boehlje, A.G. Nelson and W.G. Murray. 1998. Agricultural Finance.Kalyani Publishers. New Delhi

4. Patnaik, V.E. and A.K. Roy. 1988. Cooperation and Cooperative Management. Kalyani Publishers, Ludhiana.

**22AG040     TECHNOLOGY OF SEED PROCESSING          3 0 0 3**

**Course Objectives**

To acquire the knowledge on the various seed production and processing technologies

To impart knowledge on seed testing and the methods

To impart knowledge about seed certification, legislation and industries in India

**Course Outcomes (COs)**

1. Organize various technologies available in seed production
2. Implement the seed processing techniques and identify various seed processing equipment
3. Select the different methods and procedure to test the seeds
4. Use the knowledge on certification and legislation in seed industries
5. Assess the growth of seed industry and their role in India

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 3 | 3 | 1 | 2 | 1 | | | | | | 1 | 1 | | |
| 2 | 2 | 3 | 2 | 1 | 2 | 1 | | | | | | 1 | 1 | | |
| 3 | 2 | 1 | 2 | 1 | 1 | 3 | | | | | | 1 | 1 | | |
| 4 | 2 | 2 | 2 | 1 | 2 | 1 | | | | | | 1 | 1 | | |
| 5 | 2 | 2 | 3 | 2 | 2 | 1 | | | | | | 1 | 1 | | |

**UNIT I                                                                                          9 Hours**
**SEED PRODUCTION TECHNOLOGY**
General Principles: Genetic principles, Agronomic principles, seed morphology, shape, size, seed hardness, colour; Harvesting of seed crops. Nucleus and Breeders seed, method of maintenance of nucleus and Breeders seed in self, fertilized and cross, fertilized crops, Foundation and certified seed production; Seed production of cereals, pulse, oil seeds, fibre crops, forage crops, sugar crops and their hybrid verities; physiological and harvestable maturity of different kinds of seeds.

**UNIT II                                                                                         9 Hours**
**SEED PROCESSING TECHNOLOGY**
Preparing seed for processing, Seed moisture and drying, Air screen cleaner, shape and size separators, gravity separators, surface texture separators, affinity for liquid separators, colour separators, electrical conductivity separators; seed treatment; seed elevators, conveyors, safe seed storage, seed packaging and handling, seed bins, dust removal, seed blending, seed marketing and distribution; methods for assessment of seed quality

**UNIT III                                                                                        9 Hours**
**SEED TESTING**
Sampling methods, Determination of seed density, Tolerances, hetrogenity, Purity, genuineness of variety. Moisture estimation, Germination, equipment, seed scarification, pre sowing treatment, seed priming, pelleting; Viability: Vigour and health.

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

**SEED CERTIFICATION AND LEGISLATION**

Objectives and concepts of seed certification, seed certification agencies, minimum seed certification standards for breeders seed, certified seed. Field and seed inspection, methods of inspection, post harvest inspection. Seed legislation loss

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

**SEED INDUSTRY IN INDIA AND THEIR ROLE IN AGRICULTURAL DEVELOPMENT**

Development of Seed industries in India: overview, National seeds corporation, State seeds Development Corporation. Five year plans. Private seed industries.

**UNIT VI** **9 Hours**

**FOR FURTHER READING**

Ozone treatment of seeds

**Total: 45 Hours**

**Reference(s)**

1. J.F Harrington and J.E Douglas, Seed storage and packaging application, NSC, New Delhi, 1963

2. J.E Douglas, Seed Production Mannual, National Seeds Corporation and Rockfeller Foundation, New Delhi, 1969.

3. J.E Douglas, Seed Certification Mannual, National seeds corporation, New Delhi, 1970

4. B.R Gregg, A.G. Law, S.S Virdi and J.S Balis Seed Processing, National seed corporation, New Delhi, 1990

5. R.L Agrawal, A text book on Seed Technology, Oxford & IBH Publication, Co Pvt Ltd, New Delhi-1992

6. L.O Copeland and M.B Mc Donald, Principles of Seed Science and Technology Chapman and Hall, New York, 1995

**22AG041**         **MUSHROOM CULTIVATION AND VERMICOMPOSTING**         **3 0 0 3**

**Course Objectives**

To provide hands on training for preparing the mother culture (Spawn production).

To study the various methods of mushroom cultivation.

To provide the training for using appropriate technology, utilization of resources and suitable market strategy for mushroom production

**Course Outcomes (COs)**

1. Execute the important of mushroom and how it can convert waste material into human food.
2. Organize the different methods of mushroom spawn production within a relatively small space
3. Assess various types cultivation practices of mushroom under different agro climatic zones of Tamil Nadu and India
4. Find the post-harvest methods and value addition of mushroom for extend the shelf life
5. Assess the marketing linkages with centre to increase employment opportunities and generating income

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 1 | | | | | | | 2 | | 1 | | | | |
| 2 | | | | | | | | | 3 | | 1 | | | | |
| 3 | | 1 | | | | 1 | | 1 | 2 | | 3 | | | | |
| 4 | | 2 | | | | | | | | | | | | | |
| 5 | | 2 | | | | | | | | | | | | | |

**UNIT I**                                                      **9 Hours**
**INTRODUCTION OF MUSHROOM**
History of mushroom - Scope and Importance - Life cycle of mushroom - Area, Production, Productivity of mushroom in World, India and Tamil Nadu, Types of mushroom - Oyster mushroom - Paddy straw mushroom - Button mushroom - Milky mushroom - Shiitake mushroom - Other mushrooms - Different parts of a typical mushroom & variations in mushroom morphology.

**UNIT II**                                                      **9 Hours**
**MOTHER SPAWN PRODUCTION**
Mushroom growing technologies - Facilities required for spawn preparation, Preparation of spawn substrate, preparation of pure culture, media used in raising pure culture, culture maintenance, storage of spawn. - Growing conditions for mushrooms - Composting technology, mushroom bed preparation. Spawning, spawn running, harvesting. Cultivation of oyster and paddy straw mushroom

**UNIT II**                                                      **9 Hours**
**PEST MANGEMENT AND POST HARVEST METHODS**
Problems in cultivation - diseases, pests and nematodes, weed moulds and their management strategies. Post-harvest technology and value addition of mushroom

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

**PEST MANGEMENT AND POST HARVEST METHODS**

Pest and diseases of mushroom - Harvesting, storing and using mushrooms - post-harvest technology and value addition of mushroom

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

**VERMICOMPOST COLLECTION AND PRODUCTION TECHNIQUES**

Waste material- Classification, segregation - processing- Bed preparation - earthworm collection and applications-Inspection of beds and watering - separation, air drying, sieving - storing

**FOR FURTHER READINGS**

Government policies and programmes for promotion of mushroom

**Total: 45 Hours**

**Reference(s)**

1. Mushroom Cultivation (Paperback, N. Revathy, A. Vijayasamundeeswari, V.M. Indumathi, V. Gomathi), Shanlax Publications, ISBN: 9789390082735, Edition: 1, 2020

2. V.N. Pathak, N. Yadav and M. Gaur. 2010. Mushroom production and processing technology. Published by Agrobios, Jodhpur

3. B.C. Suman and V.P.Sharma.2007. Mushroom cultivation in india. Daya Publishing House, New Delhi.179p

4. R.D. Rai and T. Arumuganathan (2008). Post-Harvest Technology of Mushrooms, Technical BulIetin 2008, NRCM, ICAR, Chambaghat, Solan1731213, (H.P.)

5. Anand B. Masthihole and L. Nalina (2016) Organic Farming. Agrimoon.Com

### 22AG042   AGRICULTURAL ECONOMICS & PROJECT PLANNING  3 0 0 3

**Course Objectives**

Demonstrate an understanding of Engineering Economy principles.
Analyse problems that an engineer would encounter on the job site through the use of Engineering Economy techniques.
Able to plan a project using the principles of project planning and management.

**Course Outcomes (COs)**

1. Find the importance, purpose of Planning and hierarchy of planning and analyze its types.
2. Compute decision making, Organizing, Staffing, Directing and Controlling.
3. Select the best economic model from various available alternatives.
4. Show various interest rate methods and implement the suitable one.
5. Integrate various depreciation values of commodities

**Articulation Matrix**

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

**UNIT I**                                                                                  **10 Hours**
**FUNDAMENTALS OF ECONOMICS**
Wealth, Welfare and Scarce Definitions of Economics; Micro and Macro Economics; Demand- Law of Demand, Elasticity of Demand, Types of Elasticity and Factors determining price elasticity of Demand: Utility- Law of Diminishing Marginal Utility, its limitations and exceptions.

**UNIT II**                                                                                  **8 Hours**
**FORMS OF BUSINESS ORGANIZATIONS**
Features, merits and demerits of Sole Proprietorship, Partnership and Joint Stock Company- Public Enterprises and their types.

**UNIT III**                                                                                 **10 Hours**
**HUMAN RESOURCE & PRODUCTION MANAGEMENT**
Functions of Management- Taylor's Scientific Management; Henry Fayol's Principles of management; Human Resource Management –Basic functions of Human Resource Management (in brief). Production Management: Production Planning and Control, Plant Location, Break-Even Analysis- Assumptions, limitations and applications.

**UNIT IV**
**FINANCIAL MANAGEMENT**                                                                     **9 Hours**
Types of Capital: Fixed and Working Capital and Methods of Raising Finance; Final Accounts- Trading Account, Statement of Profit and Loss and Balance Sheet (simple problems).

**UNIT V**                                                                                                     **8 Hours**
**MARKETING MANAGEMENT AND ENTREPRENEURSHIP:**
Marketing Management: Functions of marketing and Distribution Channels. Entrepreneurship: Definition, Characteristics and Functions of an Entrepreneur

**FOR FURTHER READING**
Components of costs - estimation of selling price, marginal cost, first cost, all kinds of overheads - indirect cost estimation with depreciation - mensuration and estimation of material cost, cost estimation of mechanical process - idling time.

**Total: 45 Hours**

**Reference(s)**

1. Management Fundamentals - Concepts, Application, Skill Development - Robers Lusier - Thomson
2. Basics of Engineering Economy, Leland Blank & Anthony Tarquin, McGraw Hill Publication (India) Private Limited
3. Engineering Economics, R.Paneerselvam, PHI publication
4. Fundamentals of Management: Essential Concepts and Applications, Pearson Education, Robbins S.P. and Decenzo David A.
5. Economics: Principles of Economics, N Gregory Mankiw, Cengage Learning
6. Modern Economic Theory, By Dr. K. K. Dewett & M. H. Navalur, S. Chand Publications A.M. Michael, and T.P. Ojha, Principles of Agricultural Engineering Vol II Jain Brothers, New Delhi, 1980

**22AG043**  **VALUE ADDITION OF INDIGENOUS FRUITS AND VEGETABLES**  **3 0 0 3**

**Course Objectives**

Understand Fruits and Vegetable Processing Techniques and its quality grading

Analyse the methods of processing for value added products from fruits and vegetables through different methods

Evaluate the conventional and modern packaging methods and quality control of value-added products

**Course Outcomes (COs)**

1. Assess the trend and selection of raw materials in value-added products.
2. Assess the techniques involved in fruit and vegetable processing
3. Outline the quality and manufacturing techniques of fruit products
4. Outline the quality and manufacturing techniques of vegetable products
5. Analyse the conventional and modern packaging methods.

**Articulation Matrix**

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

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

**INTRODUCTION TO VALUE-ADDED PRODUCTS**

Overview of Value-Added Processing – Definition and significance of value added products- Market trends and consumer demand for processed fruits and vegetables- Selection of raw materials – importance of quality and ripeness of fruits and vegetables- Heat treatment methods (blanching, pasteurization)

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

**PROCESSING TECHNIQUES**

Canning– Introduction and Method; Drying techniques of fruits and vegetables – benefits and challenges; Maturity and ripening process – factors affecting ripening of fruits and vegetables- chemicals used for hastening and delaying ripening of fruits and vegetables; Freezing methods – benefits and challenges; Packaging consideration of frozen fruits and vegetables

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

**VALUE ADDED PRODUCTS FROM FRUITS**

Value added products of mango – pulp, juice, concentrates, toffee, kernel flour; value added products of pineapple – canned pineapple, jam, vinegar, toffee; Value added products of grapes – wine, jelly, raisins.

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

**VALUE ADDED PRODUCTS FROM VEGETABLES**

Value added products of tomato – puree, paste, powder, sauce; Value added products from tuber crops- cassava flour, sago, starch; Value-added products of curcurbits – pumpkin seeds, cucumber pickles, bottle gourd tuty fruit, ash gourd petha. Minimally processed products and vegetable powders, plant based foods.

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

**PACKAGING AND QUALITY CONTROL OF VALUE ADDED PRODUCTS**

Various methods of packaging-packaging materials and transport – packaging technology for export. Fabrication of type of containers, cushioning material, vacuum packaging, poly shrink packaging, specific packaging for value added fruits and vegetables; Quality analyses, standards and FSSAI specifications of fruits and vegetable products. Market value; Waste Reduction

**Total: 45 Hours**

**Reference(s)**

1. Chakraverty, A, Arun S. Mujumdar, G.S.Vijayaraghavan, and Hosahalli. S. Ramaswamy. Handbook of Post Harvet Technology: Cereals, Fruits, Vegetables, Tea and Spices, Marcel Dekker. Inc. New York.2003

2. K.Sharma, Stevan J.Mulvaney and Syed S.H. Rizvi, Food Process Engineering-Theory and Laboratory equipments, John Wiley & Sons, New York, 2000.

3. Norman W. Desrosier, and James N. Desrosier. The Technology of Food Preservation 4th Edition, CBS Publisher & Distributions, New Delhi, 2004.

4. Siddappa, G.S. and Tendon, G. L. (2009). Preservation of Fruits and Vegetables. ICAR, Publications, New Delhi.

5. Srivastava, R.P. and Kumar, Sanjeev (2019). Fruit and Vegetable Preservation- Principles and Practices. 3rd Ed. CBS, Publishers, New Delhi

**22AG044 PRINCIPLES OF ORGANIC FARMING**              **3 0 0 3**

**Course Objectives**

To Understand the Concept of Organic Farming.

To Understand the Scope and Importance of Organic Farming.

To Ensure Safe and Healthy Food production

**Course Outcomes (COs)**

1. Assess the holistic concept organic farming as a system
2. Find the cultural production practices typically employed in organic farming
3. Organize the challenges and trends in the production, processing, and marketing of organic farm products
4. Determine the large body of literature relating to organic agriculture
5. Organize and develop an organic production system

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 1 | 1 | 1 | 1 |  | 1 | 2 |  | 2 | 3 |  | 1 | 2 |  |  |
| 2 |  |  |  | 1 |  |  | 2 |  | 3 | 2 |  | 1 | 2 |  |  |
| 3 | 1 |  |  | 1 | 3 | 2 |  |  | 3 |  |  | 2 | 2 |  |  |
| 4 |  |  |  | 1 | 2 | 1 |  | 2 |  | 3 |  | 1 | 1 |  |  |
| 5 |  |  |  | 1 | 2 |  |  |  | 2 | 3 |  | 2 | 2 |  |  |

**UNIT I**                                                                                                          **9 Hours**
**FUNDAMENTALS OF ORGANIC FARMING**
Introduction to organic farming: Definition, concepts, principles and objectives, characteristics - relevance to modern agriculture. Converting soil into organic. Basic concepts of cropping pattern, cropping system and farming system. Integrated Farming System

**UNIT II**                                                                                                         **10 Hours**
**ORGANIC FARMING INITIATIVES**
Initiatives taken by the central and state governments-NGOs and other organizations for promotion of organic agriculture in India. Organic nutrient sources and their fortification - organic manures- methods of composting, Green manures- bio fertilizers - types, methods of application - benefits and limitations.

**UNIT III**                                                                                                       **10 Hours**
**ORGANIC ECOSYSTEM AND NUTRIENT MANAGEMENT**
Nutrient use in organic farming-scope and limitations, Nutrient management in organic farming, Organic ecosystem and their concepts, Choice of crops and varieties in organic farming - crop rotations - need and benefits - multiple cropping

**UNIT IV**                                                                                                        **10 Hours**
**ORGANIC CROP AND PEST MANAGEMENT**
Fundamentals of insect, disease and weed management under organic mode of production-cultural biological methods-non chemical pest - disease management. Botanicals- pyrethrum, neem seed kernel extract, neem seed - powder, soluble neem formulations, neem oil. Operational structure of NPOP - other agencies for organic production.

**UNIT V**                                                                                                                    **6 Hours**
**ORGANIC CERTIFICATION**
Inspection - certification - labelling and accreditation procedures for organic products. Processing - economic consideration and viability. Marketing and export potential of organic products - national economy

**FOR FURTHER READING**
Case studies of Indigenous Technical knowledge e (ITK) for nutrient, insect, pest, disease and weed management. Visit to organic farms to study the various components and their utilization

**Total: 45 Hours**

**Reference(s)**

1.  Balasubramanian, R., Balakishnan, K and Siva Subramanian, K. 2013. Principles and practices of organic farming. Satish Serial Publishing House. 453p

2.  Tarafdar, J.C., Tripathi, K.P and Mahesh Kumar, 2009. Organic agriculture. Scientific Publishers, India. 369p.

3.  Tiwari, V.N., Gupta, D.K., Maloo, S.R and Somani, L.L. 2010. Natural, organic, biological, ecological and biodynamic farming. Agrotech Publishing Academy, Udaipur. 420p.

4.  Mukund Joshi and Prabhakarasetty, T.K. 2006. Sustainability through organic farming. Kalyani publishers, New Delhi. 349p

## MINOR ELECTIVES

### 22AGM001   BUILDING MATERIALS, ESTIMATION AND COSTING

**3 0 0 3**

**Course Objectives**

To understand the fundamental knowledge on different building materials

To impart knowledge on design of different aspects of building construction

To learn to prepare detailed estimate and cost estimate of buildings

**Course Outcomes (COs)**

1. Classify rocks, bricks and clay products based on their characteristics and examine the manufacturing process of bricks including moulding, drying and burning for its properties
2. Assess the natural resources of lime, its types and timber qualities and test for water cement ratio in manufacturing Portland cement.
3. Organize foundation, stone masonry and brick masonry and compare stone masonry and brick masonry
4. Construct the buildings by considering dampness, mortar, foundation and concrete
5. Find the cost estimate based on the public works department schedule rates

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 3 | 2 | | 1 | | | 1 | | | | | | | | 2 |
| 2 | 2 | 1 | | 2 | | | 1 | | | | | | | | 2 |
| 3 | 1 | 2 | 2 | 1 | | | 3 | | | | | | | | 3 |
| 4 | 1 | 2 | 3 | | | | 1 | | | | | | | | 3 |
| 5 | 2 | 2 | 2 | | | | 1 | | | | | | | | 3 |

**UNIT I**                  **9 Hours**
**CONSTRUCTION MATERIALS**
Classification of rocks - Characteristics of Stones -Testing of Stones-Manufacture of Bricks - Moulding -Drying and Burning of bricks-Properties of good Brick -Classification of bricks -Clay Products- Ceramics - Tiles - Earthenware and Stoneware and uses

**UNIT II**                  **8 Hours**
**LIME AND CEMENT**
Lime- Natural Sources -Types of lime - Calcination-Cement -Raw materials - Water Cement Ratio. Manufacture of Portland Cement Wet and Dry process -Standard Specifications- Storage of cement -Timber - Definition - Defects in timber -Qualities of good timber

**UNIT III**                  **9 Hours**
**BRICK, STONE MASONRY AND FOUNDATION**
Concept of Foundation -Factors affecting Selection of Foundations -Types of soils-Subsurface Investigations -Bearing Capacity of soil -Testing & Improving Bearing Capacity of soil- Types of Foundations-Piles -Foundation in Black Cotton soil-Site Selection - General principles - classification of brick masonry-precautions in brick masonry -Stone Masonry -Comparison between Brick and Stone Masonry -Classification -General Principles and precautions in stone masonry

**UNIT IV**                                                                                                                    **10 Hours**
**BUILDING CONSTRUCTION**
Walls -Classification of walls - Dampness -Causes of Dampness -Methods of Preventing Dampness - Damp Proofing materials - Methods of providing Damp Proofing Materials-Mortars -Functions and Types of mortars - Concrete -Characteristics -Types and uses - Cube Strength of Concrete -Roofs - Classification - Floors -Types of Floor-Types of Plastering and Pointing -Painting and Distempering

**UNIT V**                                                                                                                     **9 Hours**
**ESTIMATING AND COSTING**
PWD schedule of rates - data sheet - detailed estimate - abstract estimate - preparation of estimate market rate estimation

**FOR FURTHER READING**
Estimating and costing of farm structures- irrigation systems- farm ponds- poultry shed- dairy barn
                                                                                                                            **Total: 45 Hours**

**Reference(s)**

1. B.N. Datta, Estimation and costing. Published by the Author, Tagore Palli, Motilal Bose road, Lucknow, 2002

2. S.C Rangwala, Estimating and costing, Charotar book stall, Station road, Anand, 1991.

3. N.L. Arora and B.R. Gupta, Building construction. Sathyaprakasham, 16/7698, New market, New Rohtak road, New Delhi -5, 1995

4. B.L. Handoo and V.M. Mahajan, Civil engineering materials. Sathyaprakasam, 16/7698, New market, New Rohtak road, New Delhi-5, 1995

5. S.C. Rangwala, Building construction, Charotar publishing house, Anand, 2000

6. S.V Deodhar and Singhal, Civil engineering materials. Khanna publishers, 2B, Nath market, Naisark, Delhi - 2001

## 22AGM002     GROUNDWATER, WELLS AND PUMPS          3 0 0 3

**Course Objectives**

To provide students with an understanding of the principles of groundwater and its behavior

To introduce the methods and technologies used in groundwater exploration, development, and management

To familiarize students with the design and installation of wells and pumping systems

**Course Outcomes (COs)**

1. Identify the sources and availability of groundwater in a given area
2. Design and construct wells for accessing groundwater
3. Select and operate pumps for groundwater extraction
4. Organize the water quality of groundwater resources
5. Find sustainable management practices for groundwater resources

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 1 | 3 |   | 2 |   |   |   |   |   |   |   |   |   |   | 2 |
| 2 | 1 | 2 | 3 |   |   |   |   |   |   |   |   |   |   |   | 2 |
| 3 | 1 | 2 | 3 |   |   |   |   |   |   |   |   |   |   |   | 1 |
| 4 | 1 | 3 |   | 2 |   |   | 2 |   |   |   |   |   |   |   | 2 |
| 5 |   | 1 | 2 |   |   | 2 |   | 3 |   |   |   |   |   |   | 2 |

**UNIT I**                                                                                              **9 Hours**
**INTRODUCTION TO GROUNDWATER RESOURCES**
Sources and availability of groundwater, groundwater exploration methods, hydrologic cycle and water budget, water quality parameters and their significance, water scarcity issues and solutions

**UNIT II**                                                                                             **8 Hours**
**WELLS**
Types of wells, design principles and construction methods, logging and interpretation, well development, well rehabilitation, wellhead protection, well maintenance and troubleshooting

**UNIT III**                                                                                            **9 Hours**
**PUMPS**
Types of pumps and their selection criteria, operating characteristics and performance evaluation, pump installation and operation, energy efficiency of pumps, pump maintenance and troubleshooting

**UNIT IV**                                                                                             **9 Hours**
**GROUNDWATER QUALITY**
Parameters affecting water quality, water quality standards and guidelines, water quality testing methods, interpretation of water quality data, water treatment options, safe use and disposal of water

**UNIT V**                                                                                                                                   **10 Hours**
**SUSTAINABLE GROUNDWATER MANAGEMENT**
Groundwater management principles, groundwater monitoring and modeling, groundwater recharge techniques, conjunctive use of surface and groundwater resources, integrated water resources management, policies and regulations for sustainable groundwater management

**FOR FURTHER READING**
Estimating and costing of farm structures- irrigation systems- farm ponds- poultry shed- dairy barn
                                                                                                                                             **Total: 45 Hours**

**Reference(s)**

1.  David Keith Todd. "Groundwater Hydrology", John Wiley & Sons, Inc. 2007

2.  Bhagu R. Chahar, Groundwater Hydrology, McGraw Hill Education (India) Pvt Ltd, New Delhi, 2017

3.  Subramanya K, Fluid Mechanics and Hydraulic Machines: Problems and Solutions, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2018.

4.  Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014

**22AGM003**     **PROTECTED CULTIVATION**     **3 0 0 3**

**Course Objectives**

To impart knowledge on the protected cultivation of vegetables, fruits and flower crops

To sensitize the students on hi-tech production technology of fruits and vegetables and flower crops

To learn and practices the various production practices of flower and other high value crops

**Course Outcomes (COs)**

1. Execute the different methods of protected cultivation practices available for vegetable crops and flowers
2. Assess the technology available for vegetable crops
3. Assess the technology available for flower crops
4. Select precision farming techniques using sensors and Geographic information systems for the crops
5. Implement the technology available for horticulture crops

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 3 | 1 | 2 | | | | | | | 1 | 2 | | |
| 2 | 2 | 3 | 3 | 1 | 2 | | | | | | | 2 | 1 | 1 | |
| 3 | 2 | 2 | 2 | 1 | 2 | | | | | | | 1 | 1 | 1 | |
| 4 | 2 | 3 | 3 | 1 | 2 | | | | | | | 1 | 2 | | 1 |
| 5 | 2 | 2 | 3 | 1 | 2 | | | | | | | 1 | 2 | 1 | |

**UNIT I** 9 Hours
**PROTECTED CULTIVATION AND ITS TYPES**
Importance and methods of protected culture in horticultural crops. Importance and scope of protected cultivation, different growing structures of protected culture viz., green house, poly house, net house, poly tunnels, screen house, protected nursery house. Study of environmental factors influencing greenhouse production, cladding / glazing / covering material, ventilation systems, cultivation systems including nutrient film technique / hydroponics / aeroponic culture, growing media and nutrients, canopy management, micro irrigation and fertigation systems.

**UNIT II** 9 Hours
**PROTECTED CULTIVATION OF VEGETABLE CROPS**
Protected cultivation technology for vegetable crops: Hi-tech protected cultivation techniques for tomato, capsicum nursery, cucumber, gherkins, strawberry and melons, integrated pest and disease management, post-harvest handling.

**UNIT III** 9 Hours
**PROTECTED CULTIVATION OF FLOWER CROPS**
Protected cultivation technology for flower crops: Hi-tech protected cultivation of cut roses, cut chrysanthemum, carnation, gerbera, asiatic lilies, anthurium, orchids, cut foliages and fillers, integrated pest and disease management, postharvest handling.

**UNIT IV**                                                                                                    **9 Hours**
**PRECISION FARMING TECHNIQUES**
Concept and introduction of precision Farming: importance, definition, principles and concepts. Role of GIS and GPS. Mobile mapping system and its application in precision farming. Design, layout and installation of drip and fertigation in horticultural crops, role of commuters in developing comprehensive systems needed in site specific management (SSM), geo-referencing and photometric correction.

**UNIT V**                                                                                                      **9 Hours**
**PRECISION FARMING OF CROPS**
Sensors for information gathering, geo-statistics, robotics in horticulture, postharvest process management (PPM), remote sensing, information and data management and crop growth models, GIS based modeling, VRT, robotics and drones in agriculture Precision farming techniques for horticultural crops: Precision farming techniques for tomato, chilli, bhendi, bitter gourd, bottle gourd, cauliflower, cabbage, grapes, banana, rose, jasmine, chrysanthemum, marigold, tuberose, china aster, turmeric, coriander, coleus and gloriosa.

**FOR FURTHER READING**
Design of greenhouse roof trusses, sorting, grading and packing of fruits, vegetables and flowers, and their transportation to market.

                                                                                                        **Total: 45 Hours**

**Reference(s)**

1.  Lyn. Malone, Anita M. Palmer, Christine L. Vloghat Jach Dangeermond. Mapping out world: GIS lessons for Education, ESRI press, 2002

2.  David Reed, Water, media and nutrition for greenhouse crops. Ball publishing USA, 1996

3.  Adams, C.R. K.M. Bandford and M.P. Early, Principles of Horticulture, CBS publishers and distributors, Darya ganj, New Delhi, 1996

## 22AGM004   WATER 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

**Course Outcomes (COs)**

1. Assess the basic concepts of water conservation and water harvesting based on watershed

2. Implement the methods of water harvesting and their design criteria based on the hydrogeology

3. Organize various flood water and groundwater harvesting techniques

4. Select suitable soil erosion control structures with their design criteria based on the flow hydraulics

5. Assess various water storage structures with detailed design criteria

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | | 2 | | | | 2 | 3 | | | | | | | 1 | |
| 2 | 2 | 2 | 3 | | | 1 | | | | | | | | 2 | |
| 3 | | 1 | 3 | | | 1 | 1 | | | | | | | 1 | |
| 4 | 2 | 1 | 3 | | | 1 | 1 | | | | | | | 1 | |
| 5 | 1 | 1 | 3 | | | 2 | 2 | | | | | | | 1 | |

**UNIT I**                                                                                   **9 Hours**
**WATER RESOURCES AND CONSERVATION CHALLENGES**
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; Watershed – water resources management – public participation – integrated approach; Water governance – water sharing plans – policy, schemes and concerns

**UNIT II**                                                                                   **9 Hours**
**WATER HARVESTING CONCEPTS**
Principles of water harvesting – 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.

**UNIT III**                                                                                   **9 Hours**
**WATER HARVESTING TECHNIQUES**
Water harvesting principles for rural and urban – classification based on source, storage and use; 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 system and components – optimization for sustainable operation – cost estimation

**UNIT IV**                                                                                                  **9 Hours**
**FLOOD WATER AND GROUNDWATER 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; Groundwater harvesting – aquifer characteristics – subsurface techniques – infiltration wells – recharge wells – groundwater dams; Watershed-based approach – project planning at micro and macro levels – community participation – rain centres

**UNIT V**                                                                                                   **9 Hours**
**DESIGN ASPECTS OF WATER HARVESTING SYSTEMS**
Estimation of water quantity – selection of runoff coefficients – computation of rainwater runoff volume – hydrograph analysis; Design of drainage system – types – design criteria – filter design – causes of failures; Design of storage structures - storage capacity – selection of component – methods of construction; Trenching and Diversion Structures – types – site selection – design criteria – most economic section – design consideration of ditch system

**FOR FURTHER READING**

Global history of RWH – water sharing policy – water quality management – construction materials and processes – project on designing a RWH system for a residential complex, factory, college, any other institution – field visit

                                                                                          **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, 3 rd edition, Rain source 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

**22AGM005**     **WATERSHED PLANNING AND MANAGEMENT**     **3 0 0 3**

**Course Objectives**

> To acquire knowledge about the principles of watershed development activities

> To understand the hydrological responses of a watershed and its control measures

> To investigate the applicability of hydrological models for watershed conservation

**Course Outcomes (COs)**

1. Assess the watershed characteristics for their classification and prioritization
2. Execute the watershed planning activities based on the inventory and scope
3. Find the needs, methods and implementation strategies of watershed management projects
4. Assess the watershed responses for suggesting suitable control measures
5. Organize the selection of hydrologic models for watershed management

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | | | | | 3 | | | | | | | | | 3 |
| 2 | | | | | | 3 | 2 | | | | | | | | 3 |
| 3 | | | | | | 2 | 3 | | | | | | | | 3 |
| 4 | 1 | 2 | 3 | | | 1 | 2 | | | | | | | | 3 |
| 5 | 1 | | | | 3 | | 2 | | | | | | | | 3 |

**UNIT I**                                                                                   **9 Hours**
**WATERSHED CHARACTERISTICS**
Watershed-Concept and objectives - watershed classifications - land use and capabilities - watershed delineation - toposheets - codification - watershed priorities - Indian scenario - watershed issues

**UNIT II**                                                                                  **9 Hours**
**WATERSHED PLANNING**
Watershed resources inventory - land use data - hydrologic data - planning principles - watershed development plan - planning process - scope and objectives - step wise process - implementation strategy - monitoring and evaluation system

**UNIT III**                                                                                 **9 Hours**
**WATERSHED MANAGEMENT**
Project proposal formulation - action plan - watershed economics - runoff management - temporary and permanent soil conservation structures - water conservation practices - participatory watershed management - watershed based rural development - national programs on watershed management - Government of India guidelines

**UNIT IV**                                                                                  **9 Hours**
**WATERSHED RESPONSES**
Estimation of water yield - analysis of overland flow and rain water harvesting - assessment and management perspectives - development of recharge structures - estimation of soil erosion - measurement and controls - estimation of sediment yield - measurement and controls - watershed prioritization - index based models - morphometric analysis

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

**WATERSHED MODELS**

Hydrologic modelling - basic principles - objectives and scope - classification of watersheds models - empirical - conceptual - physical based - selection of watershed model - suitability - model assessment - sensitivity analysis - major watershed models - governing equations - software tools - working principles - exercises to expertise

**FOR FURTHER READING**

GIS for watershed management; Case studies in watershed development projects; decision support system for watershed management

**Total: 45 Hours**

**Reference(s)**

1. Ghanashyam Das, Hydrology and Soil Conservation engineering, Prentice Hall of India Private Limited, New Delhi, 2000

2. Suresh R, Land and water management principles, Standard Publishers & Distributors, New Delhi, 2008

3. K. Palanisami, V. N. Sharda and D. V. Singh, Water management in the Hill regions -Evidences from field studies. Bloomsbury Publishing India Pvt. Ltd, 2013

4. Das M, Saikia MD, Watershed management, PHI Learning, 2013

5. Brooks KN, Ffolliott PF, Magner JA, Hydrology and the Management of Watersheds, Wiley- Blackwell, Ames, IA, USA, 2013

**22AGM006**      **RESERVOIR AND FARM POND DESIGN**          **3 0 0 3**

**Course Objectives**

> To acquire knowledge about water harvesting structures and their design
>
> To understand the design aspects of reservoirs and farm ponds
>
> To infer the design, operation and maintenance of reservoirs and farm ponds

**Course Outcomes (COs)**

1. Assess the hydrological and watershed concepts of reservoirs and farm ponds
2. Design of reservoirs, embankment ponds and excavation ponds
3. Assess the seepage discharge and its impact on stability aspects of the dams
4. Find the constructional, operational and maintenance aspects of reservoirs and farm ponds
5. Organize the economic indicators for the cost-benefit analysis of water harvesting projects

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 1 | 2 | | | | 1 | | | | | | | | 3 |
| 2 | 2 | 1 | 3 | | | | 1 | | | | | | | | 3 |
| 3 | 2 | 2 | 3 | | | | 2 | | | | | | | | 3 |
| 4 | | 2 | 3 | | | 1 | 1 | | | | | | | | 3 |
| 5 | | 2 | | | | 2 | 3 | | | | | | | | 3 |

**UNIT I**                                                                                          **9 Hours**
**FUNDAMENTALS OF RESERVOIR AND FARM PONDS**
water harvesting - hydrological aspects - watershed aspects - topographical aspects for location - General considerations - drainage area - pond capacity - landscape evaluation - dam reservoir - classification - selection criteria - farm ponds - classification - design criteria

**UNIT II**                                                                                         **9 Hours**
**DESIGN ASPECTS OF RESERVOIR AND FARM POND**
Earthen embankments - functions - advantages and disadvantages -classification - hydraulic fill and rolled fill dams - basic design concepts - site selection - foundation requirements - grouting -harvesting principles - components - catchment and reservoir yield - estimating storm runoff - design catchment yield - dependable flow - excavated ponds -soils investigation - spillway and inlet requirements - planning and construction

**UNIT III**                                                                                        **9 Hours**
**SEEPAGE AND STABILITY ANALYSIS**
Estimation of seepage discharge - location of seepage line - graphical and analytical methods -flow net and its properties - seepage pressure - seepage line in composite earth embankments - drainage filters - piping and its causes - drainage system for seepage control - stability of slopes - analysis of failure by slice method - stability of earthen embankments against failure by tension, overturning, sliding - Slope protection

**UNIT IV** **9 Hours**
**CONSTRUCTION OF EARTHEN DAM**
Earthen dam - staking for construction - construction methods and specifications - considerations in implementation - checking with compliance standards - sealing methods -considerations in maintenance - monitoring evaluation and protection - extension and training - miscellaneous aspects - water quality considerations - seepage and evaporation reduction measures - runoff inducement methods

**UNIT V** **9 Hours**
**ECONOMIC ANALYSSI OF FARM POND AND RESERVOIR**
Estimation of earthwork - cost analysis - initial investment - variable cost - annual returns - present worth analysis - economic indicators - net present value - benefit cost ratio - internal rate of return - Payback period
**FOR FURTHER READING**
Other water harvesting structures - Appurtenant structures - design of dam components
**Total: 45 Hours**

**Reference(s)**

1. Murthy, V.V.N. and Jha. M. K. (2011). Land and Water Management Engineering. Kalyani Publication.

2. Garg, S. K. (2011). Irrigation Engineering and Hydraulic Structures. Khanna Publishers

3. Theib YO, Dieter P, Ahmed YH, Rainwater Harvesting

4. Agriculture in the Dry Areas, CRC Press, Taylor and Francis Group, London, 2012

5. Suresh R, Soil and Water Conservation Engineering, Standard Publisher Distributors, New Delhi, 2014

**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

**Course Outcomes (COs)**
1. Classify and characterize the various energy utilization techniques.
2. Identify suitable technique to provide an energy efficient system.
3. Identify the need for thermal systems with latest technologies.
4. Choose suitable techniques doe conserving energy with respect to emerging trends.
5. Assess the impact economics on the conservation of energy.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | | | | | | | | | | 1 | 3 | | | |
| 2 | 1 | 3 | | | | | | | | | 1 | 3 | | | |
| 3 | 1 | 3 | | | | | | | | | 2 | 3 | | | |
| 4 | 1 | 3 | 2 | | | | | | | | 3 | 3 | | | |
| 5 | 1 | 2 | 2 | | | | | | | | 1 | 3 | | | |

**UNIT I**                                                                                          **9 Hours**
**INTRODUCTION**
Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

**UNIT II**                                                                                          **9 Hours**
**ELECTRICAL SYSTEMS**
Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

**UNIT III**                                                                                          **9 Hours**
**THERMAL SYSTEMS**
Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and Encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

**UNIT IV** **9 Hours**
**ENERGY CONSERVATION IN MAJOR UTILITIES**
Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers –
D.G. sets

**UNIT V** **9 Hours**
**ECONIMICS**
Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing
–ESCO concept

**Total: 45 Hours**

**Reference(s)**
1. Energy Manager Training Manual (4 Volumes) available at www.energymanager training.com,a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.
2. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
3. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
4. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982
5. Turner. W.C., "Energy Management Hand book", Wiley, New York, 1982.
6. Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987.

**22OEC01      BASICS OF ANALOG AND DIGITAL ELECTRONICS      3 0 0 3**

**Course Objectives**

Understand the working of diodes and transistors in electronic circuits.

Understand the analog operational amplifier and its applications.

Understand the implementation of combinational and sequential circuits in digital systems.

**Course Outcomes (COs)**

1. Apply the diodes and transistors in regulators and amplifiers and analyze their characteristics.
2. Illustrate the working of analog IC with different configurations and its applications.
3. Simplification of Boolean expressions using K-map and implementation of combinational circuits.
4. Analyze the Flip flops and memory configurations in digital circuits.
5. Classify and analyze A/D and D/A converters with its parameters.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 3 | 1 | | | | | | | | | | | |
| 2 | 2 | 2 | 3 | | | | | | | | | | | | |
| 3 | 2 | 2 | 3 | 2 | | | | | | | | | | | |
| 4 | 2 | 2 | 3 | 3 | | | | | | | | | | | |
| 5 | 2 | 2 | 3 | 3 | | | | | | | | | | | |

**UNIT I**                                                                    **9 Hours**
**SEMICONDUCTORS DEVICES**
Conductor, Semiconductors & Insulators, Semiconductors: intrinsic & extrinsic, energy band diagram - Mobility - Electrons and holes - The P-N junction diode - Zener diode - Avalanche effect- Rectifier Circuits Half wave, Full wave circuits, Efficiency, PIV, Ripple factor and AC and DC current and voltage in rectifier. PNP and NPN Bipolar junction Transistors - H parameters equivalent circuit - Common emitter amplifier - DC behavior: the load slope and the Q point - AC behavior - Emitter follower amplifier - Field effect transistors: JFET and MOSFET.

**UNIT II**                                                                   **9 Hours**
**OPERATIONAL AMPLIFIERS: DC PERFORMANCE**
The operational amplifier - Input resistance, Output resistance, Open loop gain - Bias currents - Offset currents - Offset voltage - Differential mode gain - Common mode gain - Common mode rejection ratio - Negative feedback - Open loop gain and closed loop gain - Inverter amplifier - Non-inverter amplifier - The voltage follower - Transimpedance amplifier (Current to voltage converter) - Differential amplifier. Adders, Subtractors, Comparator, Integrator and Differentiator.

**UNIT III**                                                                  **9 Hours**
**DIGITAL TECHNIQUES: COMBINATIONAL CIRCUITS**
Numbering systems - Binary, octal and hexadecimal numbers - Boole algebra - Conversion and operations - AND gate- OR gate - Inverter - NAND gate - NOR gate - Exclusive OR gate. Morgans laws. Combinational Circuits: Truth tables, logic expressions, Logic simplification using K- map, half and full adder/subtractor, multiplexers, demultiplexers, Logic families :TTL and CMOS.

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

**DIGITAL TECHNIQUES: SEQUENTIAL CIRCUITS**

Gated Latches & Flip Flops- Level triggered and Edge triggered Flip-Flops, Flop (FF) types: RS type. JK FF. JK FF Master slave. D FF. T FF. Flip Flop Conversion. Shift registers, Counters. Memories Structure: address and data bus. ROM, PROM, EPROM and flash RAM. Volatiles Memories: RAM, SRAM, DRAM. Addressing modes.

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

**DIGITAL TO ANALOG CONVERTERS AND ANALOG TO DIGITAL CONVERTERS**

DIGITAL TO ANALOG CONVERTERS : Input latch. Binary Weighted Resistor Network. R-2R Ladder Resistor Network. Pulse Width Modulation . Resolution. Accuracy. Linearity. Zero Offset. Settling Time. Glitches. ANALOG TO DIGITAL CONVERTERS: Sampling. Real time sampling and equivalent time sampling. Sampling frequency. Sampling theorem (Nyquist). Anti-aliasing filtering. Sampling and holding. Conversion.

**Total: 45 Hours**

**Reference(s)**

1. L Robert Boylestead, Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education,2012.
2. J Millman, C. Halkias & Satyabrata Jit, Electronic Devices and Circuits, Tata McGraw- Hill,2010.
3. Ramakant A.Gayakwad, OP-AMP and Linear IC"s , Prentice Hall of India, 2002.
4. D.RoyChoudhry, Shail Jain, Linear Integrated Circuits, New Age International Pvt. Ltd., 2000.
5. Thomas L.Floyd, Digital Fundamentals, Prentice Hall, 11th Edition, 2015.
6. M.Morris Mano, Michael D Ciletti Digital Design 4th edition Pearson, 2011.

**22OEC02** **MICROCONTROLLER PROGRAMMING** **3 0 0 3**

**Course Objectives**

Understand Series of Microcontrollers in terms of architecture, Programming and Interfacing.

Learn Programming of PIC series of microcontrollers and learn building of hardware circuits using PIC 16F series of Microcontrollers

Learn the emerging trends in the design of advanced Microcontrollers.

**Course Outcomes (COs)**

1. Interpret the components and functionalities of 8051 Microcontrollers.
2. Develop microprocessor applications using the Assembly Language Program
3. Illustrate the working nature of PIC microcontroller on various versions
4. Illustrate the interfacing of different peripherals using PIC Microcontroller
5. Analyze the architecture and instruction set of ARM Microcontroller

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 1 | | | | | | | | | | | | |
| 2 | 1 | 3 | 1 | | | | | | | | | | | | |
| 3 | 1 | 1 | 2 | | 1 | | | | | | | | | | |
| 4 | 1 | 1 | 2 | | 3 | | | | | | | | | | |
| 5 | 1 | 1 | 3 | | 2 | | | | | | | | | | |

**UNIT I** **9 Hours**
**8-BIT MICROCONTROLLER**
Introduction-Intel 8051 architecture-Counters and Timers-Serial Interface- Interrupts- Interfacing to external memory and 8255- Instruction set- Address modes.

**UNIT II** **9 Hours**
**8051 ALP AND APPLICATIONS**
Assembly language program- Timers and Counters programming- DAC- ADC- Sensor- Keyboard and LCD.

**UNIT III** **9 Hours**
**PIC MICROCONTROLLER**
PIC Microcontroller features- PIC Architecture, Program Memory, Addressing Modes, Instruction Set, Instruction Format- Byte-oriented Instructions- Bit-oriented Instructions- Literal Instructions- Control Instructions (CALL & GOTO)- Destination Designator. MPLAB overview: Using MPLAB, Toolbars, Select Development Mode and Device type, Project, Text Editor, Assembler, MPLAB operations.

**UNIT IV** **9 Hours**
**PIC HARDWARE**
Reset, Clock, Control registers, Register banks, Program Memory Paging, Ports, Interrupts, Timer and Counter, Watchdog Timer, Power up timer, Sleep mode, I2C bus- A/D converter.

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

**HIGH PERFORMANCE RISC ARCHITECTURE**

ARM: The ARM architecture- ARM organization and implementation- The ARM instruction set- The THUMB instruction set- Basic ARM Assembly Language Program- ARM CPU Cores.

**FOR FURTHER READING**

Introduction- Architecture- Registers- Memory- Instruction set- Addressing Modes- I/O Pins- Timers- Counters- Interrupts.

**Total: 45 Hours**

**Reference(s)**

1. Ayala, Kenneth, "The 8051 Microcontroller", Thomson, 3rd Edition, 2004.

2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, " The 8051 Microcontroller and Embedded Systems", Person Education, 2nd Edition, 2004.

3. John B.Peatman, "Design with Microcontrollers", Person Education", 1st Edition, 2004.

4. Steave Furber, "ARM system-on-chip architecture" Addison Wesley, 2nd Edition, 2000.

5. A.V.Deshmukh, "Microcontrollers: Theory and Applications", Tata Mc Graw Hill, 12th reprint, 2005.

**22OEI01  PROGRAMMABLE LOGIC  CONTROLLERS        3 0 0 3**

**Course Objectives**

To impart knowledge about automation and architecture of PLC

To understand the PLC programming using timers, counters and advanced PLC functions

To familiarize the student with PLC based applications

**Course Outcomes (COs)**

1.  Outline the fundamental Concepts of Automation

2.  Conclude the architecture, interfacing and communication techniques of PLC

3.  Execute the suitable PLC Programming languages

4.  Attribute the various functions and instruction sets of PLC

5.  Generate a suitable logical programming for given applications

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | | 2 | 2 | | 3 | | | | | | | | |
| 2 | 2 | 1 | | 2 | 2 | | 3 | | | | | | | | |
| 3 | 2 | 1 | | 2 | 2 | | 3 | | | | | | | | |
| 4 | 2 | 1 | | 2 | 2 | | 3 | | | | | | | | |
| 5 | 2 | 1 | | 2 | 2 | | 3 | | | | | | | | |

**UNIT I**                                                                          **10 Hours**
**INTRODUCTION TO AUTOMATION**
Evolution of automation -Types of automation - Fixed, flexible and programmable automation - Batch process and continuous process - open loop system and closed loop system - Function of sensors - Proximity sensors: Capacitive and Inductive - Infrared and Laser Push-buttons and toggle switches - Actuators: Solenoid valve - servo motor - electromagnetic relays.

**UNIT II**                                                                          **9 Hours**
**ARCHITECTURE OF PLC**
Components of PLC - sink and source I/O cards - Processor - Memory: Types of memory, Input and Output modules: Discrete, Analog -Scan time of PLC -Interfacing computer and PLC: RS232, RS485, Ethernet - Selection criteria for PLC.

**UNIT III**                                                                          **8 Hours**
**PLC PROGRAMMING**
Programming languages - Ladder logic components: User and bit Instructions, branch instructions, internal relay instruction Boolean logic using ladder logic programming, Latching -Timers: On Delay timer, OFF Delay timer and Retentive timer - Counters: Up Counter and Down Counter.

**UNIT IV**                 **10 Hours**
**ADVANCED PLC FUNCTONS**
Instructions in PLC: Program Control Instructions, Math Instructions, Data Manipulation Instructions: Data compare operations, Data transfer operations - Sequencer and Shift register instructions- Analog Instructions: PID Controller - Scaling Instructions.

**UNIT V**                 **8 Hours**
**APPLICATIONS OF PLC**
Case Studies: Bottle filling system - Pick and place robot - Car Parking - Traffic light control (4 ways with pedestrian signal) -Elevators - Pneumatic stamping system - alarm annunciator system.

**Total: 45 Hours**

**Reference(s)**

1. F.D. Petruzella, Programmable Logic Controllers, Tata Mc-Graw Hill, Third edition, 2015.

2. Benjamin C Kuo, Automatic Control Systems, Prentice Hall of India, New Delhi, 2014.

3. John Park, Steve Mackay, Edwin Wright, Practical data communications for instrumentation and control, Newnes, Elsevier, 2015.

4. K. L.S. Sharma, Overview of Industrial Process Automation, Elsevier, 2014.

5. John W Webb and Ronald A Resis, Programmable Logic Controller, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.

**22OEI02** **SENSOR TECHNOLOGY** **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

**Course Outcomes (COs)**

1. Conclude the static and dynamic characteristics of measuring instruments
2. Compare the characteristics and working principles of Resistance, Inductance and Capacitance type sensors
3. Construct the interfacing and signal conditioning circuit for measurement system using different types of sensor
4. Analyze and select the suitable sensor for different industrial applications
5. Combine the modern technologies and smart materials to design various sensors

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 3 | 2 | 1 | | | | | | | | | | | | |
| 2 | 2 | 3 | 2 | 1 | 1 | | | | | | | | | | |
| 3 | 1 | 2 | 3 | 3 | 1 | | | | | | | | | | |
| 4 | 2 | 1 | 1 | 3 | 3 | | | | | | | | | | |
| 5 | 1 | 2 | 1 | 2 | 3 | | | | | | | | | | |

**UNIT I** **8 Hours**
**SENSORS FUNDAMENTALS AND CHARACTERISTICS**
Sensors: Principles of Sensing - Sensor Classification and terminology- Units of Measurements - Measurands- Sensor Characteristics: Static and Dynamic.

**UNIT II** **8 Hours**
**PHYSICAL PRINCIPLES OF SENSING**
Electric Charges, Fields, and Potentials; Capacitance; Magnetism; Induction; Resistance; Piezoelectric Effect; Hall Effect; Temperature and Thermal Properties of Material; Heat Transfer; Light; Dynamic Models of Sensor Elements.

**UNIT III** **9 Hours**
**INTERFACE ELECTRONIC CIRCUITS**
Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits, Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries for Low Power Sensors.

**UNIT IV** **10 Hours**
**SENSORS IN DIFFERENT APPLICATION AREA**
Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity and Acceleration; Force, Strain, and Tactile Sensors; Pressure Sensors, Temperature Sensors.

**UNIT V**                                                                                              **10 Hours**

**SENSOR MATERIALS AND TECHNOLOGIES**

Materials, Surface Processing- MEMS microsystem components- Microfluidics microsystem components - Nano Technology- Smart Materials.

**Total: 45 Hours**

**Reference(s)**

1. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer, 2016.

2. D. Patranabis, Sensors and Transducers, 2nd Edition, Prentice Hall India Pvt. Ltd, New Delhi, 2009.

3. Guozhen Shen, Zhiyong Fan, "Flexible Electronics: From Materials to Devices", 1st Edition, World Scientific Publishing Co, Singapore, 2015.

4. Horowitz, P., and W. Hill. The Art of Electronics. 2nd ed. Cambridge University Press, 1989.

| | | |
|---|---|---|
| **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 sustainabledevelopment

To give way to the bolster green technology and incline towards more ecofriendly options.

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | | 2 | | | | 3 | | | | | | | | |
| 2 | 2 | | | | | | 1 | | | | | | | | |
| 3 | 1 | | | | | | 3 | | | | | | | | |
| 4 | 2 | | | | | | 3 | | | | | | | | |
| 5 | 1 | | | | | | 1 | | | | | | | | |

**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 feed stocks, 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, Trans esterification: 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 andthermal 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, purification - wet and dry milling processes, saccharification-chemical and enzymatic. Production of bio methane and bio hydrogen.

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

**BIOREFINERIES**

Definition and types of biorefineries, co-products of biorefineries-oil cake and glycerol, purificationof 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**

Understand the importance of traditional foods and food habits

Know the traditional processing of snack, sweet and dairy food products

Infer the wide diversity and common features of traditional Indian foods and meal patterns.

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 1 | | | | | | | | | | | | | | |
| 2 | | 1 | | | | | | | | | | | | | |
| 3 | 2 | 1 | 1 | | | | | | | | | | | | |
| 4 | | | | | | | | 2 | | | | | | | |
| 5 | | | | | | | | 2 | | | | | | | |

**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**

Introduce the concept of food hygiene, importance of safe food and laws governing it

Learn common causes of food borne illness - viz. physical, chemical and biological and identification through food analysis

Understand food inspection procedures employed in maintaining food quality

**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**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 1 | 2 | 1 | | | | | | | | | | | | |
| 2 | | 1 | | | | 1 | 2 | 1 | | | | | | | |
| 3 | | 1 | | | | | | | | | | | | | |
| 4 | 1 | 2 | | | | | | | | | | | | | |
| 5 | 1 | 2 | | | | | | | | | | | | | |

**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

## 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

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | | | | | | | | | | | | | |
| 2 | 2 | 2 | | | | | | | | | | | | | |
| 3 | 3 | 1 | | | | | | | | | | | | | |
| 4 | 1 | 1 | | | | | | | | | | | | | |
| 5 | 2 | 3 | | | | | | | | | | | | | |

**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.

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

**9 Hours**
**UNIT V**
**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.  Willam A. Goddard, Donald 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.

**22OPH02**  **SEMICONDUCTOR PHYSICS AND DEVICES**  **3 0 0 3**

## Course Objectives

Impart knowledge in physical properties of semiconducting materials
Analyze the factors affecting the operation of semiconductor devices
Apply the physics of semiconductors to develop semiconductor devices

## Course Outcomes (COs)

1. Exemplify the band gap, drift and diffusion current densities due to carrier transport in semiconductors
2. Analyze the energy band diagram in thermal equilibrium and space charge width of PN junction
3. Illustrate the operation of Bipolar Junction transistor at different modes and different configurations
4. Illustrate the operation of metal oxide field effect transistor and their memory devices
5. Represent the working mechanism of opto-electronic devices

## Articulation Matrix

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 1 | | | | | | | | | | | | | |
| 2 | 2 | 1 | | | | | | | | | | | | | |
| 3 | 2 | 1 | | | | | | | | | | | | | |
| 4 | 2 | 1 | | | | | | | | | | | | | |
| 5 | 2 | 1 | | | | | | | | | | | | | |

**UNIT I**  **9 Hours**
**ENERGY BANDS AND CARRIER TRANSPORT PROPERTIES**
Energy Bands: Formation of energy bands - doping effects - energy levels - electron and hole concept in semiconductor. Carrier transport: Carrier drift-drift current density - conductivity- diffusion current density - total current density

**UNIT II**  **9 Hours**
**P-N JUNCTION**
Basic structure and fabrication process of p-n junction - current - voltage characteristics - energy band diagram - equilibrium Fermi levels - depletion region - junction breakdown phenomena - zener - avalanche breakdown.

**UNIT III**  **9 Hours**
**BIPOLAR JUNCTION TRANSISTOR**
The basic transistor action - operation in the active mode - current gain - static characteristics - carrier distribution in emitter, base and collector region - modes of operation - current - voltage characteristics of common base and emitter configuration - frequency response and switching of bipolar transistor

**UNIT IV** **9 Hours**
**MOSFET**
The ideal MOS diode - basic fundamentals and characteristics - types - CMOS and BiCMOS - CMOS inverter - MOSFET on insulator - thin film transistor (TFT) - silicon on insulators (SOI) devices - MOS Memory structures - DRAM and SRAM

**UNIT V** **9 Hours**
**PHOTONIC DEVICES**
Radiative transitions and optical absorption-light emitting diodes-organic LED - infrared LED - semiconductor laser - temperature effect - photo detector - photo diode - silicon and compound semiconductor solar cells - efficiency

**Total: 45 Hours**

**Reference(s)**
1. Donald A Neamen, "Semiconductor Physics and Devices", Tata McGraw Hill, 2012
2. S. M. Sze and M. K. Lee, "Semiconductor Devices, Physics and Technology", John-Wiley & Sons, 2015
3. Ben. G. Streetman and S. K. Banerjee , "Solid State Electronic Devices", Pearson Education Ltd, 2015
4. C. Kittel, "Introduction to Solid State Physics", John-Wiley & Sons, 2012
5. J. Millman and C. Halkias, "Electronic Devices and Circuits", Tata McGraw Hill, 2010
6. Hagen Klauk, "Organic Electronics: Materials, Manufacturing and Applications", Wiley-VCH, 2006

## 22OPH03      APPLIED LASER SCIENCE            3 0 0 3

**Course Objectives**

Impart knowledge on laser science

Explore different strategies for producing lasers

Create expertise on the applications of lasers in various fields

**Course Outcomes (COs)**

1. Illustrate the transition mechanisms and the components of a laser system
2. Compare the different types of lasers based on pumping method, active medium and energy levels
3. Compute the rotation of earth, velocity and distance using lasers and apply the same for day today applications
4. Analyze the role of lasers in surgical and endoscopy applications
5. Apply the laser techniques in industrial applications

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | | | | | | | | | | | | | |
| 2 | 1 | 2 | | | | | | | | | | | | | |
| 3 | 2 | 1 | | | | | | | | | | | | | |
| 4 | 2 | 1 | | | | | | | | | | | | | |
| 5 | 1 | 2 | | | | | | | | | | | | | |

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

**LASER FUNDAMENTALS**

Introduction - principle - absorption and emission of light - thermal equilibrium - Einstein's prediction - Einstein's relations - A and B coefficients - condition for large stimulated emission - spontaneous and stimulated emission in optical region - light amplification - condition for light amplification - population inversion- Components of lasers - pumping methods - pumping mechanisms - optical resonator

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

**LASER BEAM CHARACTERISTICS AND TYPES**

Characteristics of laser - Classification of lasers - principle, construction, working, energy level diagram and applications of molecular gas laser ($CO_2$ laser) - liquid laser (dye laser) - excimer laser - Solid state laser (Nd:YAG laser) - semiconductor laser (homojunction laser).

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

**LASERS IN SCIENCE**

Introduction - Harmonic generation (SHG) - Stimulated Raman emission - lasers in chemistry - laser in nuclear energy - lasers and gravitational waves - rotation of the earth - measurement of distance - Light detection And Ranging (LIDER) - velocity measurement – holography

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

**LASERS IN MEDICINE AND SURGERY**

Light induced biological hazards: Eye and skin - Eye laser surgery - photocoagulations - homeostasis - dentistry - laser angioplasty - different laser therapies - advantages & disadvantages - laser endoscopy.

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

**LASERS IN INDUSTRY**

Applications in material processing: laser welding - hole drilling - laser cutting - Lasers in electronics industry: information storage - bar code scanner- Lasers in defence: laser based military weapons - laser walls.

**Total: 45 Hours**

**Reference(s)**

1. K. Thiyagarajan and A. K. Ghatak, "LASERS: Fundamentals and Applications", Springer, USA, 2015
2. M. N. Avadhanulu, "An Introduction to Lasers Theory and Applications", S. Chand Publisher, 2013
3. W. Koechner, M. Bass, "Solid State Lasers: a graduate text", Springer Verlag, New York, 2006
4. K. P. R. Nair, "Atoms, Molecules and Lasers", Narosa Publishing House, 2009
5. K. R. Nambiar, "Lasers: Principles Types and Applications", New Age International Publications, 2006
6. A. Sennaroglu, "Solid-State Lasers and Applications", CRC Press, 2006

### 22OPH04          BIO-PHOTONICS                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.

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | | | | | | | | | | | | | |
| 2 | 3 | 2 | | | | | | | | | | | | | |
| 3 | 3 | 2 | | | | | | | 3 | | | | | | |
| 4 | 3 | 2 | | | | | | | 3 | | | | | | |
| 5 | 3 | 2 | | | | | | | | | | | | | |

**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 Photoexcitation – photo-induced physical, chemical, thermal and mechanical effects in biological systems – Optical biopsy – Single molecule detection

**UNIT III** **9 Hours**
**BIO-NANO-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 of 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. Introduction to Biophotonics, ParasN.Prasad, WileyInter-science, AJohnWiley & Sons, Inc., Publication (Class notes are developed mainly based on this book.)
2. Introduction to Biomedical Imaging, Andrew G.Webb, 2002, IEEE Press.
3. Biomedical Optics: Principles and Imaging, Lihong.V.Wang, Hsin.-I.Wu, 2007, Wiley Interscience 2007. & "An Introduction to Biomedical Optics", R.Splinterand B.A.Hooper, Taylor & Francis
4. Bioimaging Current Concepts in Light and Electron Microscopy, DouglasE.Chandler & Robert W.Roberson, Jones and Bartlett publishers.
5. Optical Imaging and Microscopy : Techniques and Advanced Systems, Peter Török and Fu-JenKao, 2004, Springer.

## 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 supramolecules
   To summarize the soft matter proprties of structures and components of life

### 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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | | | | | | | | | | | | | |
| 2 | 2 | 1 | | | | | | | | | | | | | |
| 3 | 2 | 2 | | | | | | | | | | | | | |
| 4 | 2 | 2 | | | | | | | | | | | | | |
| 5 | 2 | 2 | | | | | | | | | | | | | |

**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**

**REFERENCES**

1. Richard A L Jones, *Soft Condensd 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. A. Fernandez-Nieves, A M Puertas, *Fluids, Colloids and Soft materials: An Introduction to Soft Matter Physics*, John Wiley & Sons, 2016

5. Maurice Kleman, 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

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 2 | 1 | | | | | | | | | | | | | |
| 2 | 2 | | | | | | 1 | | | | | | | | |
| 3 | 1 | 3 | | | | | | | | | | | | | |
| 4 | 2 | 2 | | | | | | | | | | | | | |
| 5 | 3 | 3 | | | | | 1 | | | | | | | | |

**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", CreateSpace Independent Publishing Platform, 2016.

2. E.McCafferty, "Introduction to Corrosion Science", Springer; 2010 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, 2008

5. David E.J. Talbot (Author), James D.R. Talbot, "Corrosion Science and Technology", Second Edition (Materials Science & Technology), CRC Press; 2nd Edition, 2007.

6. http://corrosion-doctors.org/Corrosion-History/Eight.html

**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

## 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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | | | | | | | | | | | | | |
| 2 | 1 | 2 | | | | | | | | | | | | | |
| 3 | 2 | 2 | | | | | | | | | | | | | |
| 4 | 1 | 1 | 2 | | | | | | | | | | | | |
| 5 | 1 | 3 | 2 | | | | | | | | | | | | |

**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. F. W. Billmeyer,"Text Book of Polymer Science", John Wiley & Sons, New York, 2008

4. Barbara H. Stuart, "Polymer Analysis", John Wiley & Sons, New York, 2008

5. George Odian , "Principles of Polymerization", John Wiley & Sons, New York, 2004

6. R. J. Young and P. A. Lovell, "Introduction to Polymers", CRC Press, New York, 2011

7. Common Biocompatible Polymeric Materials for Tissue Engineering and Regenerative Medicine (2019), Materials Chemistry and Physics https://doi.org/10.1016/j.

<div style="text-align:center">

**22OCH03  ENERGY STORING DEVICES**            **3 0 0 3**
</div>

**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.

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | | | | | | | | | | | | | |
| 2 | 2 | 3 | | | | | 1 | | | | | | | | |
| 3 | 3 | 1 | | | | | | | | | | | | | |
| 4 | 2 | 2 | | | | | 1 | | | | | | | | |
| 5 | 3 | 3 | | | | | 1 | | | | | | | | |

**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.  N. Eliaz, E. Gileadi, Physical Electrochemistry, Fundamentals, Techniques and Applications, Wiley, 2019.
2.  J. Garche, K. Brandt, Electrochemical Power sources: Fundamentals Systems and Applications, Elsevier, 2018
3.  S.P. Jiang, Q. Li, Introduction to Fuel Cells, Springer, 2021.
4.  A. Iulianelli, A. Basile, Advances in Hydrogen Production, Storage and Distribution, Elsevier, 2016.
5.  M.M. Eboch, The Future of Energy, From Solar Cells to Flying Wind Farms, Capstone, 2020.

**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.

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 | 1 | 2 | | | | | | | | | | | | | |
| 2 | 1 | 3 | | | | | | | | | | | | | |
| 3 | 2 | 3 | | | | | | | | | | | | | |
| 4 | 2 | 3 | | | | | | | | | | | | | |
| 5 | 3 | 3 | | | | | | | | | | | | | |

**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.

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | 2 | | 3 | | | | |
| 2 | | | | | | | | | 2 | | 2 | | | | |
| 3 | | | | | | | | | 2 | | 2 | | | | |
| 4 | | | | | | | | | 3 | | 2 | | | | |
| 5 | | | | | | | | | 2 | | 2 | | | | |

**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

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | 1 | 2 | | 2 | | | | | | |
| 2 | | | | | | 1 | 2 | | 2 | | | | | | |
| 3 | | | | | | 1 | 2 | | 2 | | | | | | |
| 4 | | | | | | 1 | 2 | | 2 | | | | | | |
| 5 | | | | | | 1 | 2 | | 2 | | | | | | |

**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

**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 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 |  |  |  |  |  | 1 | 2 |  | 2 |  |  |  |  |  |  |
| 2 |  |  |  |  |  | 1 | 2 |  | 2 |  |  |  |  |  |  |
| 3 |  |  |  |  |  | 1 | 2 |  | 2 |  |  |  |  |  |  |
| 4 |  |  |  |  |  | 1 | 2 |  | 2 |  |  |  |  |  |  |
| 5 |  |  |  |  |  | 1 | 2 |  | 2 |  |  |  |  |  |  |

**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

**Course Outcomes (COs)**

1. Understand religo-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 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | | 1 | | | | 1 | | | | | 3 | | | |
| 2 | 2 | | 2 | | | | 2 | | | | | 2 | | | |
| 3 | 2 | | 1 | | | | 1 | | | | | 2 | | | |
| 4 | 2 | | 3 | | | | 3 | | | | | 3 | | | |
| 5 | 2 | | 1 | | | | 1 | | | | | 2 | | | |

**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**
Introduction to Digital Signal Processors- Basic Classification-Features TMS320C6713 Architecture-Functional Unit-Pipelining- Addressing Modes -Instruction set Simple Assembly Language Program.

**Total: 45 Hours**

**Reference(s)**
1. Director General NCC Website: https://indiancc.nic.in/ncc-general-elective-subject-course-design/
2. Grooming Tomorrow's Leaders, published by DG, NCC. https://indiancc.nic.in/
3. Youth in Action, published by DG, NCC. https://indiancc.nic.in/
4. The Cadet, Annual Journal of the NCC. https://indiancc.nic.in/
5. Précis Issued by respective Service Headquarters on specialized subject available to PI Staff as reference material. https://indiancc.nic.in/

**22AG0XA**          **OPONICS FARMING OF HORTICULTURAL CROPS**          **1 0 0 1**

**Course Objectives**

To understand the working of the Hydroponics system.

To identify different components involved in the automated Hydroponic system and to
rectify the issues to ensure proper functioning of the system

**Course Outcomes (COs)**

1. Development of a hydroponics farming system
2. Analyze and rectify the problems involved in hydroponics farming

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 1 |   | 2 | 2 |   | 2 |   |   |   |   |   |   |   | 2 |   |   |
| 2 |   |   | 2 | 2 | 2 |   |   |   |   |   |   |   | 2 |   |   |

**15 Hours**

**HYDROPONICS FARMING**

Hydroponics - Soil versus Hydroponics - Growing of Horticultural Crops - Vegetables and Flowers - Fodder cultivation in Hydroponics - Components - Nutrient Management Techniques - Nutrient Solutions for Hydroponics - Planning of Commercial Hydroponics – Daily Maintenance - General Maintenance Tips - Working - Implementation in greenhouse - Troubleshooting and remedies - Automation in Hydroponics.

**Total: 15 Hours**

**Reference(s)**

1. Sharma, N., Acharya, S., Kumar, K., Singh, N., & Chaurasia, O. P. (2018). Hydroponics as an advanced technique for vegetable production: An overview. Journal of Soil and Water Conservation, 17(4), 364-371A.M.Michael, Irrigation theory and practice, Vikas publishers, New Delhi, 2010.

2. Shrestha, A., & Dunn, B. (2010). Hydroponics. Oklahoma Cooperative Extension Service.

3. https://rkvy.nic.in/Uploads/SucessStory/TAMILNADU/2016/2016023524Hydrophonic_Final.pdf

4. https://ccari.icar.gov.in/Hydroponics.pdf

**22AG0XB   ENERGY AUDITING IN INDUSTRIAL            1 0 0 1
SECTORS**

**Course Objectives**

To imbibe basics of energy auditing and learn guidelines for conducting energy audit in industrial sectors

To identify various areas of implementing energy conservation strategies to enhance energy security

To impart knowledge on handling energy auditing instruments and to prepare energy audit report

**Course Outcomes (COs)**

1.  Analyze the energy conservation possibilities in industrial sectors through energy auditing

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 2 | 2 | | | | 2 | | | | | | | 2 | |

**15 Hours**

**ENERGY AUDITING**

Energy Scenario - Energy Security - Energy Conservation Act - Schemes of BEE - Energy Audit methodology - Energy Audit Instruments - Benchmarking - Energy performance – Energy balance – Material balance – Energy analysis and Sankey diagram – Project Management - Financial management - Energy Action Planning - Duties and responsibilities of Energy Manager - Energy monitoring and Targeting.

**Total: 15 Hours**

**Reference(s)**

1.  Guide Book For National Certification Examination For Energy Managers And Energy Auditors - Third Edition - Bureau Of Energy Efficiency - New Delhi - 2010

2.  Hasanbeigi, A., & Price, L. (2010). Industrial energy audit guidebook: Guidelines for conducting an energy audit in industrial facilities (No. LBNL-3991E). Lawrence Berkeley

3.   National Lab.(LBNL), Berkeley, CA (United States).

4.  Thollander, P., Karlsson, M., Rohdin, P., Wollin, J., & Rosenqvist, J. (2020). Introduction to industrial energy efficiency: energy auditing, energy management, and policy issues. Academic Press.

5.  Thumann, A., & Younger, W. J. (2003). Handbook of energy audits. River Publishers.