B.E. (MECHATRONICS)

Revised 2018 Regulations, Curriculum & Syllabi

(Candidates admitted during Academic Year 2021-2022)

Stay Ahead

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

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

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VISION OF THE DEPARTMENT

To prepare students to achieve academic excellence in Mechatronics education with a practically oriented curriculum, research and innovative product development.

MISSION OF THE DEPARTMENT

1. To provide pedagogical expertise to disseminate technical knowledge.

2. To foster continuous learning and research by establishing state of the art facilities.

3. To provide exposure to latest technologies through industry-institute interaction.

4. To nurture the innovation to develop interdisciplinary projects.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. Graduates possess adequate knowledge on mechanical, electronics and electrical engineering to solve problems pertaining to mechatronics

II. Graduates are capable of integrating and using systems or devices incorporating information technologies and modern engineering tools for product design, development and manufacturing

III. Graduates aspire for higher studies and can reveal professional interaction and work effectively on multi-disciplinary teams along with professional and ethical responsibility

PROGRAM OUTCOMES

Engineering Graduates will be able to:

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. **Communication**: 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.

PO11. Project Management and Finance: 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.

PO12. Life-long Learning: 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.

PROGRAM SPECIFIC OBJECTIVE (PSO)

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

MAPPING OF PEOs AND POs

POs	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2
PEO1	X	X											X	X
PEO2			X	X	X		X						X	X
PEO3						X		X	X	X	X	X		X

S8

Professional Elective VII

Professional Elective VIII

Professional Elective IX

Life Skills: Gate Exams

S7

Principles of Management

Professional Elective V

Professional Elective VI

S6

Professional Ethics in Engineering

Elective III

Elective IV

Soft Skills - Aptitude II

S5

Professional Elective I

Professional Elective II

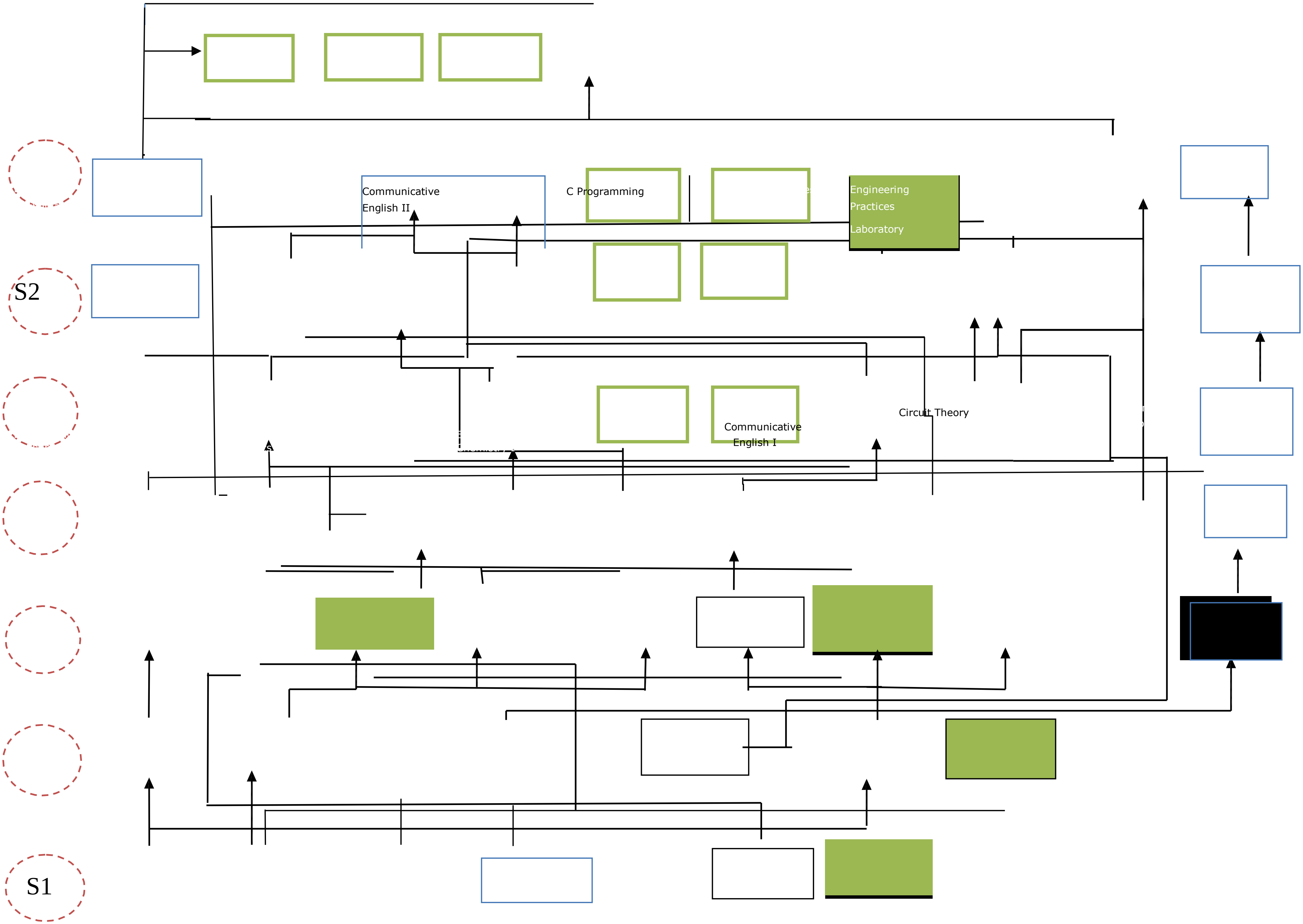
Soft Skills - Aptitude I

S4

Soft Skills- Reasoning

S3

Technology


S2
Communicative
English II
C Programming
Engineering
Practices
Laboratory
Circuit Theory
Communicative
English I
S1

DEPARTMENT OF MECHATRONICS Minimum Credits to be Earned : 162										
I SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
18MA101	ENGINEERING MATHEMATICS I	3	1	0	4	4	40	60	100	BS
18MC102	ENGINEERING PHYSICS I	2	0	2	3	4	50	50	100	BS
18MC103	ENGINEERING CHEMISTRY I	2	0	2	3	4	50	50	100	BS
18MC104	CIRCUIT THEORY	2	0	2	3	4	50	50	100	ES
18HS101	COMMUNICATIVE ENGLISH I	1	0	2	2	3	100	0	100	HSS
18MC106	ENGINEERING GRAPHICS	1	0	4	3	5	100	0	100	ES
Total		**11**	**1**	**12**	**18**	**24**				
II SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
18MA201	ENGINEERING MATHEMATICS II	3	1	0	4	4	40	60	100	BS
18MC202	ENGINEERING PHYSICS II - MECHANICS	3	1	0	4	4	40	60	100	ES
18MC203	ENGINEERING CHEMISTRY II	2	0	2	3	4	50	50	100	BS
18MC204	C PROGRAMMING	2	0	2	3	4	50	50	100	ES
	LANGUAGE ELECTIVE	1	0	2	2	3	100	0	100	HSS
18MC206	ELECTRON DEVICES AND CIRCUITS	2	0	2	3	4	50	50	100	ES
18MC207	ENGINEERING PRACTICE LABORATORY	0	0	2	1	2	100	0	100	ES
Total		**13**	**2**	**10**	**20**	**25**				

III SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
18MC301	ENGINEERING MATHEMATICS III	3	1	0	4	4	40	60	100	BS
18MC302	ELECTRICAL MACHINES	3	0	2	4	5	50	50	100	ES
18MC303	DIGITAL ELECTRONICS	3	0	0	3	3	40	60	100	PC
18MC304	STRENGTH OF MATERIALS	3	1	0	4	4	40	60	100	ES
18MC305	FLUID MECHANICS AND HYDRAULIC MACHINES	2	0	2	3	4	50	50	100	ES
18MC306	MANUFACTURING TECHNOLOGY	3	0	0	3	3	40	60	100	PC
18MC307	DIGITAL ELECTRONICS LABORATORY	0	0	2	1	2	100	0	100	PC
18MC308	MANUFACTURING TECHNOLOGY LABORATORY	0	0	2	1	2	100	0	100	PC
18GE301	SOFT SKILLS - VERBAL ABILITY	0	0	2	-	2	100	0	100	EEC
Total		**17**	**2**	**10**	**23**	**29**				

IV SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
18MC401	ENGINEERING MATHEMATICS IV	3	1	0	4	4	40	60	100	BS
18MC402	SENSORS AND SIGNAL CONDITIONING	3	0	0	3	3	40	60	100	PC
18MC403	POWER ELECTRONICS AND DRIVES	3	0	2	4	5	50	50	100	PC
18MC404	FLUID POWER SYSTEM	2	0	2	3	4	50	50	100	PC
18MC405	THEORY OF MACHINES	3	1	0	4	4	40	60	100	PC
18MC406	METROLOGY AND MEASUREMENTS	3	0	0	3	3	40	60	100	PC
18MC407	SENSORS LABORATORY	0	0	2	1	2	100	0	100	PC
18MC408	COMPUTER AIDED DESIGN LABORATORY	0	0	4	2	4	100	0	100	PC
18HS001	ENVIRONMENTAL SCIENCE	2	0	0	-	2	100	0	100	HSS

18GE401	SOFT SKILLS – BUSINESS ENGLISH	0	0	2	-	2	100	0	100	EEC
Total		**19**	**2**	**12**	**24**	**33**				

V SEMESTER										
Code No.	Course	L	T	P	C	Hours /Week	Maximum Marks			Category
							CIA	SEE	Total	
21MC501	CONTROL SYSTEMS	3	1	0	4	4	40	60	100	PC
21MC502	ROBOTICS	3	0	0	3	3	40	60	100	PC
21MC503	MICROPROCESSORS AND MICROCONTROLLERS	3	0	0	3	3	40	60	100	PC
21MC504	THERMODYNAMICS AND HEAT TRANSFER	3	1	0	4	4	40	60	100	PC
	PROFESSIONAL ELECTIVE I	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE II	3	0	0	3	3	40	60	100	PE
21MC507	ROBOTICS LABORATORY	0	0	4	2	4	100	0	100	PC
21MC508	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	0	0	2	1	2	100	0	100	PC
18GE501	SOFT SKILLS - APTITUDE I	0	0	2	-	2	100	0	100	EEC
Total		**18**	**2**	**8**	**23**	**28**				**-**

VI SEMESTER										
Code No.	Course	L	T	P	C	Hours /Week	Maximum Marks			Category
							CIA	SEE	Total	
21HS002	HUMAN VALUES AND ETHICS	2	0	0	2	2	40	60	100	HS
21MC602	MACHINE DESIGN	3	1	0	4	4	40	60	100	PC
21MC603	EMBEDDED SYSTEM DESIGN	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
21MC607	COMPUTER AIDED MANUFACTURING LABORATORY	0	0	2	1	2	100	0	100	PC
21MC608	OBJECT ORIENTED PROGRAMMING LABORATORY	0	0	4	2	4	100	0	100	PC
18GE601	SOFT SKILLS - APTITUDE II	0	0	2	-	2	100	0	100	EEC
Total		**17**	**1**	**10**	**22**	**28**				

VII SEMESTER											
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
21MC701	MICRO ELECTRO MECHANICAL SYSTEMS	3	0	0	3	3	40	60	100	PC
21MC702	INDUSTRIAL AUTOMATION	3	0	0	3	3	40	60	100	PC
	PROFESSIONAL ELECTIVE VI	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VII	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VIII	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IX	3	0	0	3	3	40	60	100	PE
21MC707	INDUSTRIAL AUTOMATION LABORATORY	0	0	2	1	2	60	40	100	PC
21MC708	MICRO ELECTRO MECHANICAL SYSTEM LABORATORY	0	0	2	1	2	60	40	100	PC
21MC709	PROJECT WORK I	0	0	6	3	6	60	40	100	EEC
	Total	**18**	**0**	**10**	**23**	**28**				

VIII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
21MC801	PROJECT WORK II	0	0	18	9	18	60	40	100	EEC
	Total	**9**	**0**	**18**	**9**	**18**	**-**	**-**	**-**	-

ELECTIVES										
LANGUAGE ELECTIVE										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
18HS201	COMMUNICATIVE ENGLISH II	1	0	2	2	3	100	0	100	HSS
18HSH01	HINDI	1	0	2	2	3	100	0	100	HSS
18HSG01	GERMAN	1	0	2	2	3	100	0	100	HSS
18HSJ01	JAPANESE	1	0	2	2	3	100	0	100	HSS
18HSC01	CHINESE	1	0	2	2	3	100	0	100	HSS
18HSF01	FRENCH	1	0	2	2	3	100	0	100	HSS
PROFESSIONAL ELECTIVES										
VERTICAL I – APPLIED ROBOTICS										
21MC001	MODELLING OF INDUSTRIAL ROBOTS	3	0	0	3	3	40	60	100	PE
21MC002	ROBOT CONTROL USING ROS	3	0	0	3	3	40	60	100	PE
21MC003	DRONE TECHNOLOGY	3	0	0	3	3	40	60	100	PE
21MC004	ROBOTIC VISION	3	0	0	3	3	40	60	100	PE
21MC005	MEDICAL ROBOTICS	3	0	0	3	3	40	60	100	PE
21MC006	MOBILE ROBOTICS	3	0	0	3	3	40	60	100	PE
VERTICAL II – DESIGN AND MANUFACTURING										
21MC007	CNC TECHNOLOGY	3	0	0	3	3	40	60	100	PE
21MC008	COMPUTER INTEGRATED MANUFACTURING	3	0	0	3	3	40	60	100	PE
21MC009	ADDITIVE MANUFACTURING	3	0	0	3	3	40	60	100	PE
21MC010	NON - DESTRUCTIVE TESTING	3	0	0	3	3	40	60	100	PE
21MC011	DESIGN FOR MANUFACTURING AND ASSEMBLY	3	0	0	3	3	40	60	100	PE
21MC012	INDUSTRIAL ENGINEERING	3	0	0	3	3	40	60	100	PE

VERTICAL III – SMART MOBILITY										
21MC013	ELECTRIC AND HYBRID VEHICLES	3	0	0	3	3	40	60	100	PE
21MC014	AUTONOMOUS AND CONNECTED VEHICLES	3	0	0	3	3	40	60	100	PE
21MC015	AUTOMOTIVE EMBEDDED SYSTEM	3	0	0	3	3	40	60	100	PE
21MC016	AUTOMOTIVE COMMUNICATION PROTOCALS	3	0	0	3	3	40	60	100	PE
21MC017	VEHICLE CONTROL SYSTEM	3	0	0	3	3	40	60	100	PE
21MC018	MACHINE LEARNING FOR AUTONOMOUS VEHICLES	3	0	0	3	3	40	60	100	PE
VERTICAL IV – INTELLIGENT SYSTEMS										
21MC019	APPLIED IMAGE PROCESSING	3	0	0	3	3	40	60	100	PE
21MC020	FUZZY LOGIC & ARTIFICIAL NEURAL NETWORK	3	0	0	3	3	40	60	100	PE
21MC021	ARTIFICIAL INTELLIGENCE	3	0	0	3	3	40	60	100	PE
21MC022	DEEP LEARNING TECHIQUES	3	0	0	3	3	40	60	100	PE
21MC023	SOFT COMPUTING	3	0	0	3	3	40	60	100	PE
21MC024	OPTIMIZATION TECHNIQUES	3	0	0	3	3	40	60	100	PE
VERTICAL V – AUTOMATION										
21MC025	MEDICAL MECHATRONICS	3	0	0	3	3	40	60	100	PE
21MC026	VIRTUAL INSTRUMENTATION	3	0	0	3	3	40	60	100	PE
21MC027	INDUSTRIAL DRIVES AND CONTROL	3	0	0	3	3	40	60	100	PE

21MC028	CONTROL SYSTEM AND DRIVES FOR ELECTRIC VEHICLES	3	0	0	3	3	40	60	100	PE
21MC029	PROCESS CONTROL	3	0	0	3	3	40	60	100	PE
21MC030	ADVANCED INDUSTRIAL AUTOMATION	3	0	0	3	3	40	60	100	PE

VERTICAL VI – SENSOR TECHNOLOGIES AND IOT										
21MC031	IOT PROTOCOLS AND INDUSTRIAL SENSORS	3	0	0	3	3	40	60	100	PE
21MC032	IOT PROCESSORS	3	0	0	3	3	40	60	100	PE
21MC033	IOT SYSTEM DESIGN	3	0	0	3	3	40	60	100	PE
21MC034	WIRELESS SENSOR NETWORK DESIGN	3	0	0	3	3	40	60	100	PE
21MC035	INDUSTRIAL IOT AND INDUSTRY 4.0	3	0	0	3	3	40	60	100	PE
21MC036	PYTHON FOR IOT DATA ANALYTICS	3	0	0	3	3	40	60	100	PE
LIST OF MINOR COURSES (VERTICAL VI – SENSOR TECHNOLOGIES AND IOT)										
21MCM01	IOT PROTOCOLS AND INDUSTRIAL SENSORS	3	0	0	3	3	40	60	100	PE
21MCM02	IOT PROCESSORS	3	0	0	3	3	40	60	100	PE
21MCM03	IOT SYSTEM DESIGN	3	0	0	3	3	40	60	100	PE
21MCM04	WIRELESS SENSOR NETWORK DESIGN	3	0	0	3	3	40	60	100	PE
21MCM05	INDUSTRIAL IOT AND INDUSTRY 4.0	3	0	0	3	3	40	60	100	PE
21MCM06	PYTHON FOR IOT DATA ANALYTICS	3	0	0	3	3	40	60	100	PE
LIST OF HONOUR COURSES (VERTICAL I – APPLIED ROBOTICS)										
21MCH01	MODELLING OF INDUSTRIAL ROBOTS	3	0	0	3	3	40	60	100	PE
21MCH02	ROBOT CONTROL USING ROS	3	0	0	3	3	40	60	100	PE
21MCH03	DRONE TECHNOLOGY	3	0	0	3	3	40	60	100	PE
21MCH04	ROBOTIC VISION	3	0	0	3	3	40	60	100	PE

21MCH05	MEDICAL ROBOTICS	3	0	0	3	3	40	60	100	PE
21MCH06	MOBILE ROBOTICS	3	0	0	3	3	40	60	100	PE
ONE CREDIT COURSES										
18MC0XA	COMMUNICATION PROTOCOLS	1	0	0	1	15	100	0	100	EEC
18MC0XB	AC/DC DRIVES	1	0	0	1	15	100	0	100	EEC
18MC0XC	ADVANCED METROLOGYAND QUALITY CONTROL	1	0	0	1	15	100	0	100	EEC
18MC0XD	INDUSTRIAL HYDRAULICS	1	0	0	1	15	100	0	100	EEC
18MC0XE	DESIGN AND ASSEMBLY OF ELECTRONICSCOMPONENTS IN PCB	1	0	0	1	15	100	0	100	EEC
18MC0XF	CNC SERVICING	1	0	0	1	15	100	0	100	EEC
18MC0XG	SMART FACTORY	1	0	0	1	15	100	0	100	EEC
18MC0XH	ONLINE WEB MONITORING	1	0	0	1	15	100	0	100	EEC
18MC0XI	ELECTRONIC ENGINE MANAGEMENT SYSTEM	1	0	0	1	15	100	0	100	EEC
18MC0XJ	IoT USING RASPBERRY PI	1	0	0	1	15	100	0	100	EEC
18MC0XK	INDUSTRIAL DATA COMMUNICATIONS PROTOCOLS	1	0	0	1	15	100	0	100	EEC
18MC0XL	PRODUCTION LINE ARCHITECTURE DESIGN AND METHODOLOGY	1	0	0	1	15	100	0	100	EEC
18MC0XM	ROBOT OPERATING SYSTEM	1	0	0	1	15	100	0	100	EEC

18MC0XN	MODERN UI DESIGN FOR INDUSTRIAL AUTOMATION CONTROLLER USING .NET	1	0	0	1	15	100	0	100	EEC
18MC0XO	CLOUD SERVICES AND IOT PLATFORMS	1	0	0	1	15	100	0	100	EEC
18MC0XP	DIGITAL TRANSFORMATION TO INDUSTRY 5.0	1	0	0	1	15	100	0	100	EEC
ADDITIONAL ONE CREDIT COURSE										
18GE0XA	ETYMOLOGY	1	0	0	1	15	100	0	100	EEC
18GE0XB	GENERALPSYCHOLOGY	1	0	0	1	15	100	0	100	EEC
18GE0XC	NEUROBEHAVIORALSCIE NCE	1	0	0	1	15	100	0	100	EEC
18GE0XD	VISUALMEDIAANDFI LM MAKING	1	0	0	1	15	100	0	100	EEC
18GE0XE	YOGAFORHUMAN EXCELLENCE	1	0	0	1	15	100	0	100	EEC
18GE0XF	VEDICMATHEMATICS	1	0	0	1	15	100	0	100	EEC
18GE0XG	HEALTHANDFITNESS	1	0	0	1	15	100	0	100	EEC
18GE0XH	CONCEPT,METHODO LOGY AND APPLICATIONS OF VERMI COMPOSITING	1	0	0	1	15	100	0	100	EEC
18GE0XI	BLOGWRITING	1	0	0	1	15	100	0	100	EEC
18GE0XJ	INTERPERSONALSKILLS	1	0	0	1	15	100	0	100	EEC
18GE0XK	COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT	1	0	0	1	15	100	0	100	EEC
18GE0XL	NATIONALCADET CORPS	1	0	0	1	15	100	0	100	EEC
18GE0XM	NEWAGE INNOVATION AND ENTREPRENEURSHIP	1	0	0	1	15	100	0	100	EEC
18GE0XN	DISRUPTIVE INNOVATION BASED STARTUP ACTIVITIES	1	0	0	1	15	100	0	100	EEC

18GE0XO	SOCIAL PSYCHOLOGY	1	0	0	1	15	100	0	100	EEC
18GE0XP	FM RADIO BROADCASTING TECHNOLOGY	1	0	0	1	15	100	0	100	EEC

OPEN ELECTIVES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours / Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
21OCE01	ENERGY CONSERVATION AND MANAGEMENT	3	0	0	3	3	40	60	100	OE
21OCS01	OBJECT ORIENTED PROGRAMMING	3	0	0	3	3	40	60	100	OE
21OCS02	JAVA FUNDAMENTALS	3	0	0	3	3	40	60	100	OE
21OCS03	KNOWLEDGE DISCOVERY IN DATABASES	3	0	0	3	3	40	60	100	OE
21OCS04	E-LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	OE
21OCS05	SOCIAL TEXT AND MEDIA ANALYTICS	3	0	0	3	3	40	60	100	OE
21OEC01	BASICS OF ANALOG AND DIGITAL ELECTRONICS	3	0	0	3	3	40	60	100	OE
21OEC02	MICROCONTROLLER PROGRAMMING	3	0	0	3	3	40	60	100	OE
21OEC03	PRINCIPLES OF COMMUNICATION SYSTEMS	3	0	0	3	3	40	60	100	OE
21OEC04	PRINCIPLES OF COMPUTER COMMUNICATION AND NETWORKS	3	0	0	3	3	40	60	100	OE
21OEI01	PROGRAMMABLE LOGIC CONTROLLER	3	0	0	3	3	40	60	100	OE
21OEI02	SENSOR TECHNOLOGY	3	0	0	3	3	40	60	100	OE
21OEI03	FUNDAMENTALS OF VIRTUAL INSTRUMENTATION	3	0	0	3	3	40	60	100	OE
21OEI04	OPTOELECTRONICS AND LASER INSTRUMENTATION	3	0	0	3	3	40	60	100	OE
21OME01	DIGITAL MANUFACTURING	3	0	0	3	3	40	60	100	OE
21OME02	INDUSTRIAL PROCESS ENGINEERING	3	0	0	3	3	40	60	100	OE
21OME03	MAINTENANCE ENGINEERING	3	0	0	3	3	40	60	100	OE
21OME04	SAFETY ENGINEERING	3	0	0	3	3	40	60	100	OE
21OBT01	BIOFUELS	3	0	0	3	3	40	60	100	OE
21OFD01	TRADITIONAL FOODS	3	0	0	3	3	40	60	100	OE
21OFD02	FOOD LAWS AND REGULATIONS	3	0	0	3	3	40	60	100	OE

21OFD03	POST HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES	3	0	0	3	3	40	60	100	OE
21OFD04	CEREAL, PULSES AND OIL SEED TECHNOLOGY	3	0	0	3	3	40	60	100	OE
21OFT01	FASHION CRAFTSMANSHIP	3	0	0	3	3	40	60	100	OE
21OFT02	INTERIOR DESIGN IN FASHION	3	0	0	3	3	40	60	100	OE

21OFT03	SURFACE ORNAMENTATION	3	0	0	3	3	40	60	100	OE
21OPH01	NANOMATERIALS SCIENCE	3	0	0	3	3	40	60	100	OE
21OPH02	SEMICONDUCTOR PHYSICS AND DEVICES	3	0	0	3	3	40	60	100	OE
21OPH03	APPLIED LASER SCIENCE	3	0	0	3	3	40	60	100	OE
21OPH04	BIO-PHOTONICS	3	0	0	3	3	40	60	100	OE
21OPH05	PHYSICS OF SOFT MATTER	3	0	0	3	3	40	60	100	OE
21OCH01	CORROSION SCIENCE AND ENGINEERING	3	0	0	3	3	40	60	100	OE
21OCH02	POLYMER SCIENCE	3	0	0	3	3	40	60	100	OE
21OCH03	ENERGY STORING DEVICES	3	0	0	3	3	40	60	100	OE
21OMA01	GRAPH THEORY AND COMBINATORICS	3	0	0	3	3	40	60	100	OE
21OGE01	PRINCIPLES OF MANAGEMENT	3	0	0	3	3	40	60	100	OE
21OGE02	ENTREPRENEURSHIP DEVELOPMENT I	3	0	0	3	3	40	60	100	OE
21OGE03	ENTREPRENEURSHIP DEVELOPMENT II	3	0	0	3	3	40	60	100	OE
21OGE04	NATION BUILDING: LEADERSHIP AND SOCIAL RESPONSIBILITY	3	0	0	3	3	40	60	100	OE

SUMMARY OF CREDIT DISTRIBUTION

S. No	CATEGORY	CREDITS PER SEMESTER								TOTAL CREDIT	CREDITS in%	Range of TotalCredits	
		I	II	III	IV	V	VI	VII	VIII			Min	Max
1	BS	10	7	4	4					25	15%	15%	20%
2	ES	6	11	11						28	17%	15%	20%
3	HSS	2	2				2			4	5%	5%	10%
4	PC			8	20	17	14	8		67	40%	30%	40%
5	PE					6	6	12		24	16%	15%	20%
6	EEC							3	9	12	7%	7%	10%
Total		18	20	23	24	23	22	23	9	162	100%	-	

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

18MA101 ENGINEERING MATHEMATICS I 3 1 0 4

Course Objectives

- Understand the concepts of vectors and Eigenvectors for different matrices to describe the stability of the linear systems in engineering fields.
- Exemplify the concepts of differentiation and integration to identify the area of 2D and 3D surfaces in engineering problems.
- Explain the concepts of analytic functions in complex domain to predict the nature of different engineering systems.

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems, reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PSO1. Analyze, design and develop electro mechanical system using contemporary tools.

Course Outcomes (COs)

1. Apply the principles of coordinate systems in the complex plane and characteristics of linear systems by Eigenvalues and Eigenvectors.
2. Analyse various types of functions and their differentiation techniques involved in engineering fields.
3. Apply different methods of integration to solve the engineering problems
4. Execute the suitable integration technique to calculate the area and volume of different surfaces.
5. Apply the concept of analytic function to estimate the integral in complex plane.

Articulation Matrix

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

UNIT I **9 Hours**

COMPLEX NUMBERS,VECTORS AND MATRICES

Complex plane, polar coordinates and polar form of complex numbers, powers and roots, fundamental theorem of algebra. Vector algebra in 2-D and 3-D space, dot product and cross product. Matrices: Eigenvalues and Eigenvectors, properties of eigenvalues and eigenvectors.

UNIT II **9 Hours**

CALCULUS

Limits and Continuity of Functions: Limits of functions, types of limits, evaluation of limits, continuity of functions, properties of continuous functions.

Derivatives: Derivatives, differentiability rules and properties, differentiation of transcendental functions, higher order derivatives, implicit differentiation, and differentiation of hyperbolic functions.

Integration: Anti-derivatives, Riemann Sum, indefinite and definite integration, Mean Value Theorem for definite integral, Fundamental Theorem of Calculus.

UNIT III **9 Hours**

INTEGRATION METOD

Basic integration formulas for algebraic and transcendental functions. Integration by special devices: integration by parts, rationalizing substitution or trigonometric substitution, partial fractions, reduction formulas, improper integrals, convergence tests.

UNIT IV **9 Hours**

APPLICATIONS OF DERIVATIVES AND INTEGRATIONS

Extreme values, points of inflection and curve sketching, Rolle's Theorem, Mean Value Theorem, optimization, indeterminate forms, L'Hôpital's Rule. Area between curves, volume of a general solid by slicing and cylindrical shell methods, volume of a solid of revolution, length of plane curves, area of a surface of revolution.

UNIT V **9 Hours**

COMPLEX ANALYSIS

Analytic Functions - Properties of Analytic Functions - Determination of Analytic Function using Milne-Thompson method. Cauchy's Integral Formula - Classification of Singularities - Cauchy's Residue TheorePSO1:

Total: 60 Hours

Reference(s)

1. Finney R. L., Weir PSO1: D., and Giordano F. R., *Thomas' Calculus*, 10th edition, Addison-Wesley, 2001.
2. Smith R. T. and Minton R. B., *Calculus*, 2nd edition, McGraw-Hill, 2002.
3. Kreyszig E., *Advanced Engineering Mathematics*, 8th edition, John Wiley & Sons, 1999.
4. Anton H., *Calculus with Analytic Geometry*, 5th edition, John Wiley & Sons, 1995.
5. Ayres F. J. R. and Mendelson E., *Schaum's Outline of Theory and Problems of Calculus*, 4th edition, McGraw-Hill, 1999.

18MC102 ENGINEERING PHYSICS I 2 0 2 3

Course Objectives

- Illustrate the Newtons laws of motion and wave motion with applications
- Understand the basic properties of electricity, magnetism and optics
- Differentiate the special theory of relativity and quantum physics from classical physics

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO9.Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Apply the Newton's three laws of motion to solve the real world problems involving elevator, at wood machine and acceleration of objects
2. Differentiate the physical characteristics of simple harmonic motion, wave motion and find the solutions for wave equations
3. Analyse the electric and magnetic elements using the fundamental laws and properties of electricity and magnetism.
4. Justify the characteristics of mirrors, lenses, microscopes and diffraction gratings using the concepts of physical and geometrical optics.
5. Conclude the wave and particle nature of matter with special theory of relativity and quantum physics

Articulation Matrix

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

UNIT I 6 Hours

MECHANICS

Newtons laws of motion: Concept of force and its nature - Newtons first law and inertial framesdefinition of mass - Newtons second law-gravitational force and weight - Newtons third law. Applications of Newtons laws: particle in equilibrium, particle under net force - weighing a mass in an elevator, the atwood machine and acceleration of two objects connected by a cord

UNIT II 6 Hours

OSCILLATIONS AND WAVES

Fundamentals of simple harmonic motion -energy of simple harmonic oscillator - spring mass system time period of simple pendulum, compound pendulum and torsional pendulum - Dampedoscillations.

Travelling wave motion - sinusoidal waves on strings - speed of a wave - reflection and transmission - rate of energy transfer in wave motion

UNIT III **6 Hours**

ELECTRICITY AND MAGNETISM

Point charges - electric fields - Gauss law and its applications - electric potential - capacitance - energy stored in a capacitor. Concept and source of magnetic fields - Amperes theorem determination of magnetic field due to different current distributions - Faradays law self-induction and mutual induction - energy stored in an inductor

UNIT IV **6 Hours**

LIGHT AND OPTICS

Nature of light -laws of reflection and refraction -refractive index and Snells law - dispersion of light - total internal reflection - image formation: concave mirrors - convex mirrors - thin lenses –compound microscope -human eye. Conditions of interference -Youngs double slit experiment intensity distribution of interference - phase change due to reflection - diffraction-narrow slit diffraction - single slit and two slit - intensity distribution - diffraction grating - applications

UNIT V **6 Hours**

MODERN PHYSICS

Special theory of relativity - simultaneity and time dilation -twin paradox - length contraction - relativistic mass variation - space time graph. Black body radiation and Planck hypothesis - allowed energy levels - thermal radiation from different objects - photoelectric and Compton effect. Matter waves - de-Broglie hypothesis - wave nature of particles - Davission-Germer experiment 1 5 H

EXPERIMENT 1 **5 Hours**

Determination of resultant of system of concurrent coplanar forces-Parallelogramlaw of forces

EXPERIMENT 2 **5 Hours**

Determination of moment of inertia-Torsional pendulum

EXPERIMENT 3 **5 Hours**

Determination of wavelength of mercury spectral lines-spectrometer

EXPERIMENT 4 **4 Hours**

Determination of refractive index of solid and liquid-travelling microscope

EXPERIMENT 5 **3 Hours**

Determination of wavelength of laser-diffraction grating

EXPERIMENT 6 **4 Hours**

Determination of frequency of a tuning fork-Meldes apparatus

EXPERIMENT 7 **4 Hours**

Thickness of a thin wire using interference of light-Air wedge method

60 Hours

Reference(s)

1. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2011
2. Halliday and Resnick, Fundamentals of Physics, John Wiley and Sons, Inc, 2011
3. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, NewDelhi, 2017
4. H D Young and R A Freedman, Sears and Zemanskys University Physics with Modern Physics, Pearson education, 2016
5. R K Gaur and S L Gupta, Engineering Physics, Dhanpat Rai Publications, 2012

18MC103 ENGINEERING CHEMISTRY I 2 0 2 3

Course Objectives

a. Assess the purpose of alloying and heat treatment in the field of metallurgy applications
b. Identify the types of corrosion and its suitable prevention method
c. Classify polymers based on its properties and molding techniques
d. Interpret the properties and applications of lubricants
e. Classify polymers based on its properties and molding techniques

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1 Apply the alloying principle to improve the strength, durability, corrosion resistance, and flexibility of metals by combining with other elements
2 Apply heat treatment processes to improve material properties by understanding their transformation behaviours
3 Analyze the types of corrosion, factors influencing the corrosion rate, and identify corrosion control method for effective material protection
4 Assess the properties of addition and condensation polymeric materials used in electonic and automobile industries
5 Outline the properties and application of lubricants used in high speed - low load and low speed - high load machines

Articulation Matrix

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

UNIT I 6 Hours

ALLOYS

Purpose of alloying - function and effects of alloying elements - classification of alloys. Composition - properties - uses of ferrous alloys (steel, cast iron and stainless steel) and non-ferrous alloys (aluminum, nickel, copper) - shape memory alloys.

UNIT II 7 Hours

HEAT TREATMENT

Fundamentals of simple harmonic motion -energy of simple harmonic oscillator - spring mass system time period of simple pendulum, compound pendulum and torsional pendulum - Dampedoscillations. Travelling wave motion - sinusoidal waves on strings - speed of a wave - reflection and transmission - rate of energy transfer in wave motion

UNIT III **7 Hours**

CORROSION SCIENCE

Corrosion - chemical and electrochemical corrosion - Pilling-Bedworth rule - types of oxide layer, oxygen absorption, hydrogen evolution mechanism - galvanic series. Types of electrochemical corrosion: Galvanic corrosion - differential aeration corrosion (pitting, pipeline and stress). Factors influencing corrosioPSO2: Corrosion control: Sacrificial anode - impressed current method.

UNIT IV **5 Hours**

POLYMER

Polymers - polymerization - functionality - degree of polymerization - classification of polymers. Types of polymerizatioPSO2: Structure, properties and applications of thermosetting (epoxy resin and Bakelite) and thermoplastics (poly vinyl chloride and PMMA). Rubber: SBR. Compounding of plastics (injection and extrusion).

UNIT V **5 Hours**

LUBRICANTS

Functions - properties (viscosity index, oiliness, carbon residue, aniline point, cloud and pour point) - classification: Grease (calcium based, sodium based and lithium based) - solid lubricants (graphite and molybdenum disulphide). Grading of lubricants. Hydraulic oils - Properties and applications - gas as a lubricant.

FURTHER READING

Biogas production, its benefits and disadvantages. Polymers in automobiles. Pollution of water in India in a decade.

EXPERIMENT 1 **2 Hours**

Instruction about safety rules, reagent handling and precautions need to be followed in lab

EXPERIMENT 2 **4 Hours**

Estimation of copper in brass alloy

EXPERIMENT 3 **4 Hours**

Estimate the amount of iron present in the given solution using spectrophotometer by thiocyanate method

EXPERIMENT 4 **4 Hours**

Determination of hardenability using Jominy end quench test

EXPERIMENT 5 **4 Hours**

Determination of corrosion percentage by weight loss method

EXPERIMENT 6 **4 Hours**

Thermalstability of polymer using thermogravimetry analysis

EXPERIMENT 7 **4 Hours**

Determination of molecular weight of a polymer by viscosity measurement method

EXPERIMENT 8

Comparison of viscosity for liquid lubricants by Ostwald viscomete

60 Hours

Reference(s)

1. P. C. Jain and Monica Jain, Engineering Chemistry, 16th Edition, Dhanpat Rai Publisher, New Delhi, 2013.
2. G.E.Dieter, Mechanical Metallurgy, McGraw Hill, 2007.
3. William D Callister Jr., Materials science and engineering: An introduction, 7th Edition, John Wiley&sons Inc.,New York,2007.
4. B.R. Puri, L. R. Sharma, M.S. Pathania, Principles of Physical Chemistry, 41st Edition, Vishal Publishing Co., (2004)
5. R. Gowariker, N.V. Viswanathan, J. Sreedhar, Polymer Science,1st Edition, New age International Publishers, New Delhi, 2014.

6. R. Mukhopadhy and S. Datta, Engineering Chemistry, New Age International Pvt. Ltd, New Delhi, 2010

18MC104 CIRCUIT THEORY 2 0 2 3

Course Objectives

- To understand the basic concepts of electrical circuits and machines
- To examine the speed control methods of DC motor
- To illustrate the construction and operation of three phase systems

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

PO10. Communication: 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.

PO12. Life-long Learning: 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

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Apply fundamental laws for electric circuits to understand basic components resistors, inductors, and capacitors
2. Analyze concepts AC circuits to compute RMS, peak factor, and star to delta transformation
3. Analyze the performance and characteristics of electromagnetic fields to verify point, line, and disc charges
4. Implement concepts of three-phase systems, their advantages, and effect power, voltage, and current in star and delta configurations
5. Assess series and parallel resonance circuits to analyse Q factor and bandwidth

Articulation Matrix

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

UNIT I **6 Hours**
DC CIRCUITS
Definition of voltage, current, power, energy, resistor, inductor and capacitor - Ohms statement, illustration and limitations- Kirchoffs laws statement and illustration - current and voltage division technique - resistance in series and parallel - problems, mesh and nodal analysis.

UNIT II **6 Hours**
AC CIRCUITS
Generation of single phase alternating emf - RMS value, average value, peak factor and form factor, analysis of pure resistive, inductive and capacitive circuits J operator - Representation of alternating quantities in rectangular and polar forms - star to delta transformation - simple problems

UNIT III **6 Hours**
ELECTROMAGNETIC FIELD THEORY
Gauss And Stokes Theorem - Maxwell equations and significance. Electric Charge - Coulombs law - Electric field and potential - Electric field due to a point charge, electric dipole - line of charge and charge disc

UNIT IV **6 Hours**
THREE PHASE SYSTEM
Advantage of 3 phase system - phase sequence - Interconnection of three phase - Star and Delta connection - Voltage current and power in star and delta connection

UNIT V **6 Hours**
RESONANCE AND COUPLED CIRCUITS
Series and parallel resonance - Q factor and bandwidth - Resonant frequency of a tank circuit - Basics of magnetic circuits - Simple and Composite magnetic circuits - Self and Mutual inductances - Coefficient of Coupling - Coupled circuits - Dot convention - Coupled circuits in Series and Parallel

FURTHER READING
Voltage Regulator - BLDC Motor -SMPS-Autotransformer-Ac Servomotor

EXPERIMENT 1 **5 Hours**
Identification of basic Electronic components such as Resistor, Capacitor, and Inductor and measuring the fundamental characteristics

EXPERIMENT 2 **5 Hours**
Residential house wiring using switches, fuse, indicator, lamp and energy meter, Fluorescent lamp wiring, Stair case wiring

EXPERIMENT 3 **5 Hours**
Verify KCL and KCL using simple circuits

EXPERIMENT 4 **5 Hours**
Implement star to delta and delta to star transformation circuits

EXPERIMENT 5 **5 Hours**

Measurement of electrical quantities voltage, current, power

EXPERIMENT 6 **5 Hours**

Apply the voltage division and current division techniques for series and parallel connections of lamp loads.

60 Hours

Reference(s)

1. Smarjith Ghosh, Fundamentals of Electrical and Electronics Engineering, Prentice Hall (India) Pvt. Ltd., 2010
2. R. Muthusubramanian, S. Salivahanan, Basic Electrical and Electronics Engineering, Tata McGraw-Hill Education, Reprint 2012
3. William H. Hayt, Jack E. Kemmerly, and Steven PSO1: Durbin, Engineering Circuit Analysis, Eighth Edition, Tata McGraw Hill, 2013
4. Charles K. Alexander, Fundamentals of Electric Circuits, Fifth Edition, Tata McGraw Hill Publishing Co Ltd, 2013.
5. Mahmood Nahvi, Joseph A Edminister, Electric Circuits, Fifth Edition, Tata McGraw Hill Publishing Company Limited, 2017.
6. S P Ghosh, A K Chakraborty, Network Analysis and Synthesis, Tata McGraw Hill Education Private Limited, 2010.

18HS101 COMMUNICATIVE ENGLISH I 1 0 2 2

Course Objectives

- Read and understand the main points on familiar matters regularly encountered in work, school, or leisure
- Listen and respond in most common situations where English is spoken
- Write simple connected texts on topics which are familiar or of personal interest
- Describe experiences and events, hopes and ambitions and briefly give reasons and explanations for opinions and plans

Programme Outcomes (POs)

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

PO10.Communication: 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.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Apply appropriate grammar and vocabulary that aligns with the expectations of the Competitive exam level.
2. Analyze the general meaning of non-routine letters within your work area, and find key details in short reports of a predictable nature.
3. Construct straightforward, routine letters of a factual nature, and select relevant information to make notes on routine matters, such as taking or placing orders.
4. Use simple presentations or demonstrations and demonstrate understanding by summarizing key points.
5. Resolve predictable requests from a visitor, outline routine requirements, and offer advice within your job area on simple matters.

Articulation Matrix

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

UNIT I 9 Hours

GRAMMAR

Tenses Future continuous, Past continuous, Past perfect, Past simple, Past tense responses, Present perfect continuous, Present perfect/past simple Reported speech Adverbs intensifiers Comparatives and superlatives Conditionals 2nd and 3rd Connecting words expressing cause and effect, contrast Phrasal verbs Prepositions of place Simple passive - Wh-questions in the past Question tags Will and going to, for prediction.

UNIT II 9 Hours

READING

Understanding short real-world notices, messages Detailed comprehension of factual material; skimming and scanning skills - Interpreting visual information Reading for detailed factual information Reading for gist and specific information - Grammatical accuracy and understanding of text structure - Reading and information transfer

UNIT III 9 Hours

WRITING

Internal communication including note, message, memo or email - arranging / rearranging appointments, asking for permission, giving instructions - Business correspondence including letter, fax, email apologising and offering compensation, making or altering reservations, dealing with requests, giving information about a product.

UNIT IV **9 Hours**

LISTENING

Listening for specific information Listening for numbers and letters Note completion Listening for gist listening to monologues (presentations, lectures, announcements and briefings) listening to interacting speakers (telephone conversations, face-to-face conversations, interviews and discussions).

UNIT V **9 Hours**

SPEAKING

Exchanging personal and factual information expressing and finding out about attitudes and opinions organise a larger unit of discourse Turn-taking, negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing and/or disagreeing, suggesting, speculating, comparing and contrasting, and decision-making. 1.Goodbye party for Miss Pushpa T S - Nissim Ezekiel 2.Our Casuarina Tree - Toru Dutt 3.Palanquin Bearers - Sarojini Naidu 4.The Tyger - William Blake 5.Ode on a Grecian Urn - John Keats

45 Hours

Reference(s)

1. Alexander Garrett, Cambridge BEC Preliminary Students Book with Answers, Cambridge University Press, 2016.
2. Lan Wood, Anne Williams and Anna Cowper. Pass Cambridge BEC Preliminary, Second Edition, New Delhi, 2014.
3. Norman Whitby. Cambridge Business Benchmark. Pre-Intermediate to Intermediate, Students Book. South Asian Edition, 2018

18MC106 ENGINEERING GRAPHICS 1 0 4 3

Course Objectives

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

Programme Outcomes (POs)

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

PO4. Conduct Investigations of Complex Problems: 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.

PO9.Communication: 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.

PO10. Communication: 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.

PO11. Project Management and Finance: 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.

PO12. Life-long Learning: 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.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Apply the engineering drawing concepts as per industrial standards.
2. Construct orthographic projections of points and lines
3. Create projection of planes and simple solids
4. Develop section of solids and surfaces
5. Demonstrate the conversion of orthographic to isometric and vice versa

Articulation Matrix

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

UNIT I 12 Hours

FUNDAMENTALS OF ENGINEERING DRAWINGS

Definition of voltage, current, power, energy, resistor, inductor and capacitor - Ohms statement, illustration and limitations- Kirchoffs laws statement and illustration - current and voltage division technique - resistance in series and parallel - problems, mesh and nodal analysis.

UNIT II 15 Hours

PROJECTION OF POINTS

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 **16 Hours**

PROJECTION OFPLANES AND SOLIDS

Projection of simple planes and projection of simple solids parallel, perpendicular and inclined to one plane using change of position method.

UNIT IV **16 Hours**

SECTION OFSOLIDS AND DEVELOPMENT OF SURFACES

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

UNIT V **16 Hours**

ORTHOGRAPHIC PROJECTIONS AND ISOMETRIC VIEW

Orthographic projections and isometric view of components used in engineering applications

75 Hours

Reference(s)

1. K Venugpoal, Engineering Drawing and Graphics, Third edition, New Age International,2005
2. Basant Agrawal, Mechanical drawing, Tata McGraw-Hill Education, 2008
3. Engineering Drawing Practice for Schools & Colleges, Bureau of Indian StandardsSp46,2008
4. PSO2: D. Bhatt and V. PSO1: Panchal, Engineering Drawing, Charotar Publishing House Pvt.Limited, 2008
5. K.V. Natarajan, AText Book of Engineering Graphics, Dhanalakshmi Publishers, 2013

18MA201 **ENGINEERING MATHEMATICS II** **3 1 0 4**

Course Objectives

- Understand the concepts of partial derivatives and multiple integrals to define the area, volume and extreme values of various surfaces in engineering fields.
- Classify the sequences and series in linear systems is convergent or divergent.
- Formulate the real time engineering problem into mathematical model using ordinary differential equation and solve it by appropriate method.

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Apply the concepts of partial differentiation to evaluate various parameters in signals and systems and characterize maxima and minima of functions for optimization problems.
2. Apply multiple integral concepts to calculate the area and volume by appropriate vector integral theorems.
3. Analyse the convergence and divergence of sequences and series by various tests.
4. Apply mathematical concepts to construct first-order differential equations derived from real-time phenomena and solve them using appropriate analytical methods
5. Execute the appropriate method to solve the second order differential equations.

Articulation Matrix

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

UNIT I **9 Hours**

PARTIAL DIFFERENTIATION

Tenses Future continuous, Past continuous, Past perfect, Past simple, Past tense responses, Present perfect continuous, Present perfect/past simple Reported speech Adverbs intensifiers Comparatives and superlatives Conditionals 2nd and 3rd Connecting words expressing cause and effect, contrast Phrasal verbs Prepositions of place Simple passive - Wh-questions in the past Question tags Will and going to, for prediction.

UNIT II **9 Hours**

MULTIPLE INTEGRALS

Sequences and series, convergence and divergence of series, absolute convergence, conditional convergence, test for convergence and divergence. Power series for functions, interval of convergence, Taylor and Maclaurin series, Taylor s Theorem with remaind

UNIT III **9 Hours**

SEQUENCES AND SERIES

Internal communication including note, message, memo or email - arranging / rearranging appointments, asking for permission, giving instructions - Business correspondence including letter, fax, email apologising and offering compensation, making or altering reservations, dealing with requests, giving information about a product.

UNIT IV **9 Hours**

FIRST ORDERDIFFERENTIAL EQUATIONS

Listening for specific information Listening for numbers and letters Note completion Listening for gist listening to monologues (presentations, lectures, announcements and briefings) listening to interacting speakers (telephone conversations, face-to-face conversations, interviews and discussions).

UNIT V **9 Hours**

SECOND ORDER DIFFERENTIAL EQUATIONS

Second order homogeneous and non-homogeneous equations with constant coefficients, variation of parameters, method of undetermined coefficients, series solutions of differential equations, applications

45 Hours

Reference(s)

1. Finney RL, Weir MD and Giordano FR, Thomas Calculus, 10th edition, Addison-Wesley, 2001
2. Smith RT and Minton RB, Calculus, 2nd Edition, McGraw Hill, 2002.Kreysgiz E, Advanced Engineering Mathematics, 8th edition, John Wiley & Sons, 1999.
3. Ray Wylie and C Louis Barrett Advanced Engineering Mathematics, Sixth Edition, Tata McGraw-Hill Publishing Company Ltd, 2003. 4. Peter V. O Neil , Advanced Engineering Mathematics, Seventh Edition , Cengage Learning India Private Limited, 2012. 5. Glyn James, Advanced Engineering Mathematics, Third Edition,Wiley India, 2014.

18MC202 ENGINEERING PHYSICS II - MECHANICS 3 1 0 4

Course Objectives

- To impart knowledge in crystallography and the crystal growth methods
- To understand the properties of conductors and semiconductors
- To familiarise basic concepts of force and system of forces in real world environment
- To analyse the properties of surface and friction between the surfaces

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Analyze the seven crystal systems, planes, and stacking sequences in metallic crystal structures
2. Find the characteristics of conducting and semiconducting materials in terms of the crystal lattice, charge carriers and energy band diagrams
3. Apply the conceptual knowledge to solve problems of particles and rigid bodies in two dimensions under equilibrium conditions
4. Outline the properties of surfaces and solids using the parallel and perpendicular axis theorems
5. Differentiate the two types of friction and analyse the equilibrium of bodies on an inclined plane

Articulation Matrix

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

UNIT I 8 Hours

CRYSTALPHYSICS

Lattice - unit cell - Bravais lattice - lattice planes - miller indices - d-spacing in cubic lattice - calculation of number of atoms per unit cell - atomic radius - coordination number - packing density for SC, BCC, FCC and HCP structures- crystal growth: Bridgman and Czochralski techniques -X- ray diffraction methods

UNIT II 8 Hours

CONDUCTING AND SEMICONDUCTING MATERIALS

Conductors: Classical free electron theory -electrical and thermal conductivity -Wiedemann-Franz law - success and drawbacks of classical free electron theory -quantum theory - Fermi level -Fermi distribution function Semiconductors: Elemental and compound semiconductors -intrinsic semiconductor - Fermi level - electrical conductivity - band gap -extrinsic semiconductor -variation of Fermi level with temperature and impurity concentration -Hall Effect -applications of Hall Effect -solar cell -I-V characteristics

UNIT III 10 Hours

EQUILIBRIUM OFPARTICLES AND RIGID BODIES

Sequences and series, convergence and divergence of series, absolute convergence, conditional convergence, test for convergence and divergence. Power series for functions, interval of convergence, Taylor and Macular in series, Taylor s Theorem with remainder.

UNIT IV **10Hours**

PROPERTIES OF SURFACES AND SOLIDS

Determination of area, volume and mass of centroid - Pappus and Guldinus theorem -moment of inertia of plane and area - Parallel axis theorem - perpendicular axis theorem - product of inertia -mass moment of inertia - radius of gyration

UNIT V **9 Hours**

FRICTION

Frictional force - laws of Coulomb friction - angle of friction - cone of friction - equilibrium of bodies on an inclined plane - ladder friction - wedge friction - belt friction - rolling resistance

EXPERIMENT 1 **4 Hours**

Virtual fabrication of silicon cantilever using Intelli FAB MEMS software

EXPERIMENT 2 **4 Hours**

Determination of standard electrode potential of Zinc/Copper/silver using calomel as reference electrode.

EXPERIMENT 3 **4 Hours**

Determination of pH of an unknown solution using pH sensor.

EXPERIMENT 4 **4 Hours**

Estimate the amount of ferrous iron present in the given sample solution using potentiometer.

EXPERIMENT 5 **4 Hours**

Construct a battery (using scrap metal/ other sources) exhibiting valid output and compare it with the existing commercial batteries based on cost and output. (Marks awarded based on battery output)

EXPERIMENT 6 **0 Hours**

Conduct metric titration of mixtures of acid using a conductivity cell

EXPERIMENT 7 **0 Hours**

Estimate the amount of Prussian Blue dye in the given solution using spectrophotometer by thiocyanate method.

EXPERIMENT 8 **0 Hours**

Analysis of NPK fertilizer compounds by using IR Spectroscopy

65 Hours

Reference(s)

1. Charles Kittel, Introduction to Solid State Physics, 8th Edition, Wiley, India Pvt limited New Delhi 2012
2. Arthur Beiser, Shobjit Mahaja and S Rai Choudhury, Concepts of Modern Physics, 6th Edition, Tata McGraw Hil Education Pvt Ltd New Delhi, 2010
3. M.PSO2: Avadhanalu, P.G. Kshirsagar, A Text Book of Engineering Physics S. Chand Company New Delhi 2018
4. F.P. Beer, and Jr. E.R Johnston, Vector Mechanics for Engineers Statics and Dynamics, Tata McGraw-Hill Publishing Company, New Delhi, 2007
5. PSO2: H. Dubey, Engineering Mechanics - Statics and Dynamics, Tata McGraw-Hill Education Private Limited, New Delhi, 2013
6. D. P. Sharma, Engineering Mechanics, Dorling Kindersley (India) Pvt. Ltd., New Delhi, 2010

18MC203 ENGINEERING CHEMISTRY - II 2 0 2 3

Course Objectives

- Identify the importance of micro system and substrate materials for MEMS
- Summarize the terminologies of electrochemical reactions and explain the function of batteries and chemical sensors
- Characterize the chemical compounds using suitable analytical techniques

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO1. Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Apply the concept of atomic/molecular theory in microsystems and their fabrication
2. Analyze MEMS substrate materials, emphasizing silicon properties, crystal structure, and compounds for microfabrication applications.
3. Predict the suitable sensing method for the detection of ionic and gaseous chemical substances
4. Analyze the characteristics and performance of primary, secondary, and modern batteries to determine their suitability for effecient utilization
5. Select the suitable analytical method for the identification of functional group and determination of metals

Articulation Matrix

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

UNIT I 6 Hours

CHEMISTRYFOR MICROSYSTEMS

Introduction - atomic structure of matter - ions and ionization - molecular theory of matter - intermolecular forces - doping of semiconductors - the diffusion theory

UNIT II 6 Hours

MATERIALS FOR MEMS

Introduction - substrates and wafers - active substrate materials. Silicon as a substrate material: The ideal substrate for MEMS - single crystal silicon and wafers - crystal structure - Miller indices - mechanical properties of silicoPSO2: Silicon compounds (silicon dioxide, silicon carbide, and silicon nitride and polycrystalline silicon).

UNIT III 6 Hours

CHEMICAL SENSORS

Electrode potential: Single and standard electrode potential - half-cell reactions. Cells: Cell representation, types (electrochemical and electrolytic cells), Types of electrodes. Sensor: Definition classification of chemical sensors - electrochemical devices: pH sensors, pellistors, NPK sensor, solid electrolyte sensor for sensing oxygen.

UNIT IV 6 Hours

BATTERIES

Batteries: Difference between cell and battery - characteristics and types. Construction, working and applications of primary battery: Alkaline - secondary battery: Lead acid - modern battery: Lithium battery. Environmental and safety issues in disposal of batteries

UNIT V **6 Hours**

INSTRUMENTAL METHODS

Beer-Lamberts law. Principle, instrumentation (block diagram only) and applications: Ultra violet spectroscopy - infrared spectroscopy - atomic absorption spectroscopy - colorimetry (estimation of transition metals) - thermogravimetric analyzer (TGA)

FURTHER READING

Energy resources: Renewable (solar and wind) and nonrenewable (fossil fuels). Fuel cells.

EXPERIMENT 1 **4 Hours**

Virtual fabrication of silicon cantilever using Intelli FAB MEMS software

EXPERIMENT 2 **4 Hours**

Determination of standard electrode potential of Zinc/Copper/silver using calomel as reference electrode.

EXPERIMENT 3 **4 Hours**

Determination of pH of an unknown solution using pH sensor.

EXPERIMENT 4 **4 Hours**

Estimate the amount of ferrous iron present in the given sample solution using potentiometer.

EXPERIMENT 5 **4 Hours**

Construct a battery (using scrap metal/ other sources) exhibiting valid output and compare it with the existing commercial batteries based on cost and output. (Marks awarded based on battery output)

EXPERIMENT 6 **6 Hours**

Conduct metric titration of mixtures of acid using a conductivity cell

EXPERIMENT 7 **6 Hours**

Estimate the amount of Prussian Blue dye in the given solution using spectrophotometer by thiocyanate method.

EXPERIMENT 8 **2 Hours**

Analysis of NPK fertilizer compounds by using IR Spectroscopy

60 Hours

Reference(s)

1. Tai-Ran Hsu, MEMS and Microsystems, Tata McGraw Hill Eduction Pvt. Ltd, New Delhi, 2010
2. P. C. Jain and Monica Jain, Engineering Chemistry, 16th Edition, Dhanpat Rai Publisher, New Delhi, 2013.
3. William D Callister Jr., Materials science and engineering: An introduction, 7th Edition, John Wiley&sons Inc.,New York,2007.
4. B.R. Puri, L. R. Sharma, M.S. Pathania, Principles of Physical Chemistry, 41st Edition, Vishal Publishing Co., (2004)
5. R. Gowariker, N.V. Viswanathan, J. Sreedhar, Polymer Science,1st Edition, New age International Publishers, New Delhi, 2014.
6. R. Mukhopadhy and S. Datta, Engineering Chemistry, New Age International Pvt. Ltd, New Delhi, 2010

18MC204 C PROGRAMMING 2 0 2 3

Course Objectives

- To learn the basics of computer organisation
- To study the basics of C primitives, operators and expressions.
- To understand the different primitive and user defined data types

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO11. Project Management and Finance: 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.

PO12. Life-long Learning: 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.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Apply problem solving techniques and number conversions in real time applications
2. Implement programs using operators and expressions
3. Apply decision making and branching in C program
4. Execute programs using Arrays and strings.
5. Apply the concepts of structures and functions

Articulation Matrix

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

UNIT I 6 Hours

INTRODUCTION TO COMPUTERS

Introduction to computers - Characteristics of Computers - Evolution of Computers - Computer Generations - Basic Computer Organization - Number System - Problem Solving Techniques - Features of a Good Programming Language.

UNIT II **6 Hours**

INTRODUCTION TO C PROGRAMMING

Overview of C-Structure of C program-Keywords-Constants- Variables-Data types-Type conversion Operators and Expressions: Arithmetic-Relational-Logical-Assignment- Increment and Decrement Conditional-Bitwise -Precedence of operators-Managing I/O operations-Formatted I/O-Unformatted I/O

UNIT III **6 Hours**

CONTROL STATEMENTS

Decision Making and Branching: simple if statement-if else statement-nesting of if else Statement Switch Statement. Decision Making and Looping: while statement-do while statement-for statement Nested for statement Jump Statements: go to-break-continue-return statement

UNIT IV **6 Hours**

ARRAYS AND STRINGS

Arrays: Introduction, one dimensional array, declaration - Initialization of one dimensional array, two dimensional arrays, initializing two dimensional arrays, multi dimensional arrays. Strings: Declaring and initializing string variables- Reading strings from terminal - writing string to screen - String handling functions.

UNIT V **6 Hours**

STRUCTURES AND FUNCTIONS

Structures and Unions: Introduction-defining a structure- declaring structure variables-accessing structure members- structure initialization-Unions-Enumerated data type User Defined Functions: Elements of user defined functions -Definition of functions-return values and their types- function calls-function declaration-categories of function -call by value and call by reference-recursion-Pre-processor directives and macros

EXPERIMENT 1 **3 Hours**

Write a C program to perform arithmetic operations on integers and floating point numbers

EXPERIMENT 2 **3 Hours**

Write a C program to implement ternary operator and relational operators

EXPERIMENT 3 **3 Hours**

Write a C program to find the greatest of three numbers using if-else statement

EXPERIMENT 4 **3 Hours**

Write a C program to display the roots of a quadratic equation with their types using switch case

EXPERIMENT 5 **3 Hours**

Write a C program to generate pyramid of numbers using for loop

EXPERIMENT 6 **3 Hours**

Write a C program to perform Matrix Multiplication

EXPERIMENT 7 **4 Hours**

Write a C program to check whether the given string is Palindrome or not

EXPERIMENT 8 **4 Hours**

Design a structure to hold the following details of a student. Read the details of a student and display them in the following format Student
Details: roll no, name, branch, year, section, cgpa.

NAME:
ROLL NO:
BRANCH:
YEAR:
SECTION:
CGPA:

60 Hours

Reference(s)

1. Pradeep K. Sinha, Priti Sinha, Computer Fundamentals, BPB publications, 2008
2. Ashok. PSO2: Kamthane, Computer Programming, Second Edition, Pearson Education, 2012
3. E.Balagurusamy, Programming in ANSI C, Tata McGraw-Hill, 2012
4. Herbert Schildt, C -The complete Reference, Tata McGraw-Hill, 2013
5. Byron Gottfried, Programming with C, Schaum's Outlines, Tata Mcgraw-Hill, 2013

18MC206 ELECTRON DEVICES AND CIRCUITS 2 0 2 3

Course Objectives

- To understand the characteristics, operations, and application of solid state devices like diode, BJT, FET, MOSFET and various optoelectronic devices
- To understand various applications of electronic devices.

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO12. Life-long Learning: 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.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Analyze the characteristics of PN junction diodes including diffusion, drift currents, and biasing conditions.
2. Apply DC analysis techniques to BJT circuits and biasing for amplifier circuits
3. Compare the different amplifier configurations (CE, CB, CC) based on their voltage gain, input/output impedence, and other small signal characteristics
4. Analyze the significance of pinch-off voltage in JFETs and threshold voltage in MOSFETs, and find the channel length modulation in MOSFETs
5. Demonstrate the operation and applications of various display devices LEDs, LCDs, photo transistors, opto-couplers, solar cells, and CCDs

Articulation Matrix

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

UNIT I **6 Hours**
SEMICONDUCTOR DIODES
Semiconductor material and Properties, PN junction diode, Current equations, Diffusion and drift current densities, forward and reverse bias characteristics, Switching Characteristics - Zener diodes
UNIT II **6 Hours**
BIPOLAR JUNCTIONTRANSISTOR
Device structure and physical operation, current voltage characteristics, the BJT as an amplifier and a switch, DC Analysis of BJT Circuits, Biasing BJT Amplifier Circuit
UNIT III **6 Hours**
BJT AMPLIFIERS
Small Signal operations and models, trans conductance, input resistances, voltage gain, hybrid pi model, T-model, Small Signal equivalent circuit, Early effect, Single stage BJT amplifiers CE, CB, CC, Comparison
UNIT IV **6 Hours**
FIELD EFFECTTRANSISTOR
JFETs Drain and Transfer characteristics,-Current equations-Pinch off voltage and its significance MOSFET- Characteristics- Threshold voltage -Channel length modulation, D-MOSFET, E-MOSFET Current equation - Equivalent circuit model and its parameters
UNIT V **6 Hours**
DISPLAY DEVICES
LED, LCD, Photo transistor, Opto Coupler, Solar cell, CCD

EXPERIMENT 1 **3 Hours**
Volt-Ampere characteristics of diode and zener diode
EXPERIMENT 2 **3 Hours**
Volt-Ampere characteristics of Transistor and MOSFET
EXPERIMENT 3 **3 Hours**
Volt-Ampere characteristics of SCR
EXPERIMENT 4 **3 Hours**
Experimental verification of half and full wave rectifiers with and without filter
EXPERIMENT 5 **3 Hours**
Design and verification of series voltage regulator
EXPERIMENT 6 **3 Hours**
Design and implementation of CE amplifier
EXPERIMENT 7 **3 Hours**
Design and implementation of class B push pull amplifier
EXPERIMENT 8 **3 Hours**
Design and implementation of RC Phase shift and we in bridge oscillator
EXPERIMENT 9 **3 Hours**

Design and implementation of multi vibrator circuits using transistor

EXPERIMENT 10 **3 Hours**

Design of audio amplifier using any one type of power amplifier

60 Hours

Reference(s)

1. Jacob. Millman, Christos C.Halkias, Electronic Devices and Circuits, 3rd Edition, Tata McGraw Hill Publishing Limited, New Delhi, 2010.
2. David A. Bell, Electronic Devices and Circuits, 5th Edition, Oxford University Press, 2009.
3. Allen Mottershead, Electronic Devices and Circuits-An Introduction, Prentice Hall of India Private Limited, New Delhi, 2003
4. N.P.Deshpande, Electronic Devices and Circuits, 1st Edition, Tata McGraw Hill Publishing Limited, New Delhi, 2013.
5. R.L.Boylestad and Louis Nashelsky, Electronic Devices and Circuits, 9th Edition, Pearson/Prentice Hall, 2013.
6. Thomas L Floyd, Electronic Devices, Prentice Hall of India, New Delhi, 2011.

18MC207 ENGINEERING PRACTICE LABORATORY 0 0 2 1

Course Objectives

- To provide hands on training for fabrication of components using carpentry, sheet metal and welding equipment / tools.
- To gain the skills for making turning, facing operations using suitable Lathe.
- To develop the skills for making wood/sheet metal models using suitable tools

Programme Outcomes (POs)

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

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO8.Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO11. Project Management and Finance: 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.

PO12. Life-long Learning: 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.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Fabricate simple components using carpentry tools
2. Make the machining process and measure the dimensions using Vernier Caliper
3. Prepare corner joint, Butt joint, Lap joint using welding equipment/tools.
4. Make simple models using wood and sheet metal
5. Develop an object using different sheets.

Articulation Matrix

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

EXPERIMENT 1 2 Hours

For the given wire, plate measure the dimensions using screw gauge and Vernier caliper

EXPERIMENT 2 3 Hours

Perform turning, facing operations on given work piece to produce the stepped diameter on the MS rod. Measure the dimensions using Vernier caliper

EXPERIMENT 3 3 Hours

Perform turning, facing, chamfering operations on given work piece to produce tapered diameter on the MS rod. Measure the dimensions using Vernier caliper

EXPERIMENT 4 2 Hours

Perform drilling, reaming, tapping operation on the given work piece

EXPERIMENT 5 4 Hours

Make lap joint, Corner joint, Butt joint using Arc and gas welding methods on the given two plates

EXPERIMENT 6 **6 Hours**

Develop a rectangular tray, hopper, cylinder using the sheet metal operations

EXPERIMENT 7 **4 Hours**

Making of Pen Stand, Teapoy using carpentry power tools

EXPERIMENT 8 **2 Hours**

Use hand grinder to make a square plate from the given object and make a hole of multiple diameters

EXPERIMENT 9 **4 Hours**

Fabrication of a simple component using thin and thick plates to make a Book rack

Total **30 Hours**

18MC301 ENGINEERING MATHEMATICS III 3 1 0 4

Course Objectives

- Aimed to provide basic knowledge on periodic, Non periodic functions and their representations using Fourier series and Fourier transforms respectively
- Assess the electrical and mechanical potentials using Laplace transform techniques through partial differential equations
- Predict the changes in the manufacturing process using the concepts of statistics

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Represent the periodic motions of mechanical appliances with the help of Fourier series
2. Demonstrate the non periodic vibrations and their properties using Fourier Transforms
3. Formulate a function in frequency domain for which the function defined in time domain through the techniques of Laplace transforms
4. Find the position of a moving particle which are depending on more than one Parameter, using partial differential equations
5. Summarise and analyse the properties of the parameters of any mechanical process with the help of Statistics

Articulation Matrix

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

UNIT I 10 Hours

FOURIER SERIES

Definition of periodic function, Eulers formula, Functions having points of discontinuity, Change of intervals, Odd and Even functions, Expansion of odd or even periodic functions, Half range sine and cosine series, Elements of harmonic analysis

UNIT II 9 Hours

FOURIER TRANSFORMS

Fourier Transform and Inverse Fourier Transform, Sine and Cosine Transforms and Properties, Transforms of Simple Functions, Convolution Theorem, Parseval s Identity

UNIT III 9 Hours

LAPLACE TRANSFORM

Laplace Transform, Existence Condition, Transforms of Standard Functions, Unit step function, Unit impulse function, Properties, Transforms of Derivatives and Integrals, Initial and Final Value Theorems, Laplace transform of Periodic Functions, Inverse Laplace transforms. Applications to ordinary differential equations

UNIT IV 10 Hours

APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATION

Classification of Second Order Quasi Linear Partial Differential Equations, Fourier Series Solutions of One Dimensional Wave Equation, One Dimensional Heat Equation, Steady State Solution of Two Dimensional Heat Equation, Fourier Series Solutions in Cartesian Coordinates

UNIT V **7 Hours**

BASIC STATISTICS

Mean, Median, Mode, Variance, Standard Deviation, Covariance, Correlation and Regression

Total: 60 Hours

Reference(s)

1. Kreyszig Erwin, Advanced Engineering Mathematics, 7th Edition, John Wiley, 1993
2. Johnson Richard A. and Bhaltacharyya Gouri K., Statistics, Principles and Methods, 3rd Edition, John Wiley, 1996
3. O'Neil Peter V., Advanced Engineering Mathematics, 4th Edition, PWS-Kent, 1995
4. James Glyn, Advanced Modern Engineering Mathematics, Addison-Wesley, 1993 5.
5. Grewal.B.S, Higher Engineering Mathematics, Khanna Publishers, 43 rd Edition, New Delhi, 2016

18MC302 ELECTRICAL MACHINES 3 0 2 4

Course Objectives

- To understand the working principle and performance characteristics of DC Generator and DC Motor
- To understand the working principle of induction motor and synchronous machines
- To Impart knowledge on special electrical machines

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO12. Life-long Learning: 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.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Implement the circuit model of DC Machines with working principles for starting and controlling the speed.
2. Compute the transformer parameters using the per unit system to compute voltage regulation and efficiency.
3. Analyze the slip-torque characteristics of induction motors to find the operating point and suitable starting methods.
4. Apply the excitation principles of synchronous motor to power factor correction in industries
5. Select the appropriate special machine based on its characteristics for constructing modern tools in industry

Articulation Matrix

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

UNIT I **8 Hours**
DC MACHINES
Introduction-Constructional Features-Motoring and generation principle -Emf And Torque equation -Circuit Model- Methods of Excitation and magnetisation characteristics - Starting and Speed Control -Universal Motor

UNIT II **10 Hours**
TRANSFORMERS
Introduction -Ideal Transformer - Accounting For Finite Permeability And Core Loss - Circuit Model Of Transformer - Per Unit System - Determination Of Parameters Of Circuit Model Of Transformer – Voltage Regulation - Nameplate Rating - Efficiency - Three Phase Transformers -Auto Transformers

UNIT III **9 Hours**
INDUCTION MACHINES
Three phase induction motors: Constructional details - Types of rotors - Principle of operation - Slip - Slip-torque characteristics - Condition for maximum torque - Losses and efficiency - Starters - Single Phase induction motors: Double field revolving Theory -Types-Applications

UNIT IV **10 Hours**
SYNCHRONOUS MACHINES
Constructional details - Types of rotors, operating characteristics - Emf equation - Synchronous reactance - Armature reaction - Voltage regulation - EMF, MMF, methods - Synchronous motor: Principle of operation - Torque equation - Starting methods - V and inverted V curves.

UNIT V **8 Hours**
SPECIAL MACHINES
Special machines - reluctance motor, repulsion motor, hysteresis motor, stepper motor, servo motor, BLDC. Dynamic, regenerative and plugging

FOR FURTHER READING
Phasor Diagram of Transformer, Blocked rotor test of induction motor, power factor correction using synchronous motor, Analysis of mechanical characteristics of special machines.

EXPERIMENT 1 **4 Hours**
Load test on DC shunt motor.

EXPERIMENT 2 **4 Hours**
Load test on DC series motor

EXPERIMENT 3 **5 Hours**
Load characteristics of separately excited DC generator

EXPERIMENT 4 **5 Hours**
Load characteristics of separately excited DC generator

EXPERIMENT 5 **4 Hours**
O C and S C test on single phase transformer

EXPERIMENT 6 **5 Hours**
Load test on three phase Induction motor.

EXPERIMENT 7 **4 Hours**
Load test on 1 phase Induction motor.

75 Hours

Reference(s)

1. D.P.Kothari and J.J.Nagrath, Electric Machines, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2017
2. A.E.Fitzgerald, Charles Kingsley and Stephen D. Umans, Electric Machinery, Tata McGrawHill Publishing Company Ltd, New Delhi, 2003
3. Stephen J. Chapman, Electric Machinery Fundamentals, Tata McGraw Hill Publishing Company Limited, New Delhi, 2017
4. P. S. Bhimbhra, Electrical Machinery, Khanna Publishers, New Delhi, 2011.
5. B.L.Theraja and A.K.Theraja, A Text Book of Electrical Technology - Volume II, S.Chand and Company Ltd, New Delhi, 2014

18MC303 DIGITAL ELECTRONICS 3 0 0 3

Course Objectives

- To understand the fundamentals of digital logic
- To understand the various number systems and codes
- To design various combinational and sequential circuits
- To study the basics about synchronous and asynchronous circuits

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design/ Development of Solutions: 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.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Use the Boolean algebra and simplification techniques to design and minimize logic circuits.
2. Design and analyze combinational circuits such as adders, subtractors, multiplexers, and encoders for efficient data processing.
3. Develop sequential circuits using flip-flops and state diagrams through state minimization and assignment techniques.
4. Outline the different memory types and implement combinational logic using PLDs, PLA, PAL, and FPGA.
5. Design synchronous and asynchronous sequential circuits while addressing potential hazards, and use VHDL to model and simulate digital systems.

Articulation Matrix

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

UNIT I 9 Hours

LOGIC GATES AND MINIMIZATION CIRCUITS

Basic digital circuits AND - OR - NAND - NOR - EX-OR - EX-NOR operations - universal building block construction using logic gates - Boolean Algebra- Simplification of Boolean functions - special forms of Boolean functions - minterm (SOP) - maxterm (POS) - K Map representation of logic functions - simplification of logic functions using K Map - Don't care conditions ,Quine-McCluskey method of minimization.

UNIT II 9 Hours

COMBINATIONAL CIRCUITS

Half and Full Adders - Half and Full Subtractors - Code converters Encoder - Decoder – Multiplexer Demultiplexer - Binary/ BCD adders, subtractors - Carry look ahead adder - parity checker - parity generators - Magnitude comparator

9 Hours

UNIT III
SEQUENTIAL CIRCUITS
General model of sequential circuits - flip-flops - latches - level triggering, edge triggering – master slave configuration - Mealy/Moore models - state diagram - state table - State minimization - State assignment - Excitation table and maps - shift registers - Ring counter

UNIT IV **9 Hours**
MEMORY DEVICES
Memory types and terminology - static and dynamic RAM - ECL RAM - Non Volatile RAM - Sequential Memories: Recirculation shift registers-First in first out memories - Magnetic core memories - magnetic disk memories - Programmable Logic Devices (PLD) - Programmable Logic Array (PLA) - Programmable Array Logic (PAL) - Field Programmable Gate Arrays (FPGA) - Implementation of combinational logic circuits using ROM, PLA, PAL

UNIT V **9 Hours**
SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS AND VHDL
Design of synchronous sequential circuits - parity checker - sequence detector - Asynchronous sequential logic: Race conditions and Cycles - Hazards in combinational circuits. Introduction to VHDL -Behavioral, Data Flow and Structural Model - Operators - Data objects - Data types, Attributes - Test Benches - Simple programs

FOR FURTHER READING
Memory types and terminology - static and dynamic RAM - ECL RAM - Non Volatile RAM --First in first out memories - Magnetic core memories - magnetic disk memories- Magnetic tape and Bubble memories

Total: 45 Hours

Reference(s)
1. PSO1: Morris Mano, Michel D. Ciletti, Digital Design, Pearson Education, New Delhi, 6th edition,2018
2. Ronald J. Tocci Neal S. Widmer and Gregory L. Moss, Digital Systems: Principles and Applications, Prentice Hall of India, New Delhi, 12th Edition, 2018
3. A. Anand Kumar, Fundamentals of Digital Circuits, PHI Learning Pvt. Ltd. 2014.
4. Thomas L. Floyd, Digital Fundamentals, Pearson Education Inc, New Delhi,10th Edition, 2006
5. Donald P.Leach and Albert Paul Malvino, Digital Principles and Applications, Tata McGrawHill Delhi, 8th Edition 2015
6. Charles H.Roth. Fundamentals of Logic Design, Thomson Learning, 7th Edition,2013

18MC304 STRENGTH OF MATERIALS 3 1 0 4

Course Objectives

- To understand the concepts of stress, strain, principal stresses and principal planes.
- To determine the stresses and understand their behaviour on beams, shafts and thin cylinders
- To assess the deflections in beams, columns and springs
- To compute the power transmitted by shafts and stain energy stored in deformed bodies

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration

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

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Identify the stress-strain relationship to determine the deformation of a composite bar in a structural engineering application.
2. Make use of Mohr's circle to determine the stresses under bending and shear loading in an engineering design scenario.
3. Examine the shear force and bending moment distributions in loaded beams for the design and safety of structural components.
4. Compute the strain energy stored and find the deflection of beams for the analysis and design of structural elements.
5. Determine the parameters of shafts and springs to design mechanical systems, such as power transmission devices and suspension systems.

Articulation Matrix

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

UNIT I 9 Hours

STRESS, STRAIN AND DEFORMATION OFSOLIDS

Rigid bodies and deformable solids - Simple stresses and strains - Stress-strain curve for ductile materials - Deformation of axially loaded member - Composite bars - Thermal stresses - Elastic constants - Relationship between elastic constants - Volumetric strains

UNIT II 9 Hours

STRESSES IN BEAM

Stresses on inclined planes - Principal stresses and principal planes - Mohr's circle of stress - Theory of simple bending - Bending stress distribution - Load carrying capacity - Proportioning of sections - Shear stress distribution - Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses - Thick cylinders - Lame's equation - Shrink fit

UNIT III **9 Hours**

TRANSVERSE LOADING ON BEAMS

Beams and its types - Transverse loading on beams - Shear force and bending moment in beams: cantilever, simply supported beam and overhanging beam - Determination of maximum bending moment - Point of contra flexure

UNIT IV **9 Hours**

STRAIN ENERGY AND DEFLECTION

Strain energy - Resilience and proof resilience - Strain energy stored in the member due to gradually applied load, suddenly applied load and impact load - Stress strain diagram showing ductile and brittle behaviour of materials - Elastic curve - Governing differential equation - Double integration method for computation of slope and deflection of determinant beams - Deflection in columns - Long column - Euler's Theory - Short column - Empirical formulae

UNIT V **9 Hours**

TORSION IN SHAFTS AND SPRINGS

Theory of Torsion - Stresses and Deformations in Solid and hollow circular shafts - Power transmitted to shaft - Shaft in series and parallel - Stepped shafts - Deflection in shafts fixed at the both ends - Closed and open coiled helical springs - springs in series and parallel - Stresses in helical springs - Deflection of helical springs - Leaf springs

FOR FURTHER READING

Bending stress distribution of flitched beams - Stresses in compound cylinders - Stress-strain curve for brittle materials

Total: 60 Hours

Reference(s)

1. Rattan, S. S., Strength of Materials, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2012
2. Egor. P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2002
3. Ferdinand P. Beer, E. Russell Johnston, Jr., John T. Dewolf and David F. Mazurek, Mechanics of Materials, McGraw-Hill Education, New York, 2015.
4. Bansal. R. K., A Textbook of Strength of Materials, Laxmi Publications Pvt. Ltd., New Delhi, 2018
5. Subramanian, R., Strength of Materials, Oxford University Press, Oxford Higher Education Series, 2016.
6. https://onlinecourses.nptel.ac.in/noc17_ce22/preview

18MC305 FLUID MECHANICS AND HYDRAULIC MACHINES 2 0 2 3

Course Objectives

- To understand the fluid properties and its application
- To acquire knowledge on kinematics and dynamics of internal flows of fluids
- To carry out the dimensional and model analysis of systems using Newtonian fluid
- To understand the concepts of hydraulic machines

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Examine the dynamic behavior of fluid motion in engineering systems.
2. Evaluate the characteristics of internal fluid flow and identify the losses occurring within the fluid path.
3. Utilize dimensional and model analysis techniques to predict the performance of hydraulic machines.
4. Apply principles of fluid mechanics to assess the performance of hydraulic turbines.
5. Analyze the operation of dynamic and positive displacement pumps.

Articulation Matrix

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

UNIT I 6 Hours

FLUID PROPERTIES

Fluid - Fluid Mechanics - Properties of fluids - Types of fluid Capillarity and Surface Tension - Two dimensional Continuity equation, Bernoulli equation, energy equation, momentum equation and moment of momentum equation.

UNIT II 6 Hours

INTERNAL FLUID FLOWAND FRICTIONAL LOSSES

Types of Fluid flow - Flow in circular pipe, - Darcy Weisbach equation - Chezy's formula -Minor losses in pipes - Flow through syphon - Flow through pipes in series and in parallel

UNIT III **6 Hours**

DIMENSIONAL ANALYSIS

Dimensional analysis - Rayleigh's Method, Buckingham's Pi Theorem - Similitude - Types of Similarities - Dimensionless parameters - Model laws

UNIT IV **6 Hours**

HYDRAULIC TURBINES

Turbines- definition - Classification, Types of Heads and Efficiencies Construction and working principle - Pelton Wheel - Francis Turbine, Kaplan Turbine - specific speed - Characteristic curve for hydraulic turbines - Governing of turbines

UNIT V **6 Hours**

HYDRAULIC PUMPS

Types of Pumps - Construction and Working - Centrifugal pump, Reciprocating Pump, Jet Pumps, Gear Pump -Definitions of Head and Efficiencies - Minimum speed - Priming and Cavitation - Slip - Characteristic curves. Slip - Indicator diagram (Description only)

FOR FURTHER READING

Pressure Measurement - Types of manometer - Lift and drag in air foils - Propeller Turbine - Air vessel - Pitot Tube

EXPERIMENT 1 **3 Hours**

Determination of fluid properties for the given samples

EXPERIMENT 2 **3 Hours**

Determination of coefficient of discharge by selecting a simple flow and efficient flow measuring device to measure the flow of water in a closed pipe

EXPERIMENT 3 **3 Hours**

Measurement of discharge of a pipe flow using a vertically oriented flow measuring device and identifying the significant parameters

EXPERIMENT 4 **3 Hours**

Measure the discharge of open channel flow using V notch or trapezoidal notch

EXPERIMENT 5 **3 Hours**

Measure and Comparison of major losses in two pipes in which the water flowing inside them

EXPERIMENT 6 **3 Hours**

Selection of suitable pump for domestic application and determining its optimum performance parameters.

EXPERIMENT 7 **3 Hours**

Selection of a non rotary positive displacement pump and determining its optimum performance parameters

EXPERIMENT 8 **3 Hours**

Determine the efficiency and characteristics of Impulse turbine

EXPERIMENT 9 **3 Hours**

Determine the efficiency and characteristics of Kaplan Turbine

EXPERIMENT 10 **3 Hours**

Design an experiment to verify the various fluid laws

60 Hours

Reference(s)

1. R. K. Bansal, A textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, New Delhi, 2018
2. Bruce R. Munson , Donald F. Young, Theodore H. Okiishi and Wade W. Huebsch, Fundamentals of Fluid Mechanics, John Wiley and Sons (Asia) Pvt. Ltd., New Delhi, 2012.
3. Pijush K. Kundu and Ira PSO1: Cohen, Fluid Machines, Academic Press, Burlington, USA, 2010
4. Yunus A. Cengel and John PSO1: Cimbala, Fluid Mechanics Fundamentals and Application, Tata McGraw-Hill Publishing Company Ltd, New Delhi 2013

5. John F. Douglas, J. PSO1: Gasiorek, John Swaffield and Lynne Jack, Fluid Mechanics, Pearson Education, New Delhi, 2008.
6. S. K. Som , Gautam Biswas and S. Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw-Hill Publishing Company Ltd, New Delhi 2017

18MC306 MANUFACTURING TECHNOLOGY 3 0 0 3

Course Objectives

- To understand working principle of conventional and non-conventional casting, welding and metal working processes
- To study the working of machining processes including non-conventional types
- To learn about the production methods of thermo and thermosetting plastics

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Select appropriate casting and molding techniques to manufacture components based on material properties and production requirements in industrial
2. Apply the principles of welding, brazing, soldering, and adhesive bonding for assembling components in automotive, aerospace, and manufacturing applications.
3. Choose the suitable metal forming processes, such as forging, rolling, extrusion, or drawing, to manufacture components in a sheet metal industry.
4. Identify the appropriate machine tool for specific machining operations to achieve desired precision and efficiency in manufacturing processes.
5. Examine the appropriate non-conventional machining method to process complex shapes or hard-to-machine materials in advanced manufacturing applications.

Articulation Matrix

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

UNIT I 9 Hours

CASTING PROCESSES

Introduction to Foundry - Procedure to make sand mould, types of cores, moulding tools, machine moulding - pattern, sand testing, - casting defects and remedies. Introduction to Plastics - Moulding of Thermoplastics - Injection moulding -Plunger and screw machines -Blow moulding -Rotational moulding -Film blowing - -Thermoforming - Compression moulding -Transfer moulding

UNIT II 9 Hours

JOINING PROCESSES

Types of Metal Joining Process - Introduction to welding process - Principle of arc and gas welding - Tools and equipment - Filler and flux materials - Flame types - Weld defects - Safety in welding -

Special welding processes: resistance welding, Friction welding, TIG welding, MIG welding -Brazing and soldering - Adhesive bonding.

UNIT III **9 Hours**

METAL FORMING THEORY

Introduction to hot and cold working - Forging: open and close die, upsetting - Rolling: high roll mills and shape rolling - Extrusion: forward and backward, tube extrusion - Drawing of wires, rods and tubes - Sheet metal work: Shearing, bending and drawing operations - Powder metallurgy (basics only)

UNIT IV **9 Hours**

MACHINE TOOLS

Cutting tools & materials, cutting fluids, metal cutting theory, Merchants circle, constructional features of machine tools: Universal milling machine, shaping machine, cylindrical grinding machine, capstan and turret lathe - Basics of CNC machine.

UNIT V **9 Hours**

NON CONVENTIONAL MACHINING

General principles and applications - Water jet machining (WJM), Abrasive Jet Machining (AJM)Electro Discharge Machining (EDM), Electro Chemical Machining (ECM) and Laser Beam Machining (LBM), Ultrasonic Machining (USM).

FOR FURTHER READING

Additive Manufacturing, Laser Beam welding, Automated Melding system

Total: 45 Hours

Reference(s)

1. J. P. Kaushish, Manufacturing Processes, Prentice Hall of India Learning Private Limited, New Delhi, 2014
2. P. PSO2: Rao, Manufacturing Technology - Vol I and II, Tata McGraw-Hill Publishing Company
Limited, New Delhi, 2013.
3. D. K. Singh, Fundamentals of Manufacturing Engineering, ANE Books, New Delhi, 2008
4. Roy A. Lindberg, Processes and Materials of Manufacture, Prentice Hall of India Learning. Ltd., New Delhi, 2009
5. T. R. Mishra, Non-Conventional Machining, Narosha Publishing House, New Delhi, 2012
6. Mikell P. Groover, Automation, Production System and Computer Integrated Manufacturing, Pearson Education, New Delhi, 2015.

18MC307 DIGITAL ELECTRONICS LABORATORY 0 0 2 1

Course Objectives

- To design and implement the digital circuits
- To gain expertise in digital systems and simulation of digital circuits with ICs

Programme Outcomes (POs)

PO3.Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Compute and implement combinational circuits, including adders, subtractors, code converters, and parity checkers, using logic gates and ICs.
2. Develop and test sequential circuits, such as counters and flip-flops, and implement these using programmable devices like ROMs and PLAs.
3. Create and simulate digital circuits using VHDL at the data abstraction level, enhancing skills in digital system modeling and verification.

Articulation Matrix

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

EXPERIMENT 1 3 Hours

Design and implementation of Adders and Subtract or using logic gates

EXPERIMENT 2 3 Hours

Design and implementation of code converters using logic gates
(i) BCD to excess-3 code and vice versa
(ii) Binary to gray and vice-versa

EXPERIMENT 3 3 Hours

Design and implementation of 4 bit binary adder/ subtract or and BCD adder

EXPERIMENT 4 3 Hours

Design and implementation of 4 bit binary adder/ subtract or and BCD adder

EXPERIMENT 5 3 Hours

Design and implement a 16 bit odd/even parity generator and checker using ICs

EXPERIMENT 6 3 Hours

Design and implement a multiplexer and DE multiplexer using ICs

EXPERIMENT 7 3 Hours

Design and implement an encoder and decoder using ICs

EXPERIMENT 8 3 Hours

Design and implement a synchronous counter

EXPERIMENT 9 3 Hours

Design a sequential circuit using ROMs and PLAs

EXPERIMENT 10 **3 Hours**

Design flip flops (JK,SR,D and T) VHDL using data level of abstraction

30 Hours

Reference(s)

1. PSO2: Nagrath, Electronics: Analog and Digital, Prentice Hall of India Pvt. Ltd, New Delhi, 2009
2. Anant Agarwal, Joffrey H. Lang, Foundations of Analog and Digital Electronic Circuit, Elsevier, 2006

18MC308 MANUFACTURING TECHNOLOGY LABORATORY 0 0 2 1

Course Objectives

- To operate conventional machine tools such as lathe, milling machine, shaping machine, drilling machine, gear hobbing machine, surface grinding machine and tool and cutter grinder
- To correlate the theory, course on machining processes
- To measure various linear dimensions

Programme Outcomes (POs)

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

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO11. Project Management and Finance: 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.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Classify various machine tools and their functions, while performing hands-on measurement of linear dimensions using precision instruments in a laboratory
2. Demonstrate the operation of conventional machine tools for drilling and welding processes to fabricate and assemble components.
3. Create machine parts according to the required design specifications using appropriate machining techniques.

Articulation Matrix

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

EXPERIMENT 1 **3 Hours**

Machining a cotter pin whose diameter is continuously varying throughout its length

EXPERIMENT 2 **3 Hours**

Making a model of screw used in Vernier caliper

EXPERIMENT 3 **3 Hours**

Practicing to make models like table, chair, rack, teapoy, stool, etc. using arc welding equipment

EXPERIMENT 4 **3 Hours**

Fabrication of a pin and hole with push fit assembly using centre lathe

EXPERIMENT 5 **3 Hours**

Preparing the shaft/key/coupling assembly by selecting suitable machining operations and to list the sequence of operations.

EXPERIMENT 6 **3 Hours**

Machining a spur gear with n number of teeth with 2 mm module by selecting suitable machine tool.

EXPERIMENT 7 **3 Hours**

Grinding of single point cutting tool in the 10 mm MS square rod with standard nomenclature using tool and cutter grinding machine

EXPERIMENT 8 **3 Hours**

Grinding of single point cutting tool in the 10 mm MS square rod with standard nomenclature using tool and cutter grinding machine

EXPERIMENT 9 **3 Hours**

Producing a square bar from the given shaft with minimum material wastage by selecting suitable machining operations

30 Hours

Reference(s)

1. Central Machine Tool Institute (CMTI), Machine Tool Design Handbook, Tata McGraw-Hill Publishing Company Ltd, Bangalore, 2017
2. Geoffery Boothroyd and Winston A. Knight, Fundamentals of Machining and Machine Tools,CRC Press, Taylor and Francis Group, Indian Edition, 2008.
3. Heinrich Gerling and Karl H. Heller, All About Machine Tools, New Age International (P) Limited Publishers, Noida, 2008
4. Steve F. Krar, Arthur R. Gill and Peter Smid, Technology of Machine Tools, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2010

18GE301 SOFT SKILLS - VERBAL ABILITY 2 0 0 0

Course Objectives

- To help students gain adequate proficiency in vocabulary
- To help students become proficient in basic writing skills related to workplace communication
- To read and understand unabridged text

Programme Outcomes (POs)

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO11. Project Management and Finance: 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.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Take up verbal ability part of the placement tests with confidence
2. Write with confidence in professional and workplace communication
3. Distinguish fact from opinion by reading passages from a text

Articulation Matrix

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

UNIT I **15 Hours**

INTRODUCTION

Synonyms - Antonyms - Word Groups - Verbal Analogies - Etymology - Critical Reasoning - Cloze Test - One Word Substitution - Idioms and Phrases - Text & Paragraph Completion

UNIT II **15 Hours**

BASICS OF VERBAL APTITUDE

Sentence Formation - Paragraph Formation - Change of Voice - Change of Speech - Reading Comprehension - Sentence Equivalence - Jumbled Sentences - Spotting Errors -Homophones Homonyms - Commonly Mispronounced/Misspelt Words

Total: 30 Hours

Reference(s)

1. Murphy, Raymond. English Grammar in Use A Self-Study Reference and Practice Book for Intermediate Learners of English. IV EditioPSO2: United Kingdom: Cambridge University Press. 2012.
2. Lewis, NormaPSO2: Word Power Made Easy. New York: Pocket Books. 1991.
3. Barron's The Official Guide for New GMAT Review, New Jersey: John Wiley & Sons, Inc. 2015

18MC401 ENGINEERING MATHEMATICS IV 3 1 0 4

Course Objectives

- Recognize and develop a mathematical model representing all important characteristics of the physical system.
- Identify and solve any type of mathematical equations by numerical methods.
- Predict and control the process by control charts.

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Compute the solution of nonlinear equations and to construct a mathematical model for the given data.
2. Assess the values of one and two dimensional partial differential equations like vibration of strings, heat distribution in a rod and plate
3. Identify the error committed by the numerical calculation of any type of mathematical models and able to rectify the errors
4. Predict the outcome of any mechanical process using the concepts probability and probability distributions.
5. Justify and validate the mathematical model for a mechanical process with the help of hypothesis testing

Articulation Matrix

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

UNIT I 10 Hours

NUMERICAL SOLUTIONS OF NON LINEAR EQUATIONS, INTERPOLATION AND ORDINARY DIFFERENTIAL EQUATIONS.

Single and multi-variable nonlinear equations by Newton s method, convergence of fixed point iterations. Curve fitting: Least squares approximation, Normal equations. Polynomial interpolation and cubic spline interpolatioPSO2: Single step method: Runge-Kutta method, Multi-step methods, Finite
Difference Methods.

UNIT II 10 Hours

NUMERICAL SOLUTIONS OF INTEGRATIONS AND PARTIAL DIFFERENTIAL EQUATIONS.

Integration using Simpson s and Trapezoidal rules. Classification of partial differential equations, solutions of Laplace s and Poisson s equations, Solutions of parabolic and hyperbolic equations

UNIT III 6 Hours

ERROR ANALYSIS

Errors, Truncation and round off errors, measurement errors, Chebychev s Polynomial and data filtering.

UNIT IV **10 Hours**

PROBABILITY THEORY

Probability. Random variables, probability densities and distributions, mean and variance of a distributioPSO2: Conditional probability. Bayes theorePSO1: Binomial, Poisson and normal distributions.

UNIT V **9 Hours**

DATA ANALYSIS

Data Sampling, Random Sampling, Reliability of Data, Testing of Hypothesis, Confidence Interval, Quality Control.

Total: 60 Hours

Reference(s)

1. Greenberg Michael D., Advanced Engineering Mathematics, Prentice-Hall International Inc, 1998.
2. Kreyszig Erwin, Advanced Engineering Mathematics, 7th Edition, John Wiley, 1993.
3. Johnson Richard A. and Bhaltacharyya Gouri K., Statistics, Principles and Methods, 3rd Edition, John Wiley, 1996.
4. Sankara Rao. K, Numerical Methods for Scientists and Engineers, Eastern Economy Edition, New Delhi.
5. Milton J. S. and Arnold Jesse C., Introduction to Probability and Statistics: Principles and Applications for Engineering and The Computing Sciences, McGraw Hill Inc, 3rd Edition, 1995.

18MC402 SENSORS AND SIGNAL CONDITIONING 3 0 0 3

Course Objectives

- To recall the basic laws governing the operation of electrical instruments and the measurement techniques
- To discuss about units, standards, error analysis and characteristics of measurement systems
- To select a suitable sensor and signal conditioning circuit for a particular applications

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Outline the various calibration techniques and signal types for sensors.
2. Compare the different sensors associated in measuring motion, proximity and ranging sensors signals
3. Construct the working principle and characteristics of force, magnetic and heading sensors
4. Select the basic principles of various pressure temperature, optical and smart sensors
5. Outline the need for signal conditioning system and their purpose

Articulation Matrix

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

UNIT I 9 Hours

SCIENCE OF MEASUREMENT

Basics of Measurement - Classification of errors - Error analysis - Static and dynamic characteristics of transducers - Performance measures of sensors -Classification of transducers - Sensor calibration techniques -Sensor Output Signal Types

UNIT II 9 Hours

MOTION, PROXIMITY AND RANGING SENSORS

Motion Sensors - Potentiometers, Resolver, Encoders - Optical, Magnetic, Inductive, Capacitive, LVDT - RVDT - Synchro - Microsyn, Accelerometer - GPS, Bluetooth, Range Sensors - RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III 9 Hours

FORCE, MAGNETIC AND HEADING SENSORS

Strain Gage, Load Cell, Magnetic Sensors - types, principle, requirement and advantages: Magneto resistive - Hall Effect -Current sensor Heading Sensors - Compass, Gyroscope, Inclinometers

UNIT IV **9 Hours**

OPTICAL, PRESSURE AND TEMPERATURE SENSORS

Photo conductive cell, photo voltaic, Photo resistive, LDR - Fiber optic sensors - Pressure - Diaphragm, Bellows, Piezoelectric - Tactile sensors, Temperature - IC, Thermistor, RTD, Thermocouple. Acoustic Sensors - flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors

UNIT V **9 Hours**

SIGNAL CONDITIONING SYSTEM

Wheatstone and Schering bridges - Amplification - Filtering - V/I, I/V and I/P converters - Sample and Hold circuits - D/A converter (R -2R ladder and weighted resistor types) - A/D converter (Dual slope, successive approximation and flash types) - Data logging - Display devices: CRO, LED and LCD

FOR FURTHER READING

Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors - applications - Automobile, Aerospace, Robotics and Manufacturing

Total:45 Hours

Reference(s)

1. A.K.Sawhney and P.Sawhney, A Course on Mechanical Measurement Instrumentation and Control, Dhanpat Rai and Co, New Delhi, 2011
2. E. O. Doeblin, Measurement Systems: Applications and Design, Tata McGraw-Hill Publishing Company Limited, 2003
3. C. Sujatha and Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001
4. Hans Kurt TÃƒÂ¶nshoff (Editor), Ichiro, Sensors in Manufacturing, Volume 1, Wiley-VCH 2001.
5. Richard Zurawski, Industrial Communication Technology Handbook 2nd edition, CRC Press, 2015
6. https://nptel.ac.in/courses/112103174/3

18MC403 POWER ELECTRONICS AND DRIVES 3 0 2 4

Course Objectives

- To obtain the switching characteristics of different types of power semiconductor devices
- To determine the operation, characteristics and performance parameters of converters
- To understand the concept of DC and AC drives

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO12. Life-long Learning: 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.

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Analyze the construction and characteristics of power semiconductor devices for protecting equipment from the overvoltage and current.
2. Apply phase control techniques in power electronics equipment for stabilizing voltage and current.
3. Implement Pulse Width Modulation (PWM) techniques in inverters to eliminate harmonics and achieve efficient AC to DC power conversion.
4. Select suitable electrical drives and control DC motors with rectifiers and choppers to achieve optimal efficiency.
5. Execute slip power recovery schemes in AC motors with static rotor resistance control to improve power factor

Articulation Matrix

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

UNIT I **9 Hours**
POWER SEMICONDUCTOR DEVICES
Construction, Operation, Characteristics of Power Diode - SCR - TRIAC - Power transistor,MOSFET and IGBT - di/dt and dv/dt protection
UNIT II **9 Hours**
CONVERTERS AND CHOPPERS
Phase Control - Single Phase and Three phase uncontrolled and controlled rectifiers with R and RL load, Choppers, Time ratio control, Types, Buck-boost chopper-four quadrant operation, cyclo converters
UNIT III **9 Hours**
INVERTERS
Single phase and three phase (both 120 Ã‚Â° and 180 Ã‚Â° modes.) voltage source inverters - PWM techniques: Sinusoidal PWM modified sinusoidal PWM and multiple PWM - Current source inverters - Harmonics elimination technique
UNIT IV **9 Hours**
SOLID STATE DC DRIVES
Types of electrical drives - selection of drives - heating and cooling curves - Four quadrant operation of hoist -Ward Leonard control system - Control of DC drives using rectifiers and choppers
UNIT V **9 Hours**
SOLID STATE AC DRIVES
Control of three phase induction motors using stator voltage and frequency control - variable frequency drive - static rotor resistance control - Slip power recovery schemes - Static Kramer control method - Static Scherbius control method - Power factor correction
FOR FURTHER READING
Sepic, pi, T converters, UPS-PV power conversion, Application of Closed Loop control method, Permanent magnet brushless DC motor drive
EXPERIMENT 1 **3 Hours**
Characteristics of SCR
EXPERIMENT 2 **3 Hours**
Characteristics of IGBT
EXPERIMENT 3 **3 Hours**
Single phase half wave uncontrolled rectifiers with R, RL load
EXPERIMENT 4 **3 Hours**
Single phase half wave controlled rectifiers with R, RL load
EXPERIMENT 5 **3 Hours**
Single phase half wave controlled rectifiers with R, RL load and feedback diode
EXPERIMENT 6 **3 Hours**
Single phase uncontrolled rectifiers with R, RL load
EXPERIMENT 7 **3 Hours**
Single phase controlled rectifiers with R, RL load
EXPERIMENT 8 **3 Hours**
Three phase uncontrolled rectifiers with R, RL load
EXPERIMENT 9 **3 Hours**

Three phase controlled rectifiers with R, RL load

EXPERIMENT 10 **3 Hours**

Single phase PWM inverter

Total: 75 Hours

Reference(s)

1. Muhammad H. Rashid, Power Electronics - Circuits, Devices and Applications, Prentice Hall of India Learning. Ltd., New Delhi, 2004
2. G. K. Dubey, Fundamentals of Electrical Drives, Wiley Eastern Ltd., New Delhi, 2007
3. S. K. Pillai, A First Course on Electrical Drives, New Age International Pvt. Ltd., New Delhi, 2012.
4. PSO1: D. Singh and K. B. Khanchandani, Power Electronics, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008
5. Vedam Subrahmaniam, Electric Drives (concepts and applications), Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2007
6. P. S. Bhimbra, Power Electronics, Khanna Publishers, New Delhi, 2012

18MC404 FLUID POWER SYSTEM 2 0 2 3

Course Objectives

- To gain knowledge on properties of fluid and various types of losses in fluid
- To understand the construction and working principle of various components used in hydraulic and pneumatic systems
- To design hydraulic and pneumatic circuits for various applications using software and hardware tools

Programme Outcomes (POs)

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

PO3.Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO1.Analyze, design and develop electro mechanical system using contemporary tools

PSO2.Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation

Course Outcomes (COs)

1. Apply the concept of fluid power system to determine head losses and pump power.
2. Select suitable hydraulic pumps and suitable actuators used in hydraulic system
3. Determine the hydraulic valvess for the fluid power application.
4. Choose the components to design a pneumatic system
5. Design the hydraulic and pneumatic circuits for a given application using various methods.

Articulation Matrix

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

UNIT I 6 Hours

FLUID POWER SYSTEMS

Introduction to fluid power History Pascals law - Comparison between various type of energy medium - Advantages - Drawbacks - Applications of fluid power system in various sectors. Hydraulic fluids: Properties and functions. Filtration system - Darcys equation: Frictional losses. Losses in valves and fittings - Determination of head losses & pump power in a hydraulic circuit.

UNIT II 6 Hours

HYDRAULIC PUMPS AND ACTUATORS

Positive and non-positive displacement pumps - Pumping theory and classification - Construction and working principle of Gear, Vane and Piston pumps - Variable Displacement Pumps (Vane and Piston), Pump performance curves - Hydraulic cylinders: Construction & Working principle - Single acting, Double acting, Double rod cylinder and Telescopic cylinder. Hydraulic motors: Gear, Vane and Piston motors

UNIT III 6 Hours

HYDRAULIC VALVES
Directional Control Valves: Check valve - Pilot operated check valve - methods of valve actuation - working principle of 2/2, 3/2, 4/2 ,4/3 and 5/2 DCV - Shuttle valve. Pressure control Valves: Pressure relief valves - Pressure reducing valve - Unloading valves - Counterbalance valves - Flow control valves - Proportional and Servo valves: Mechanical type.

UNIT IV **6 Hours**
PNEUMATICS SYSTEM
Introduction - Properties of air - gas laws - Compressors: Piston compressor, Screw compressor and Vane compressor. Fluid conditioners: Air filters, Air pressure regulators, Air lubricators, Pneumatic silencers, After coolers and Air dryers. Pneumatic actuators: Pneumatic cylinders, Rotary air motors and Performance curves

UNIT V **6 Hours**
DESIGN OF HYDRAULIC AND PNEUMATIC CIRCUITS
Fluid power Symbols - Basic circuit - Meter in and Meter Out Circuit - Counter Balance Circuit - Pipe Sizing Calculations. Sequential circuit design for simple applications: Step counter method, Cascade methods & Karnaugh Veitch map method

FOR FURTHER READING
Servo pumps - variable displacement hydraulic Motors-Pneumatic valves. Introduction to Hydraulic Accessories, Pressure switch, Pressure and Flow sensors - Accumulators

EXPERIMENT 1 **3 Hours**
Identification of fluid power system components.

EXPERIMENT 2 **3 Hours**
Drawing the standard symbols of Fluid Power System components.

EXPERIMENT 3 **3 Hours**
Actuation of a single acting cylinder using limit switch and push button in a kit and simulation software

EXPERIMENT 4 **3 Hours**
Actuation of a double acting cylinder using limit switch in a kit and simulation software

EXPERIMENT 5 **3 Hours**
Simulation of fluid power circuits with logic controls (AND valve and OR valve).

EXPERIMENT 6 **3 Hours**
Design of PLC circuits using to actuate the double acting cylinder of Hydraulic lift

EXPERIMENT 7 **3 Hours**
Actuation of meter in, meter out, synchronizing and quick exhaust circuit in a simulation software

EXPERIMENT 8 **3 Hours**
Design of pneumatic circuit for a drilling operation and simulate the operation in a simulation software (use step counter method).

EXPERIMENT 9 **3 Hours**
Design of hydraulic circuit for a pick and place operation using cascade method and simulate the operation

EXPERIMENT 10 **3 Hours**
Design of fluid power circuit using Karnaugh Veitch method and simulate the operation in a simulation software.

60 Hours

Reference(s)
1. Anthony Esposito, Fluid Power with Applications, Pearson Education New Delhi, 2015
2. S. R. Majumdar, Oil Hydraulics, Tata McGraw Hill Publishing Company Pvt Ltd. New Delhi,2014
3. James L. Johnson, Introduction to Fluid Power, Delmar Thomson Learning, 2013
4. S. R. Majumdar, Pneumatic systems - Principles and maintenance, Tata McGraw Hill
5. Publishing Company Pvt Ltd. New Delhi, 2014.

6. Andrew Parr, Hydraulics and Pneumatics, Jaico Publishing House, 2015
7. https://nptel.ac.in/courses/112105047

18MC405 THEORY OF MACHINES 3 1 0 4

Course Objectives

- To learn various mechanisms and find their 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

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO10. Communication: 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.

PO12. Life-long Learning: 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.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Demonstrate the mobility of a given planar mechanism.
2. Apply vector mechanics principles to draw the velocity and acceleration diagram of planar mechanisms.
3. Analyze the static and dynamic forces in different parts of reciprocating engine for a mechanism design.
4. Implement the concept of balancing of masses in rotating shafts to determine its effects on vibration
5. Compute 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
1	2	2	-	1	-	-	-	-	-	-	-	1	2	2
2	2	2	-	-	-	-	-	-	-	1	-	1	3	2
3	2	2	-	-	-	-	-	-	-	1	-	1	3	2
4	2	2	-	-	-	-	-	-	-	1	-	1	3	2
5	2	2	1	-	-	-	-	-	-	1	-	1	3	2

UNIT I 9 Hours

BASICS OF MECHANISMS

Basic concepts of mechanisms: link, pair, chain, mechanism, machine and structure, degree of freedom, mobility of mechanism - Kutzbach criterion, Grashof's 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 - Gyroscope and Mechanical Governors(Basics only) - Industrial robotic arms

UNIT II **9 Hours**

KINEMATICS OF MECHANISMS

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'Alembert's principle, Dynamic Analysis in Four bar mechanism

UNIT IV **9 Hours**

BALANCING AND VIBRATION

Balancing 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 - Vibration and its effects - Types of vibration: Longitudinal, Transverse and torsional-free, forced and damped vibrations (basic only)

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(Basics only) - Introduction to gear correction gear trains Speed ratio, train value, Parallel axis gear trains, Epicyclic gear trains - Determination of gear speeds and torque using tabular method

FOR FURTHER READING

Cams, dynamic analysis of reciprocating engine

Total:60 Hours

Reference(s)

1. 1. S. S. Rattan, Theory of Machines, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2014
2. 2. R. L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2009
3. Sadhu Singh, Theory of Machines, Prentice Hall of India Learning, New Delhi, 2012
4. Kenneth J. Waldron and Garny L. Kinzel, Kinematics, Dynamics and Design of Machinery, John Wiley and Sons (Asia) Pvt. Ltd., New Delhi, 2007
5. R. S. Khurmi, J. K. Gupta, Theory of Machines, Eurasia Publishing House Pvt. Ltd., New Delhi, 2005
6. https://onlinecourses.nptel.ac.in/noc19_me29/preview

18MC406 METROLOGY AND MEASUREMENTS 3 0 0 3

Course Objectives

- To familiarize the important terms connected to measurement and understand various techniques used in linear, angular, form, power, flow and temperature measurements
- To impart knowledge on fits, tolerances and gauges design

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Apply the principles of metrology to identify and correct measurement errors, ensuring accurate and reliable results in engineering applications.
2. Select suitable linear and angular measuring instruments and techniques and perform precise measurements using advanced tools.
3. Select appropriate comparators and gauges, and find the dimensional variations in engineering components.
4. Apply appropriate methods for gear and thread measurement, and select suitable tools to assess surface roughness, gear tooth variations, and thread errors.
5. Identify the device used to measure the Force,Torque, Power and temperature for industrial applications.

Articulation Matrix

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

UNIT I 9 Hours

BASICS OF METROLOGY

Introduction to metrology ÃƒÂ¢?? Precision and accuracy ÃƒÂ¢?? Terms associated with measurement: sensitivity, readability, reliability and repeatability - Errors in Measurements: systematic and random errors - Correction and calibration - Types of standards - Concepts of interchange ability and selective assembly

UNIT II 9 Hours

LINEAR AND ANGULAR MEASUREMENTS

Linear measuring instruments - Classification - Vernier calliper - Micrometer - Limit gauges - gauge design -Angular measuring instruments: bevel protractor, clinometers, angle gauges, spirit levels, slip gauges and sine bar - Autocollimator - Laser interferometers - Machine vision - Nano-measurements

UNIT III **9 Hours**

COMPARATORS AND GAUGES

Comparators: mechanical, mechanical optical comparators, electrical comparators and pneumatic comparators - Limits, fits and tolerances - Tolerance grades - Types of fits - GO and NO GO gauges: plug and snap gauges - Taylor's principle - Design of GO and NO GO gauges - Filler gauges

UNIT IV **9 Hours**

FORM MEASUREMENT

Gear measurement: gear tooth vernier, constant chord method - Measurement of lead and run out - Backlash checking - Parkinson gear tester - Thread measurement: two wire and three wire methods - Errors in threads - Surface roughness parameters: Ra, Ry, Rz and RMS values - Surface roughness symbols

UNIT V **9 Hours**

MEASUREMENT OF POWER, FLOW AND TEMPERATURE

Force - Torque - Power - Measurement of power: mechanical, pneumatic, hydraulic and electrical - Flow measurement: venturimeter, orifice meter, rotameter, Pitot tube - Temperature measurement: Liquid in glass Thermometers, Pressure Thermometers, Pyrometer and electrical resistance thermometer

FOR FURTHER READING

Basic concept of CMM - Application of CMM - 3D Scanner

Total:60 Hours

Reference(s)

1. Jain, R. K.,Engineering Metrology, Khanna Publishers, New Delhi, 2018
2. Bewoor, A. K. and Kulkarni, V. A., Metrology and Measurement, Tata McGraw-Hill
3. Publishing House, New Delhi, 2009.
4. Venkateshan, S. P., Mechanical Measurements, John Wiley and Sons, New Delhi, 2015
5. Backwith, Marangoni and Lienhard, Mechanical Measurements, Pearson Education, New
6. Delhi, 2013
7. https://onlinecourses.nptel.ac.in/noc18_me62/preview

18MC407 SENSORS LABORATORY 0 0 2 1

Course Objectives

- The purpose of this course is to acquire knowledge about LabVIEW programming and to study the interfacing of different sensors with LabVIEW.

Programme Outcomes (POs)

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

PO3.Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO2.Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Design a LabVIEW program to obtain a required measurement data for temperature
2. Carryout a design procedure to obtain a required measurement data for force
3. Demonstrate appropriate design procedure to obtain a required measurement data for displacement
4. Carryout an appropriate design procedure, suitable for signal conversion to interface with computer.
5. Design the LabVIEW program to control the speed and position of servomotor

Articulation Matrix

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

EXPERIMENT 1 3 Hours

In automobiles, temperature of the radiator has to be monitored regularly. Normally RTD's are used to monitor the coolant temperature because of its linearity property. Develop a suitable program to measure the temperature of RTD.

EXPERIMENT 2 3 Hours

Temperature measurement plays a vital role in milk processing industries. Because of high accuracy and stability, thermocouples are mostly preferred. Develop a suitable program to measure the temperature of J, K and E Type thermocouples

EXPERIMENT 3 3 Hours

Electronics produced by the telecommunications industry- out of all the devices thermistors are used in cellular phones. Thermistors help to regulate the temperature from inside a mobile device. This is important with the accepted use of rechargeable lithium-ion battery packs. Thermistors are also an important part of the protective circuitry. Develop a suitable program to measure the temperature of using thermistor

EXPERIMENT 4 3 Hours

Aerospace products require a continuous measure of weight and pressure on a near constant basis. These critical operations require the highest standard of accuracy. In which load cell are mostly preferred. Develop a suitable program to measure the force measurement using load cell

EXPERIMENT 5 **3 Hours**

Accurate and precise measurements of ligament strain, e.g. in the human knee, are still one of the most challenging tasks in biomechanical engineering. In order to measure the movement of knee joints and their reaction under mechanical load strain gauges are used. Develop a suitable program to measure the strain value using strain gauge.

EXPERIMENT 6 **3 Hours**

LVDTs are mostly used to measure spool position in a wide range of servo valve applications. Develop a suitable program to measure the displacement using LVDT.

EXPERIMENT 7 **3 Hours**

Vibration Measurement using Accelerometer and Frequency spectrum analysis, calculation of velocity and displacement using accelerometer

EXPERIMENT 8 **3 Hours**

Analog to Digital Conversion

EXPERIMENT 9 **3 Hours**

Digital to Analog Conversion

EXPERIMENT 10 **3 Hours**

Speed and Position Control of Servo Motor

30 Hours

Reference(s)

1. LabVIEW: Basics I & II Manual, National Instruments, Bangalore, 2011.
2. A. K. Sawhney and P. Sawhney, A Course on Mechanical Measurement Instrumentation and Control, Dhanpat Rai and Co, New Delhi, 2011

18MC408 COMPUTER AIDED DESIGN LABORATORY 0 0 4 2

Course Objectives

- To provide knowledge and skills to draw orthographic projections of simple components using geometric modelling software
- To provide knowledge on three dimensional model of simple mechanism and animation using CAD software

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO11. Project Management and Finance: 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.

PO12. Life-long Learning: 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.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Sketch the orthographic projections of simple components using geometric modelling software
2. Construct three dimensional assembly models of machine and robotic components using CAD Software

Articulation Matrix

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

EXPERIMENT 1 **4 Hours**
Create an orthographic view of machine components from the given isometric drawings.

EXPERIMENT 2 **4 Hours**
Construct a three dimensional assembly model of bearing

EXPERIMENT 3 **4 Hours**
Construct a three dimensional assembly model of bearing

EXPERIMENT 4 **8 Hours**
Generate a three dimensional shaft and coupling assembly model by considering tolerance in each Component.

EXPERIMENT 5 **8 Hours**
Create a three dimensional assembly model of Piston and Connecting Rod.

EXPERIMENT 6 **8 Hours**
Build a three dimensional assembly model of power drive system

EXPERIMENT 7 **4 Hours**
Create a three dimensional assembly model of two wheeler suspension system

EXPERIMENT 8 **4 Hours**
Construct a three dimensional assembly model of control valve

EXPERIMENT 9 **4 Hours**
Generate a three dimensional assembly model of Jig/fixture

EXPERIMENT 10 **8 Hours**
Create a three dimensional assembly model of Cartesian robot and animate its working using modelling software.

EXPERIMENT 11 **4 Hours**
Prepare technical documents for Cartesian robot Assembly by using 3D Via software

Total: 60 Hours

Reference(s)

1. Prof Sham Tickoo, Prabhakar Singh,Creo Parametric 2.0 for Engineers and Designers, Dreamtech press publication,New Delhi, 2013
2. Fumihiko Kimura, Geometric Modelling: Theoretical and Computational Basis towardsAdvanced CAD Applications,Springer publications, Newyork, 2001

18HS001 ENVIRONMENTAL SCIENCE 2 0 0 0

Course Objectives

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

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Explain the importance of interdisciplinary nature of environment studies, uses and exploitation of natural resources
2. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation
3. Impact the existing environmental challenges related to pollution and its management
4. Select suitable strategies for sustainable management of components of environmental science
5. Correlate 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
1	1	2	-	-	-	-	2	-	-	-	-	-	-	1
2	1	1	-	-	-	-	2	-	-	-	-	-	1	-
3	2	2	-	-	-	-	1	-	-	-	-	-	1	-
4	1	-	-	-	-	-	1	-	-	-	-	-	1	-
5	2	-	-	-	-	-	1	-	-	-	-	-	1	-

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, bio magnification). Energy resources: renewable (solar, wind, and hydro).

UNIT II 6 Hours

LINEAR AND ANGULAR MEASUREMENTS

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 ecosystePSO1: 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 pollutioPSO2: 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 depletioPSO2: E-waste.

UNIT V **5 Hours**

HUMAN POPULATION AND ENVIRONMENT
Force - Torque - Power - Measurement of power: mechanical, pneumatic, hydraulic and electrical - Flow measurement: venturimeter, orifice meter, rotameter, Pitot tube - Temperature measurement: Liquid in glass Thermometers, Pressure Thermometers, Pyrometer and electrical resistance thermometer

FOR FURTHER READING
Human rights:Biomedical waste -Identification of adulterants in food materials

Total:30 Hours

Reference(s)
1. Anubha Kaushik, C.P. Kaushik, Environmental Science and Engineering, 4th Multi Colour Editions, New Age International Publishers, New Delhi, 2014
2. Raven, P.H., Hassenzahl, D.PSO1: & Berg, L.R. 2012. Environment. 8th editioPSO2: 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. 5. A. K. De, Environmental Chemistry, 7th Edition, New age international publishers, New Delhi, 2014

18GE401 SOFT SKILLS-REASONING 2 0 0 0

Course Objectives

- To acquire command of both the receptive skills (Listening, Reading) and the productive skills (Writing and Speaking) of English language
- To understand and make effective use of English language in business contexts

Programme Outcomes (POs)

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Listen, Read, Speak, and Write Business English at the level of independent users
2. Appear for the Business English Certificate (BEC) Vantage level examination conducted by the Cambridge Assessment English

Articulation Matrix

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

UNIT I 15 Hours

LISTENING AND READING

Listening for writing short answers - filling gaps in sentences - identifying topic, context and function identify different functions of language in business situations - identify prompts -identify paraphrases of required information Scanning - reading for gist - understanding sentence structure - error identification identify paraphrases - cohesive words and phrases - understand the importance of analysing the distractors - identify grammatical and semantic relationships

UNIT II 15 Hours

WRITING AND SPEAKING

Business emails - notes - memos to colleagues or friends - giving instructions - explaining a development - asking for comments - requesting information - agreeing to requests - explaining apologising - reassuring - complaining - describing - summarising - recommending - persuading turn - taking - sustaining interaction - initiating - responding - giving personal information - talking about present circumstances, past experiences and future plans - expressing opinion - speculating organising a larger unit of discourse - giving information - expressing and justifying opinions speculating - comparing and contrasting - agreeing and disagreeing

I 15 Hours

LISTENING AND READING

Listening for writing short answers - filling gaps in sentences - identifying topic, context and function identify different functions of language in business situations - identify prompts -identify paraphrases of required information Scanning - reading for gist - understanding sentence structure - error identification identify paraphrases - cohesive words and phrases - understand the importance of analysing the distractors - identify grammatical and semantic relationships

II 15 Hours

WRITING AND SPEAKING

Business emails - notes - memos to colleagues or friends - giving instructions - explaining a development - asking for comments - requesting information - agreeing to requests - explaining apologising - reassuring - complaining - describing - summarising - recommending - persuading turn - taking - sustaining interaction - initiating - responding - giving personal information - talking about present circumstances, past experiences and future plans - expressing opinion - speculating organising a larger unit of discourse - giving information - expressing and justifying opinions speculating - comparing and contrasting - agreeing and disagreeing

Total:60 Hours

Reference(s)

1. 1. Whitehead, Russell and Michael Black. Pass Cambridge BEC Vantage Self - study Practice Tests with Key, Heinle - a part of Cengage Learning, Delhi, 2003.

21MC501 CONTROL SYSTEMS 3 1 0 4

Course Objectives

- To describe feedback control and basic components of control systems
- To understand the various time domain and frequency domain tools for analysis and design of linear control systems
- To study the methods to analyze the stability of systems from transfer function forms
- To describe the methods of designing compensators

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5.Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Apply a mathematical model of a physical system and compute the transfer function using Block diagram reduction technique and Signal flow graph.
2. Analyze the performance of first and second order system and compute the steady state error for different test signals
3. Analyze the frequency domain response and determine the phase margin and gain margin using bode plot, polar plot and Nyquist plot.
4. Analyse the cascade compensation and design a lag, lead and lag-lead series compensator using bode plot
5. Analyse the system controllability and observability using state space approach

Articulation Matrix

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

9 Hours

UNIT I

SYSTEMS REPRESENTATION

Basic elements in control systems - open loop and closed loop with applications - Transfer functions of mechanical, electrical and analogous systems - Block diagram reduction - signal flow graphs

UNIT II **10 Hours**

TIME RESPONSE ANALYSIS

Time response - Time domain specifications -Types of test inputs I and II order system response - Steady state error, error constants - Stability concept and definition - Characteristic equation - Location of poles - Routh Hurwitz criterion - Root locus techniques: construction

UNIT III **9 Hours**

FREQUENCY RESPONSE ANALYSIS

Bode plots - Polar plot - Nyquist stability criterion - Correlation between frequency domain and time domain specifications - stability analysis using frequency response methods.

UNIT IV **9 Hours**

COMPENSATOR AND CONTROLLER DESIGN

Realization of basic compensators - cascade compensation in time domain and frequency domain - feedback compensation - Design of lag, lead, lag-lead series compensator (using Bode plot)- Introduction to P, PI, PID controllers.

UNIT V **8 Hours**

STATE SPACE ANALYSIS

State equation - Solutions, Realization, Controllability, Observability - State space to transfer function conversion.

FOR FURTHER READING

Tachometer - Synchro - Need for time & frequency domain analysis and its applications - Impacts of stability and its important methods - Application of compensation

Total: 60 Hours

Reference(s)

1. Norman S. Nise, Control System Engineering, Wiley India Edition New Delhi, 2018
2. J. Nagrath and PSO1: Gopal, Control System Engineering, New Age International Publisher, New Delhi, 2008
3. Rao V Dukkipatti, Control Systems, Narosa Publications,New Delhi, 2005
4. PSO1: Gopal, Digital Control and State Variable Methods, Tata McGraw Hill,New Delhi, 2003 5. K. Ogata, Modern Control Engineering, Pearson Edition 5th Edition, London, 2010
6. https://nptel.ac.in/courses/108106098/

21MC502 **ROBOTICS** **3 0 0 3**

Course Objectives

- To acquire knowledge on the fundamentals of robotic systems

Programme Outcomes (POs)

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Use the fundamental laws and principles of robotics to describe and characterise robotic systems.
2. Select appropriate end-effector and robot control system for a specific application
3. Solve robotic arm kinematics and robot motion using transformation techniques.
4. Analyze robotic work cells and their design with appropriate controls, safety systems, and monitoring devices.
5. Compare the specifications and operational requirements of field and service robots.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TOROBOTICS

Robot anatomy-Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robots-Simple problems- Specifications of Robot-Speed of Robot-Robot joints and links-Robot classifications-Architecture of robotic systems-Robot Drive systems- Hydraulic, Pneumatic and Electric system

UNIT II **10 Hours**

END EFFECTORS AND ROBOT CONTROLS

Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, cam type-Magnetic grippers-Vacuum grippers-Air operated grippers-Gripper force analysis-Gripper design-Simple problems-Robot controls-Point to point control, Continuous path control, Intelligent robot-Control system for robot joint-Control actions-Feedback devices-Encoder, Resolver, LVDT-Motion Interpolations-Adaptive control

UNIT III **8 Hours**

ROBOT KINEMATICS

Robot kinematics-Types- 2D, 3D Transformation-Scaling, Rotation, Translation- Homogeneous coordinates, multiple transformation-Simple problems. Denavit- Hartenberg convention, Forward and inverse kinematics solution for SCARA configured robot

UNIT IV **9 Hours**

ROBOT CELL DESIGN AND APPLICATIONS

Robot work cell design and control-Sequence control, Operator interface, Safety monitoring devices in Robot-Mobile robot working principle, actuation using software. Introductions-Robot applications - Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting and underwater robot

UNIT V **9 Hours**

SERVICE AND FIELD ROBOTICS

History of service robotics - Present status and future trends - Need for service robots – applications examples and Specifications of service and field Robots.Non conventional industrial robots

FOR FURTHER READING

Medical robot, Nuclear material handling robot, Robots for thermal and chemical plants, Autonomous Vehicles, Application of collaborative robots

Total: 45 Hours

Reference(s)

1. S.R. Deb, Robotics Technology and flexible automation, 2nd Edition, Tata McGraw-Hill Education, 2017
2. Mikell P Groover & Nicholas G Odrey, Mitchell Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, Technology programming and Applications, 2nd Edition, Tata McGrawHill Education, 2017.
3. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, Robotics Engineering an Integrated Approach, PHI Learning, 2009.
4. Francis PSO2: Nagy, Andras Siegler, Engineering foundation of Robotics, Prentice Hall Inc., 1986
5. Carl D. Crane and Joseph Duffy, Kinematic Analysis of Robot manipulators, Cambridge University press, 2008 6. NPTEL - https://nptel.ac.in/courses/112105249/

21MC503 MICROPROCESSORS AND MICROCONTROLLER 3 0 0 3

Course Objectives

- To give an emphasis on the hardware features of Microprocessor and Microcontroller with their functions
- To provide essential knowledge on various operating modes of I/O ports Timers/Counters, control registers and various types of interrupts
- To design and verify the various interfacing techniques for various applications

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: 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.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Outline the architecture, pin configuration, and instruction set of the 8085 microprocessor to demonstrate its operational functionality.
2. Use programmable devices such as 8255, 8253, USART, and DMA controllers to demonstrate effective interfacing techniques for microprocessor systems.
3. Develop the programs using the 8051 instruction set and integrate its hardware features to solve embedded system challenges.
4. Assess the low-power functionalities of the MSP430 microcontroller and use its features for digital and analog signal processing.
5. Demonstrate real-time control systems by constructing solutions such as motor control, display interfacing, and process automation using microcontrollers.

Articulation Matrix

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

UNIT I 9 Hours

INTEL 8085 MICROPROCESSOR

Introduction - Organization of 8085: Architecture, Internal Register Organization and Pin Configuration - Instruction Set of 8085 - addressing modes - instruction and machine cycles with states and timing diagram

UNIT II **9 Hours**

8085 INTERFACING DEVICES

Programmable peripheral Interface (8255) - Programmable interval timer (8253) - Programmable communication interface (USART) - Programmable interrupt controller - Programmable DMA Controller (8257).

UNIT III **9 Hours**

8051 ARCHITECTURE

Microcontroller Hardware - I/O Pins, Ports - External memory - Counters and Timers - Serial data I/O - Interrupts - 8051 Assembly Language Programming: Instruction set of 8051, Addressing modes, Data transfer instructions, Arithmetic and Logical Instructions, Jump and Call Instructions

UNIT IV **9 Hours**

MSP430 MICROCONTROLLER

Introduction to MSP Microcontroller, MSP430 Architecture - Functions, Interrupts and Low- Digital Inputs and Outputs - analog inputs and outputs - Timer - Communications.

UNIT V **9 Hours**

APPLICATIONS OF MICROCONTROLLER

Interfacing of Keyboards(4x4 & 8) - Interfacing of Display Devices(LED, LCD, 7 Segment LED) - DC Motor control - Stepper motor control - Servo Motor control - Traffic light control - Closed loop process control.

FOR FURTHER READING

Designing real time clock, detecting power failure, detecting presence of objects using 8253. Microcontroller System Design - Testing the Design, Look up Tables.

Total: 45 Hours

Reference(s)

1. Ramesh Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085 6/e, Penram International Publishing (India) Pvt. Ltd., 2013
2. Douglas V Hall., Microprocessor and Interfacing: Programming and Hardware, McGraw Hill Inc., New Delhi, Second Edition 2002.
3. Davies, John H. MSP430 microcontroller basics. Elsevier, 2008.
4. Muhammad Ali Mazidi and Janice Gillipie mazidi, The 8051 Microcontroller and Embedded System, Pearson Education Asia, 2011.
5. Kenneth J Ayala, The 8051 Microcontroller Architecture Programming and Application, Thomson Delmar New Delhi, 2014
6. Krishna Kant, Microprocessor and Microcontroller Architecture, Programming and System Design using 8085, 8086, 8051 and 8096, PHI, 2007

21MC504 THERMODYNAMICS AND HEAT TRANSFER 3 1 0 4

Course Objectives

- To enlighten the knowledge of students about the fundamentals of thermodynamics and heat transfer

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO11. Project Management and Finance: 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.

PO12. Life-long Learning: 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.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Use fundamental thermodynamic properties and laws for engineering problems
2. Analyze various thermodynamic process and solve steady flow energy equation for engineering system
3. Apply the concept of entropy and evaluate efficiency for major thermodynamic gas power cycles
4. Differentiate the three modes of heat transfer and evaluate the overall heat transfer coefficient of a system
5. Evaluate the convection and radiation heat transfer coefficient for an engineering system

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO THERMODYNAMICS

Thermodynamic systems. Temperature and the zeroth law of thermodynamics. Thermodynamic scales. Ideal gas. Simple, compressible pure substances: gases and steaPSO1: Numerical problems

UNIT II **9 Hours**

FIRST LAW OF THERMODYNAMICS

Expansion work. Friction work. Internal energy. Heat. Enthalpy. Specific heats of gasses. Adiabatic, isothermal, isochoric and isobaric processes. Polytropic processes. First law of thermodynamics. Open and closed systems, steady flow energy equation- Numerical problems

UNIT III **9 Hours**

SECOND LAW OF THERMODYNAMICS

Entropy and irreversibilities. Second law of thermodynamics. Thermal engine. Carnot's efficiency. Isentropic processes and isentropic efficiencies for thermal engines. Gas turbine: Brayton cycle. Steam turbine: Rankine cycle. Steam compression refrigeration systems. Numerical problems.

UNIT IV **9 Hours**

CONDUCTION

General differential equation for conduction heat transfer. Conduction in a flat wall. Conduction in a cylindrical wall. Thermal resistance. Overall heat transfer coefficient. Numerical problems

UNIT V **9 Hours**

CONVECTION AND RADIATION

Free and forced convection mechanisPSO1: Interior and exterior convectioPSO2: Convection over flat surfaces. Convection over cylinders. Electromagnetic spectrum and radiation physics. Kirchoff's law. Black-body radiatioPSO2: Numerical problems

FOR FURTHER READING

Reversibility- S.I and C.I engines- Conduction through Plane Wall, Cylinders and Spherical system, Grey body radiation -Shape Factor Algebra - Electrical Analogy- Convective Mass Transfer Correlations

Total: 45 Hours

Reference(s)

1. P. K. Nag, Engineering Thermodynamics, Edition 5, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2013
2. Yunus A. Cengel and Michael A. Boles, Thermodynamics - An Engineering Approach in SI Units, Tata McGraw Hill Publishing Company, New Delhi, 2017
3. C. P. Kothandaraman and S. Subramanya, Fundamentals of Heat and Mass Transfer, New Age International Publishers, New Delhi, 2012
4. T. D. Eastop and McConkey, Applied Thermodynamics for Engineering Technologists, Pearson, New Delhi, 2004
5. C. P. Kothandaraman, S. Domkundwar and A. V. Domkundwar, A course in Thermal Engineering, Dhanpatrai and Co. Pvt. Ltd., New Delhi, 2016
6. NPTEL - https://nptel.ac.in/courses/112105123/1

21MC507 ROBOTICS LABORATORY 0 0 4 2

Course Objectives

- To model forward and inverse kinematics for major robotic configuration
- To simulate pick and place operation using an industrial robot

Programme Outcomes (POs)

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

PO3: Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Use the principles of Denavit-Hartenberg parameters to visualize and simulate robot kinematics for different configurations.
2. Compute and analyze the forward and inverse kinematics of different robotic configurations.
3. Demonstrate pick and place operation using teach pendant programming in a six axis industrial robot

Articulation Matrix

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

EXPERIMENT 1 6 Hours

Visualization of Denavit- Hartenberg parameters

EXPERIMENT 2 **6 Hours**

Simulation of forward kinematics of 3R robot

EXPERIMENT 3 **6 Hours**

Simulation of forward kinematics of 3P robot

EXPERIMENT 4 **6 Hours**

Simulation of Forward kinematics of PRP configured robot

EXPERIMENT 5 **6 Hours**

Simulation of Forward and inverse kinematics of SCARA robot

EXPERIMENT 6 **6 Hours**

Generate a program in CpROG environment for pick and place operation

EXPERIMENT 7 **6 Hours**

Generate a program for forward kinematics numerical solution for 3 degrees of freedom robot manipulator

EXPERIMENT 8 **6 Hours**

Generate a program for forward kinematics numerical solution for 5 degrees of freedom robot manipulator

EXPERIMENT 9 **6 Hours**

Develop a continuous motion program using 6 axis industrial robot for spray painting

EXPERIMENT 10 **6 Hours**

Develop a point to point motion program using 6 axis industrial robot for pick and place operation **6 Hours**

60 Hours

Reference(s)

1. Mikell P. Groover, Mitchell Weiss, Roger PSO2: Nagel and Nicholas G. Odrey, Industrial Robotics Technology, Programming and Applications, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017
2. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, Robotics Control, Sensing, Vision, and Intelligence, Tata McGraw-Hill Publishing Company Limited, India, 2017

21MC508 MICROPROCESSORS AND MICROCONTROLLER LABORATORY 0 0 2 1

Course Objectives

- To focus the implementation of arithmetic operations using microprocessors and microcontroller
- To simulate embedded C programs
- To implement various on-chip and off-chip interfacing and algorithms

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Compute the arithmetic and logical operations using microcontrollers and microprocessors.
2. Integrate peripherals and motors with microprocessors and microcontrollers to perform real-time control and interfacing tasks.
3. Construct embedded systems for analog-to-digital and digital-to-analog conversions and motor control applications.

Articulation Matrix

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

EXPERIMENT 1 3 Hours

Perform the basic arithmetic operations using Embedded C in Microprocessor 8085 and 8086

EXPERIMENT 2 **3 Hours**

Perform the search operation for finding the number (largest, smallest) in the array using Embedded C in Microprocessor 8085 and 8086.

EXPERIMENT 3 **3 Hours**

Execute code conversions like HEX to ASCII and Vice versa using Embedded C in Microprocessor 8085 and 8086

EXPERIMENT 4 **3 Hours**

Perform the basic arithmetic operations using Embedded C in Microcontroller 8051.

EXPERIMENT 5 **3 Hours**

Implement the search operation for finding the number (largest, smallest) in the array using Embedded C in Microcontroller 8051.

EXPERIMENT 6 **3 Hours**

Execute code conversions like HEX to ASCII and Vice versa using Embedded C in Microcontroller 8051.

EXPERIMENT 7 **3 Hours**

Perform the different mode of operation using Embedded C by interfacing the Programmable Peripheral Interface with the Microprocessor 8085 and Microcontroller 8051

EXPERIMENT 8 **3 Hours**

Perform the controlling operation to the stepper motor using Embedded C by interfacing the stepper motor with the Microprocessor 8085 and Microcontroller 8051.

EXPERIMENT 9 **3 Hours**

Perform the controlling operation of DC motor using Embedded C by interfacing the DC motor controller with the Microprocessor 8085 and Microcontroller 8051.

EXPERIMENT 10 **3 Hours**

Conversion of Analog to digital and vice versa using embedded C with Microprocessor 8085 and Microcontroller 8051. **3 Hours**

30 Hours

Reference(s)

1. Ramesh Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085 6/e, Penram International Publishing (India) Pvt. Ltd., 2013.
2. Douglas V Hall., Microprocessor and Interfacing: Programming and Hardware, McGraw Hill Inc., New Delhi, Second Edition 2002.
3. Muhammad Ali Mazidi and Janice Gillipie mazidi, The 8051 Microcontroller and Embedded System, Pearson Education Asia, 2011
4. Kenneth J Ayala, The 8051 Microcontroller Architecture Programming and Application, Thomson Delmar New Delhi, 2014
5. Krishna Kant, Microprocessor and Microcontroller Architecture, Programming and System Design using 8085, 8086, 8051 and 8096, PHI, 2007.

18GE501 SOFT SKILLS - APTITUDE I 0 0 2 0

Course Objectives

- Expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical Values.
- It will provide a lot of activities and examples for a student to learn and develop these life skills

Programme Outcomes (POs)

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

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

Course Outcomes (COs)

1. Explain various concepts of number systems and their techniques in solving the percentage, average and age problems.
2. Analyse the profit and loss of real time situations and the relation between ratio, proportion and variation
3. Apply different techniques to find the distance, speed and time of various moving objects.
4. Understand the concepts of coding, sequences and series, data interpretation and critical reasoning to solve real time logical reasoning problems.

Articulation Matrix

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

EXPERIMENT 1 2 Hours

NUMBER SYSTEMS

Introduction - Definition - Classification on Numbers- Power cycles and remainders - Short cut process- Concept of Highest Common Factor-Concept of Least Common Multiple- Divisibility Number of zeros in an expression.

EXPERIMENT 2 2 Hours

PERCENTAGE

Introduction - Definition and Utility of Percentage - Importance of base/denominator for percentage calculations-Concept of percentage values through additions-Fraction to percentage conversion table.

EXPERIMENT 3 3 Hours

AVERAGES AND AGES

Introduction-Average of different groups-Addition or removal of items and change in average - Replacement of some of the items.

EXPERIMENT 4 3 Hours

RATIO, PROPORTIONS AND VARIATION

Introduction- Ratio- Properties-Dividing a given number in the given ratio-Comparison of ratios - Proportions-Useful results on proportion- Continued proportion-Relation among the quantities more than two-Variation.

EXPERIMENT 5 **2 Hours**

PROFIT AND LOSS

Gain/Loss and percentage gain or percentage loss-Multiplying equivalents to find sale price-Relation among cost price, sale price, gain/loss and percentage gain or percentage loss-An article sold at two different selling price-Two different articles sold at same selling price-Percentage gain or percentage loss on selling price-Percentage gain or percentage loss on whole property.

EXPERIMENT 6 **2 Hours**

TIME AND WORK

Introduction-Basic concepts-Concepts on working with different efficiencies-Pipes and Cisterns Work Equivalence (Man Days) -Alternative approach.

EXPERIMENT 7 **2 Hours**

TIME, SPEED AND DISTANCE

Definition-Basics of Time, Speed and Distance - Relative speed-Problems based on Trains-Problems based on Boats and Streams-Problems based on Races-Time taken with two difference modes of transport-Time and distance between two moving bodies.

EXPERIMENT 8 **3 Hours**

CODING AND DECODING

Introduction-Description of Coding method-Coding patterns - Concepts of Coding and Decoding Problems involving Coding and Decoding methods.

EXPERIMENT 9 **2 Hours**

SEQUENCE AND SERIES

Introduction-Sequences of real numbers - Number and Alphabet series-Description of Number and Alphabet series-Analogy-Odd man out-Power series.

EXPERIMENT 10 **3 Hours**

DATA SUFFICIENCY

Introduction to Data Sufficiency - Overview of the wide variety of Data Sufficiency problems - Basic introduction on how to determine what information is sufficient to solve a given problem - Common pitfalls to avoid.

EXPERIMENT 11 **3 Hours**

DIRECTION

Introduction to Direction - sense test - Overview of the wide variety of Direction problems-Direction Plotting diagrams.

EXPERIMENT 12 **3 Hours**

CRITICAL REASONING

Introduction-Basic concept of critical reasoning- Weaken the argument-Strengthen the argument-Flaw in the argument-Evaluate the conclusion.

30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Mc Graw Hill Publications.
2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Third Edition, Pearson Education Pvt Ltd, India, 2016.
4. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S Chand Publications.
5. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
6. Jaikishan and Premkishan, How to Crack Test of Reasoning in all Competitive Examinations, Revised Edition, Arihant Publications.

21HS002 HUMAN VALUES AND ETHICS 2 0 0 2

Course Objectives

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

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO11. Project Management and Finance: 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.

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Apply the importance of human values and ethics in life.
2. Apply 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 thePSO1:
4. Analyze the intellectually mature, morally upright, ethically correct, and spiritually inspired decisions.
5. Evaluate the 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
1	2	3	2	2	-	-	-	-	-	-	2	-	-	1
2	1	2	2	2	-	-	-	-	-	-	2	-	-	2
3	1	2	2	2	-	-	-	-	-	-	3	-	-	1
4	2	3	2	2	-	-	-	-	-	-	2	-	-	1
5	2	3	2	2	-	-	-	-	-	-	2	-	-	2

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 the 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. (2011). The Little Book of Ethics: A Human Values Approach. Australia: G.P. Martin.
2. Gupta, PSO2: L. (2002). Human Values for The 21St Century. India: Anmol Publications Pvt. Limited.
3. Mishra, A. (2017). Happiness Is All We Want. India: Bloomsbury Publishing.
4. Universal Human Values. (2023). (n.p.): Booksclinic Publishing.
5. A Textbook On Professional Ethics and Human Values. (2007). India: New Age International (P) Limited

21MC603 **MACHINE DESIGN** **3 1 0 4**

Course Objectives

- To learn the different standards used in machine design
- To design the various machine elements subjected to simple and variable loads

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO11. Project Management and Finance: 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.

PO12. Life-long Learning: 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.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Interpret the evolution and working principle of CNC machine tools with its relevantapplications
2. Construct the basic structure, construction, working and control of CNC machines Over conventional units.

3. Analyse the forces acting on bolts in eccentric loading, welded joints and design the elements 4. Design a flywheel for an IC engine and calculate stresses in springs for different end conditions
5. Compute static, dynamic load carrying capacity for a bearings and select the suitable Bearings.

Articulation Matrix

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

UNIT I 9 Hours

STEADY STRESSES AND VARIABLE STRESSES IN MACHINE ELEMENTS

Machine Design: Design process - procedure & requirements of machine elements - Standards in design - Factor of safety. Design against static load: Application of Principal stresses and theories of failure in designing machine elements. Design against Fluctuating Load: Endurance limit - S-N Curve - Design for finite and Infinite life (Reversed load only) - Stress concentration: Factors - Reduction of stress concentration

UNIT II 9 Hours

DESIGN OFSHAFT, KEYS AND COUPLINGS

Design of shaft: Shaft materials - Selection of preferred sizes - Solid shaft design based on strength, torsional rigidity and A.S.M.E code. Key: types - stresses developed - Design of Square and Flat key. Couplings: Types - applications - Design of Muff coupling, clamp coupling, rigid flange coupling and bushed-pin flexible coupling

UNIT III 9 Hours

DESIGN OFTHREADED JOINTS AND WELDED JOINTS

Threaded Joints: Types - bolt of uniform strength - terminology of screw threads - ISO Metric screw thread - materials - Design of eccentrically loaded bolted joints in shear and eccentric load perpendicular to axis of bolt. Welded Joints: welding symbols - standards - types - stress relieving of welded joints - Conditions for maximum shear in parallel and transverse fillet weld. Design of butt, parallel and transverse fillet welds against static load.

UNIT IV 9 Hours

DESIGN OFSPRINGS AND FLYWHEEL

Springs: types - terminology of helical spring - styles of end - spring materials- Wahl's stress factor - Design of helical springs for static and variable loads - Design of helical torsion springs - nipping in leaf springs - design of semi-elliptic leaf spring. Flywheel: Functions - materials - types - stresses in rimmed flywheel - design of rimmed flywheel based on constructing turning moment diagram

UNIT V **9 Hours**

DESIGN OF BEARINGS

Bearings - classifications - Rolling contact bearings: Types - static and dynamic load carrying capacity - Stribeck's equation - equivalent bearing load - Selection of deep drove ball bearing from manufacturer's catalogue. Sliding contact bearings: lubricants - types - modes of lubrication - types - petroff's equation - Mckee's analysis - Design of hydrostatic thrust and full hydrodynamic bearings based on different parameters

FOR FURTHER READING

Manufacturing considerations in design - Design of cotter joint - design of levers - Fatigue failure - Notch sensitivity - Soderberg and Goodman lines - Design for infinite life (Fluctuating load) - Impact stresses - CastiglianoÃƒÂ¢??s theorem - Design of belleville spring

60 Hours

Reference(s)

1. V. B. Bhandari, Design of Machine Elements, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2017
2. J. E. Shigley and C. R. Mischke, Mechanical Engineering Design, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2017
3. R. C. Juvinall and K. PSO1: Marshek, Fundamentals of Machine Component Design, John Wiley and Sons, New Delhi, 2018.
4. R. L. Norton, Design of Machinery, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2007
5. Faculty of Mechanical Engineering, PSG College of Technology, Design Data, M/s.Kalaikathir Achchagam, Coimbatore, 2014
6. https://nptel.ac.in/courses/112105125

21MC604 EMBEDDED SYSTEM SESIGN 3 0 2 4

Course Objectives

- To impart knowledge on the Building Blocks of Embedded System, Various Embedded Development Strategies, Bus Communication in processors, Input/output interfacing and processor scheduling algorithms
- To understand Real time operating system

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Assess the structural units, processor selection, and memory management techniques for designing embedded systems.
2. Demonstrate communication protocols such as RS232, CAN Bus, SPI, and I2C for effective embedded system networking.
3. Construct embedded product development models like data flow graphs, state machines, and sequential program models to solve design challenges.
4. Integrate RTOS concepts such as multitasking, task scheduling, and communication methods to optimize embedded system performance.

5. Design embedded solutions for real-world applications, including line-following robots and temperature control systems.

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION TOEMBEDDED SYSTEMS

Embedded Systems - Overview - Structural units, selection of processor - memory devices - Memory management methods - Timer and Counting devices, Watchdog Timer, Real Time Clock

UNIT II **10 Hours**

EMBEDDED NETWORKING

Introduction - I/O Ports - Communication protocols : RS232, RS422, RS 485, CAN Bus - Serial Peripheral Interface (SPI) - Inter Integrated Circuits (I2C)

UNIT III **9 Hours**

EMBEDDED FIRMWARE DEVELOPMENT

Embedded Product Development Life Cycle- Objectives, Different Phases Of EDLC, Modelling of EDLC; Data Flow Graph, State Machine Model, Sequential Program Model, V Model

UNIT IV **9 Hours**

EMBEDDED SYSTEM DESIGN

Introduction to basic concepts of RTOS-Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication shared memory, message passing

UNIT V **9 Hours**

EMBEDDED SYSTEM APPLICATION

Line Follower robot, Linear conveyor control system, Temperature monitoring and control system

FOR FURTHER READING

Real Time Application, Device control using Mobile, Security Alert system, Automatic Car Control system, Mobile operating Land Rover

EXPERIMENT 1 **2 Hours**

Study of ARM evaluation system

EXPERIMENT 2 **3 Hours**

Interfacing ADC and DAC

EXPERIMENT 3 **3 Hours**

Interfacing LED and PWM

EXPERIMENT 4 **4 Hours**

Interfacing real time clock and serial port

EXPERIMENT 5 **3 Hours**

Interfacing keyboard and LCD through communication protocols

EXPERIMENT 6 **2 Hours**

Interfacing EPROM and interrupt

EXPERIMENT 7 **3 Hours**

Interrupt performance characteristics of ARM and FPGA

EXPERIMENT 8 **3 Hours**

Flashing of LEDS

EXPERIMENT 9 **4 Hours**

Interfacing stepper motor and temperature sensor

EXPERIMENT 10 **3 Hours**

Implementing zigbee protocol with ARM.

60 Hours

Reference(s)

1. Peckol, Embedded system Design, John Wiley & Sons,2010
2. Lyla B Das, Embedded Systems-An Integrated Approach, Pearson, 2013
3. Shibu. K.V, Introduction to Embedded Systems, Tata McGraw Hill, 2017
4. Raj Kamal, Embedded System-Architecture, Programming, Design, Tata McGraw Hill, 2013
5. C.R.Sarma, Embedded Systems Engineering, University Press (India) Pvt. Ltd, 2013
6. Han-Way Huang, Embedded system Design Using C8051, Cengage Learning, 2009.

21MC607 COMPUTER AIDED MANUFACTURINGLABORATORY 0 0 4 2

Course Objectives

- To provide knowledge on modelling and creating toolpath of machine components using computer aided manufacturing softwares
- To impart part programming knowledge on CNC lathe.
- To expose part programming knowledge on CNC milling machine
- To study the working of wire cut EDM for cutting various shapes.
- To impart knowledge on developing the prototype by additive manufacturing process

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10. Communication: 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.

PO11. Project Management and Finance: 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.

PO12. Life-long Learning: 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.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Compute the tool path for circular and prismatic parts using machining programs
2. Construct the part program for the machining component using CNC lathe.
3. Implement the part program for the machining component using CNC milling
4. Demonstrate the the wire cut EDM for producing intricate shapes
5. Demonstrate the component using additive manufacturing process

Articulation Matrix

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

EXPERIMENT 1 **4 Hours**

To make a protected type flange coupling to transmit the power from dia 20mmshaft.

EXPERIMENT 2 **4 Hours**

To manufacture the Vee block component as per the dimensions shown below.

EXPERIMENT 3 **4 Hours**

To fabricate a frame support as shown in figure.

EXPERIMENT 4 **4 Hours**

To machine a logo of Bannari amman Institute of Technology

EXPERIMENT 5 **4 Hours**

To make a profile of shaft support as per the dimensions given in the figure

EXPERIMENT 6 **4 Hours**

To make an injection molding die for Ball point pen case using CNC milling

EXPERIMENT 7 **4 Hours**

Reverse engineering of pump components like impeller, Shaft, Casing, Centre line support using 3D scanner and printer

EXPERIMENT 8 **2 Hours**

Redesign and make an extruder assembly of a 3D printer to hold three filaments using design for additive manufacturing principles

30 Hours

Reference(s)

1. Koren Y, Computer Control of Manufacturing systems, McGraw Hill, 2006
2. S.K.Sinha,CNC Programming, McGraw Hill,2007

3. Wego Wang, Reverse Engineering Technology,CRC Press,2004

21MC608 OBJECT ORIENTED PROGRAMMING LABORATORY 0 0 4 2

Course Objectives

- To understand the concepts of Object Oriented Programming
- To study the concepts of objects and classes
- To familiarize the concepts of functions and constructors, use them to create real-time applications

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: 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.

e. PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Asses the characteristics and data types of C++ language
2. Interpret the Objects and Classes of C++ language
3. Develop efficient programs using operator overloading
4. Demonstrate the concepts of polymorphism to large scalesoftware
5. Apply the concepts of files streams to real-world problems

Articulation Matrix

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

EXPERIMENT 1 **5 Hours**

Introduction to OOPS concepts, datatypes

EXPERIMENT 2 **5 Hours**

Program to implement Matrix addition, subtractioPSO2: Multiplication and division

EXPERIMENT 3 **5 Hours**

Implement the concept of type conversion, the precedence of operators

EXPERIMENT 4 **5 Hours**

Simple C Programs to check whether the entered number is positive or negative using if-else statement and realize a calculator operation Switch statement

EXPERIMENT 5 **5 Hours**

Simple C Programs to print the first 50 odd/even numbers and pyramid pattern printing using

a) for loop

b) while loop

c) do-while loop

EXPERIMENT 6 **5 Hours**

Write a C program for constructor and destructor concept

EXPERIMENT 7 **5 Hours**

Program to implement the concepts of function overloading and operator overloading and method overriding.

EXPERIMENT 8 **5 Hours**

Write a C program to Multiple, Multilevel, Hybrid, Hierarchical Inheritance

EXPERIMENT 9 **5 Hours**

Implement the concept of class using static data member and static member functions.

EXPERIMENT 10 **5 Hours**

Write a C program to file handling (file reader, file writer) random access file using Write, Read, Rename, and Remove commands

EXPERIMENT 11 **5 Hours**

Write a C program to store the information (name, roll, and marks) of 50 students using class and display the number of students who got A grade (100-85), B grade (85-70), C grade (70-66), D grade (55-45) and failed in the periodical exam.

EXPERIMENT 12 **5 Hours**

Write a C program to design Log-In screen, check username and password and to display the corresponding message on successful login/failed login.

60 Hours

Reference(s)

1. D.S.Malik, C++ Programming, Thomson, USA, 2011.
2. Robert Lafore, Object Oriented Programming in-C++,4th Edition, Galgotia Publication, Pearson India, New Delhi, 2008
3. K.R. Venugopal, Raj Kumar and T.Ravishankar, Mastering C++, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2006
4. https://nptel.ac.in/courses/106105151/

18GE601 **SOFT SKILLS-APTITUDE II** **0 0 2 0**

Course Objectives

- Expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values. It will provide a lot of activities and examples for a student to learn and develop these life skills

Programme Outcomes (POs)

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

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Apply the concepts of probability, Sets, Permutation and Combinations in estimating data for real time problems.
2. Understand the concept of logarithms, progressions and Simple and Compound interest to solve various practical problems.
3. Analyse objects involving cubes and cuboids in determining the number of sides colored.
4. Interpret various data from graphs and tables to determine ratio, percentage and averages.
5. Apply the logical reasoning skills for identifying age, relations, visual relations and puzzles.

Articulation Matrix

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

EXPERIMENT 1 **2 Hours**

PERMUTATION AND COMBINATION

Definition-Fundamental rules-Theorems on Permutation-Theorems on Combination

EXPERIMENT 2 **2 Hours**

PROBABILITY

Concept and Importance of Probability-Underlying factors for real Life estimation of probability - Basic facts about probability-Some important consideration while defining event.

EXPERIMENT 3 **2 Hours**

SYLLOGISM AND VENN DIAGRAM

Concepts on Syllogisms-Venn diagram-Interpretation-Venn diagram-solving.

EXPERIMENT 4 **4 Hours**

SIMPLE INTEREST AND COMPOUND INTEREST

Introduction-Definition - Effect of change of P, R, T on simple interest-Amount-Amount becomes N times the principle-Repayment of debt in equal installments-Rate and time are numerically equal - Compound Interest-Conversion period-Basic formula-Special cases-To find the principle / Time /Rate-Difference between Compound Interest and Simple Interest-Equal annual installment to pay the borrowed amount.

EXPERIMENT 5 **2 Hours**

MIXTURES AND ALLIGATION

Definition-Alligation rule-Mean value (cost price) of the mixture-Some typical situations where allegation can be used.

EXPERIMENT 6 **4 Hours**

CUBE AND LOGARITHM

Introduction-Basic Concepts of Cube and Cuboid-Problems involving cubes and cuboids of various dimensions-Problems involving coloured cubes and cuboids - Basic concepts of Logarithm-Laws of Logarithms including change of base-Common logarithm (base 10) - Properties of Logarithms to solve equations involving logarithmic expressions.

EXPERIMENT 7 **2 Hours**

DATA INTERPRETATION

Introduction-Ratio-Percentage-Average-Tables - Graphs and Charts.

EXPERIMENT 8 **2 Hours**

PROGRESSION AND LOGICAL REASONING

Arithmetic progression-Geometric progression-Harmonic progression-Theorems related with progressions.

EXPERIMENT 9 **2 Hours**

PROBLEM ON AGES

Introduction-Basic concept-Usage of Percentage and Averages -Applications.

EXPERIMENT 10 **2 Hours**

ANALYTICAL REASONING

Introduction-Basic concept-Non verbal Analytical Reasoning -Arrangements.

EXPERIMENT 11 **2 Hours**

BLOOD RELATION

Introduction-Basic concept-Kinds of relation-Tree diagram-Relations.

EXPERIMENT 12 **2 Hours**

VISUAL REASONING

Introduction-Basic concepts-Odd man out-Next series-Mirror image and water image

EXPERIMENT 13 **2 Hours**

SIMPLIFICATIONS

Introduction-Basic concepts-Arithmetic operations-Equation solving methods-Puzzles.

30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Mc Graw Hill Publications.
2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Third Edition, Pearson Education Pvt Ltd, India, 2016. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S Chand Publications.
4. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
5. Jaikishan and Premkishan, How to Crack Test of Reasoning in all Competitive Examinations, Revised Edition, Arihant Publications.

21MC701 MICRO ELECTRO MECHANICAL SYSTEMS 3 0 0 3

Course Objectives

- To comprehend the physical effects on miniaturisation through scaling laws
- To gain knowledge on principles of micro fabrication and micro manufacturing
- To be able to design and analyse MEMS-based sensors and actuators

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools.

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Apply the scaling laws used in conceptual design of Microsystems
2. Experiment with the working principles of micro sensors and actuators
3. Compare photolithography and its allied processes to fabricate MEMS devices
4. Identify suitable micro manufacturing technique for the fabrication of a specific MEMS device
5. Analyze the principles of micro system packaging and design

Articulation Matrix

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

UNIT I **9 Hours**

MICROSYSTEMS AND MINIATURIZATION

Introduction to Microsystems and microelectronics - Applications of micro system in automotive bio medical aerospace - telecommunication industries. Trimmers scaling vector and scaling laws - scaling in geometry scaling in rigid body dynamics scaling in electrostatic forces scaling in electric.

9 Hours

UNIT II

MICROSENSORS AND ACTUATORS

Micro sensors Types of micro sensors Micro accelerometer, Pressure sensors and thermal sensors. Micro actuation techniques piezoelectric crystals Shape memory alloys bimetallics - conductive polymers. Micro motors micro grippers - Micro fluidic devices - Micro pumps micro valves valve less micro pumps

UNIT III **9 Hours**

MICROFABRICATION

Clean room technology, Micro Fabrication processes: Photolithography - X Ray and UV, Ion implantation, Diffusion Oxidation Chemical Vapor Deposition Physical Vapor Deposition D.C. Sputtering

UNIT IV **9 Hours**

MICROMACHINING

Processes for bulk micromachining Wet vs dry etching - Chemical etching of Silicon etchant systems and etching process Reactive ion etching (RIE) and Deep reactive ion etching (DRIE) - mask layout desigPSO2: Processes for Surface micromachining Limitations of Bulk and surface micromachining LIGA

UNIT V **9 Hours**

MICROSYSTEMS DESIGN AND PACKAGING

Design Considerations- design challenges, selection of materials, manufacturing, signal transduction, electromechanical system, packaging, Mechanical design thermo mechanical loading, thermo mechanical stress analysis, dynamic analysis and interfacial fracture analysis Micro system packaging: Materials die level, device level system level packaging techniques die preparation surface bonding wire bonding sealing

FOR FURTHER READING

Optical MEMS: Micro mirrors, optical switches, RF-MEMS: RF resonators for filters, frequency sources, Power MEMS: micro power sources, batteries and solar cells vs. MEMS based devices, energy harvesting, NEMS -sensors.

Total: 45 Hours

Reference(s)

1. Tai Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2017
2. Mohamed Gad-el-Hak, The MEMS Handbook, CRC Press Publishers, India, 2002
3. Chang Liu, Foundations of MEMS, Pearson Education, New Delhi, 2011
4. James J. Allen, Micro Electro Mechanical System Design, CRC Press Publishers, India, 2005.
5. Marc J Madou Fundamentals of micro fabrication, Third Edition, CRC Press Publishers, 2011
6. MEMS and Microsystems (NPTEL Course) https://nptel.ac.in/courses/117105082/

21MC702 INDUSTRIAL AUTOMATION 3 0 0 3

Course Objectives

- To understand the need of automation in various industrial sectors
- To learn about the various technology developments such as PLC, SCADA and DCS in industrial automation
- To understand the basics of communication with its protocol

Programme Outcomes (POs)

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

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Select appropriate automation techniques and levels of automation for idustrial applications.
2. Design PLC systems using architecture, programming, ladder logic, and advanced instructions to meet industrial needs.
3. Apply supervisory control and data acquisition (SCADA) systems for industrial applications to enable real-time monitoring, and efficient management of industrial processes.
4. Apply the concept of distributed control systems (DCS) in industrial automation for real-time monitoring, and efficient control of complex industrial processes.
5. Choose and implement suitable communication buses and protocols in industrial applications to achieve reliable data transmission, and efficient process management.

Articulation Matrix

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

UNIT I 9 Hours

BASICS OF AUTOMATION

Automation in Production System-Principles and Strategies of Automation-Basic Elements of an Automated System-Advanced Automation Functions-Levels of Automation-Flow lines, Transfer Mechanisms-Fundamentals and Analysis of Transfer Lines, Fundamentals of IoT

UNIT II **9 Hours**

PROGRAMMABLE LOGIC CONTROLLER

PLC Architecture - Processor Memory Organization: Program Files, Data Files- Programming Languages- Wiring Diagrams and Ladder Logic Programs- Instructions: Simple Instructions, Timer, Counter, Program Control, Data Manipulation, Math Instructions - Selection of PLC

UNIT III **9 Hours**

SUPERVISORYCONTROL AND DATA ACQUISITION

Elements of SCADA-Functionalities of SCADA-Architecture: Hardware, Software: Development, Runtime mode functions-Tools: Tag database-Recipe database- Alarm Logging-Trends: Real Time, Historical Trends-Security and User Access Management-Management Information System-Report Function.

UNIT IV **9 Hours**

DISTRIBUTED CONTROL SYSTEM

Evolution of DCS - Types of Architecture - Local Control Unit - Communication Facilities - Operator and Engineering Interfaces - Operator Displays - Process Interfacing issues.

UNIT V **9 Hours**

COMMUNICATION PROTOCOLS

Introduction - Communication Hierarchy, Communication System Requirements - Network Topologies - Communication Modes HART Networks and OSI models- Communication buses - Field bus, Modbus, Profibus - Device net - CAN network - System Operation and Troubleshooting.

FOR FURTHER READING

24 Hour Clock Design, Automatic Control of Warehouse Door, Automatic Lubrication of Supplier Conveyor Belt, Automatic Stacking Process

Total: 45 Hours

Reference(s)

1. M. P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Fourth Edition, Pearson Education, UK, 2016
2. Webb J.W, Programmable Controller Principles and applications, Fifth Edition, Morrill Publishing Co, USA, 2002
3. Petruzella, FD, Programmable Logic Controllers, Fifth Edition, McGraw-Hill, New York, 2016.
4. Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition, Fourth Edition, ISA Publication, Europe, 2009
5. Lucas M.P, Distributed control systems, Van Nostrand Reinhold Company, Newyork, 1986

21MC707 INDUSTRIAL AUTOMATION LABORATORY 0 0 2 1

Course Objectives

- To provide a clear view on Programmable Logic Controllers (PLC) and Supervisory Control and Data Acquisition (SCADA).
- To learn the various methods involved in automatic control and monitoring

Programme Outcomes (POs)

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

PO3: Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation

Course Outcomes (COs)

1. Implement PLC programs using RS Logix software to automate logic gate operations and control two-way and four-way traffic light systems.
2. Design and develop PLC-based automation systems for bottle filling and cylinder sequencing processes.
3. Select suitable I/O modules and develop PLC programs to control elevator operations, while designing SCADA systems to monitor plant parameters such as temperature, pressure, and humidity.
4. Design SCADA screens for automatic level monitoring and recipe database management, ensuring efficient process control and monitoring.
5. Create SCADA interfaces for alarm logging and security access management to enhance system reliability and process safety.

Articulation Matrix

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

EXPERIMENT 1 **3 Hours**

Implementation of logic gates using Logix software

EXPERIMENT 2 **3 Hours**

Two way and four way traffic light control system using PLC

EXPERIMENT 3 **3 Hours**

Bottle filling process using PLC

EXPERIMENT 4 **3 Hours**

Automate the cylinder sequencing process using PLC

EXPERIMENT 5 **3 Hours**

Select the suitable I/O module for control of elevator using PLC

EXPERIMENT 6 **3 Hours**

Design a SCADA screen to display the plant information such as temperature, pressure and humidity using historical trends

EXPERIMENT 7 **3 Hours**

Design a SCADA screen for automatic level monitoring system

EXPERIMENT 8 **3 Hours**

Design a SCADA screen for recipe database

EXPERIMENT 9 **3 Hours**

Design a SCADA screen for alarm logging

EXPERIMENT 10 **3 Hours**

Design a SCADA screen for security access management

30 Hours

Reference(s)

1. Petruzella Frank D., Programmable Logic Controllers, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2010
2. Webb, John W. Programmable Logic Controllers: Principles and Application, Fifth edition, Prentice Hall of India, New Delhi, 2004.

3. Bolton , Programmable Logic Controllers, Sixth Edition Newnes, ,2015

21MC708 MICRO ELECTRO MECHANICAL SYSTEM LABORATORY 0 0 2 1

Course Objectives

- To study the micro level model, simulate and analyse the same
- To perform the static and thermo mechanical analysis
- To virtually fabricate a micro device using etching and additive manufacturing process

Programme Outcomes (POs)

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO4. Conduct Investigations of Complex Problems: 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.
PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PSO1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Create a mask layout of MEMS devices
2. Analyze the electro mechanical performance of created MEMS devices
3. Generate an appropriate procedure, to fabricate the MEMS devices

Articulation Matrix

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

EXPERIMENT 1 **3 Hours**

Development of a mask to form circular hole in a flat structure using direct and indirect methods

EXPERIMENT 2 **3 Hours**

Virtual fabrication of comb drive used in micro accelerometer

EXPERIMENT 3 **3 Hours**

Transient analysis for a bimorph cantilever in a periodically changing magnetic field

EXPERIMENT 4 **3 Hours**

Virtual fabrication of die through an anisotropic etching process.

EXPERIMENT 5 **3 Hours**

Static analysis of piezoelectric beam

EXPERIMENT 6 **3 Hours**

Thermo Electro Mechanical Analysis of Piezoelectric pump.

EXPERIMENT 7 **3 Hours**

Sub harmonic analysis of a cantilever beam

EXPERIMENT 8 **3 Hours**

Design of micro accelerometer and perform g-displacement analysis.

EXPERIMENT 9 **3 Hours**

Design of micro bolometer and perform temperature-voltage analysis

EXPERIMENT 10 **3 Hours**

Design of pressure sensor and perform pressure analysis.

30 Hours

Reference(s)

1. Chang Liu, Foundations of MEMS, Pearson Education, New Delhi, 2011.
2. James J. Allen, Micro Electro Mechanical System Design, CRC Press Publishers, India, 2005
3. Intellisuite Tutorial http://www.intellisense.com/upload/201212170207485975.pdf

21MC709 PROJECT WORK I 0 0 6 3

Course Objectives

- Formulate a real world problem, identify the requirement and develop the design solutions.
- Identify technical ideas, strategies and methodologies
- Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project
- Test and validate through conformance of the developed prototype and analysis the cost effectiveness
- Prepare report and present oral demonstrations

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO11. Project Management and Finance: 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.

PO12. Life-long Learning: 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.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies
3. Utilize the new tools, algorithms, 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 oral demonstrations

Articulation Matrix

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

Total: 45 Hours

21MC801 PROJECT WORK II 0 0 18 9

Course Objectives

- Formulate a real world problem, identify the requirement and develop the design solutions.
- Identify technical ideas, strategies and methodologies
- Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project
- Test and validate through conformance of the developed prototype and analysis the cost effectiveness
- Prepare report and present oral demonstrations

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO11. Project Management and Finance: 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.

PO12. Life-long Learning: 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.

PSO 1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies
3. Utilize the new tools, algorithms, 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 oral demonstrations

Articulation Matrix

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

Total: 45 Hours

18HS201 COMMUNICATIVE ENGLISH II 1 0 2 2

Course Objectives

- Read and understand ideas of complex text on both concrete and abstract topics
- Listen and understand technical discussions in his/her field of specialisation
- Produce clear, detailed text on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options
- Interact with a degree of fluency and spontaneity that makes regular interaction without strain

Programme Outcomes (POs)

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

j. 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.

Course Outcomes (COs)

1. Use appropriate grammar and vocabulary that is expected at the BEC Vantage examlevel.
2. Understand the general meaning of non-routine letters, and of a report of predictable / unpredictable topic
3. Write simple reports of factual nature and factual non-routine letters
4. Ask for factual information and understand the answer; and take/pass on workplace messages
5. Express opinions and present arguments to a limited extent; and give simple, prepared presentations on familiar topics

Articulation Matrix

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

UNIT I **9Hours**

GRAMMAR3

Tenses - Future continuous, Future perfect, Future perfect continuous, Past perfect, Past perfect continuous - Adjectives and adverbs - Mixed conditionals - Modals - can't have, needn't have - Modals of deduction and speculation - Narrative tenses - Passives - Phrasal verbs, extended - Relative clauses - Reported speech - Will and going to, for prediction - Wish - Would expressing habits, in the past.

UNIT II **9 Hours**

READING

Scanning and reading for gist - Understanding text structure - Reading for gist and specific information - Vocabulary and structure - Understanding sentence structure and error identification

UNIT III **9 Hours**

WRITING

A message, memo or email, Giving instructions, explaining a development, asking for comments, requesting information, agreeing to requests - Business correspondence: explaining, apologising, reassuring, complaining, short report: describing, summarising - proposal: describing, summarising, recommending, persuading.

UNIT IV **9 Hours**

LISTENING

Listening for and noting specific information - Listening to identify topic, context, Function - Following the main points and retrieving specific information from the text.

UNIT V **9 Hours**

SPEAKING

Giving personal information: Talking about present circumstances, past experiences and future plans, expressing opinions, speculating - Organising a larger unit of discourse: Giving information and expressing and justifying opinions - Turn-taking: negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing/disagreeing, suggesting, speculating, comparing and contrasting, and decision-aking. 1.A Horse and Two Goats - R K Narayan 2.My Lord the Baby - Rabindranath Tagore 3.Twist in the Tale - Jeffery Archer.4.The Third and Final Continent - Jhumpa Lahiri

Total: 45 Hours

Reference(s)

1. Guy Brook-Hart, "BEC Vantage: Business Benchmark Upper-Intermediate- Student's Books" 1st Edition, Cambridge University Press, New Delhi, 2006.
2. Ian Wood, Paul Sanderson, Anne Williams with Marjorie Rosenberg, "Pass Cambridge BEC Vantage-Student's Book" 2nd Edition, Cengage Learning, New Delhi, 2014
3. Michael Handford, Martin Lisboa, Almut Koester, Angela Pitt, "Business Advantage - Student's Book Upper-Intermediate" Cambridge University Press, New Delhi, 2014.
4. Cambridge Examinations Publishing, "Cambridge BEC VANTAGE - Self-study Edition", Cambridge University Press, UK, 2005.

18HSH01 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 -daysituations
- To teach them how to converse in Hindi on simple day- to -daysituations

Programme Outcomes (POs)

PO10. Communication: 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. **Course Outcomes (COs)**

- Construct simple sentences and use vocabulary required for day- to -day conversation
- Distinguish and understand the basic sounds of Hindi language
- Appear for Hindi examinations conducted by Dakshina Bharat Hindi Prachar Sabha

Articulation Matrix

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

UNIT I **9 Hours** Hindi

Alphabet: Introduction - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu & Visarg -Table of Alphabet -Vocabulary.

UNIT II **9Hours**

Nouns: Genders (Masculine & Feminine Nouns)- Masculine & Feminine - Reading Exercises.

UNIT III **9 Hours**

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: Parts of body - Relatives - Spices - Eatables - Fruit & Vegetables - Clothes - Directions - Seasons - Professions.

UNIT V **9 Hours**

Speaking: Model Sentences and Rhymes - Speaking practice for various occasions

Total: 45 Hours

Reference(s)

1. Hindi Prachar Vahini-1 by Dakshin Bharat
Hindi Prachar Sabha Chennai

2. B.R. Kishore, Self Hindi Teacher for Non-Hindi Speaking People,Vee Kumar Publications(P)Ltd., New Delhi,2009

18HSG01 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-dayscenarios

Programme Outcomes (POs)

PO10. Communication: 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.

Course Outcomes (COs)

- listen and identify individual sounds of German
- use basic sounds and words while speaking
- read and understand short passages on familiar topics
- use basic sentence structures while writing
- understand and use basic grammar and appropriate vocabulary in completing languagetasks

Articulation Matrix

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

UNIT I **9 Hours**

Introduction to German language: Alphabet - Numbers - Greetings - Days and Seasons- Working with Dictionary.

UNIT II **9 Hours** Nouns - articles - Speaking about one self - Listening to CD supplied with the books, paying special attention to pronunciation

UNIT III **9 Hours**

Regular & Irregular verbs - Personal pronouns - family - Introduction to types of sentences

UNIT IV **9 Hours**

Question words-Types of Questions - Nominative case- Verb Conjugation - country - nationalities

UNIT V **9 Hours**

Verbs - to be & to have - conjugation - Hobbys - 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.

18HSJ01 JAPANESE **1 0 2 2**

Course Objectives

- To train students for N5 Level Examination
- To teach them use basic Japanese sentences in day-to-dayconversation
- To make students familiar with the Japanese cultural facets and social etiquettes

Programme Outcomes (POs)

Course Outcomes (COs)

1. Recognise 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										2				
2										3				
3										2				
4										2				
5										2				

UNIT I **9 Hours**

Introduction to Japanese - Japanese script- Pronunciation of Japanese(Hiragana)- (Katakana) Long vowels - Pronunciation of in,tsu,ga - Letters combined with ya,yu,yo - Daily Greetings and Expressions - Numerals. N1 wa N2 desu - N1 wa N2 ja arimasen - S ka N1 mo - N1 no N2 - san - Kore - Sore - Are - Kono N - Sono N - Ano N - Sou desu - Sou ja Arimasen - S1 ka - S2 ka - N1 no N2 - Sou desu ka - Koko - Soko - Asoko - Kochira - Sochira Achira - N1 wa N2 (place) desu - Doko - Dochira - N1 no N2 - Ko - So - A - Do (Demonstrative words) - O kuni Kanji10 - Technical Japanese Vocabulary (30 Numbers)

UNIT II **9 Hours**

Introduction to time - Ji - Fun - Pun - Introduction of verbs - V Masu - V Masen - V Mashita - V Masendeshita N (Time) Ni V - N1 Kara - N2 Made - N1 to N2 - S Ne - N (Place) e Ikimasu – Kimasu Kaerimasu - Doko (e) Mo Ikimasen - Ikimasendeshita - N (Vechile) de Ikimasu - Kimasu - Kaerimasu - N (Person / Animal) to V - Itsu - S Yo N o (transitive) - N o Shimasu - Nani o Shimasuka Nan and Nani N (place) de V - V Masenka - V Mashou - o - Kanji 10 - Technical JapaneseVocabulary (30 Numbers) .

UNIT III **9 Hours** N

(tool/means) de V - Word/Sentence wa Go de Nani desu ka - N (person) Ni Agemasu, etc - N (person) Ni Moraimasu etc - Mou V Mashita - Introduction to Adjectives - N wa Na adj (Na) desu - N wa II adj (II) desu - Na adj Na n - II adj (II) N - Totemo - Amari - N wa Dou desuka - N1 wa Donna N2 desuka - S1 Ga S2 - Dore N ga Arimasu - Wakarimasu - N Ga Sukidesu - Kiraidesu - Jozu desu - Heta desu - Donna N - Yoku - Daitai - Takusan - Sukoshi - Amari - Zenzen - S1 kara S2 - Doushite - Kanji 10 - Technical Japanese Vocabulary (30 Numbers)

UNIT IV **9Hours**

N ga Arimasu - Imasu - N1 (place) Ni N2 ga Arimasu - Imasu - N1 (thing/person/place) no N2 (position) - N1 ya N2 - Word (s) desuka - Chirisosu wa Arimasuka - Saying numbers - Quantifier (period) Ni kai V - Quantifier Dake - N dake - Past tense of Noun sentences and Na adjective sentences - Past tense of ii adjective sentences - N1 wa N2 yori adjective desu - N1 to N2 to dochira ga adjective desu ka - N1/N2 no houga adjective desu - Kanji 10 - Technical Japanese Vocabulary (30 Numbers)

UNIT V **9Hours**

N ga hoshi desu - V masu form tai desu - N (place) e V masu form - N Ni - ikimasu - kimasu - kaerimasu N ni V - N o V - dou ko ka - nani ka - go chuu mon - Verb conjugation - Verb groups - Verb te form - V te form kudasai - V te form imasu - V masu from mashouka - S1 ga S2 - N ga V - V te form mo ii desu - V te form wa ikemasen - V te form imasu Shrimasen - Kanji 10 - Technical Japanese Vocabulary (30 Numbers)

Total: 45 Hours

Text Book(s)

1. Japanese for Everyone: Elementary Main Textbook 1-2, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

Reference(s)

1. Japanese for Everyone: Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

18HSC01 CHINESE 1 0 2 2

Course Objectives

- To help students appear for HSK Level 1 Exam
- To help students acquire the basics of Chinese language
- To teach the students how to converse in Chinese in various situations

Programme Outcomes (POs)

PO10. Communication: 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.

Course Outcomes (COs)

1. listen and identify individual sounds of Chinese
2. use basic sounds and words while speaking
3. read and understand short passages on familiar topics
4. use basic sentence structures while writing
5. understand and use basic grammar and appropriate vocabulary in completing languagetasks

Articulation Matrix

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

UNIT I **9 Hours**

Hello

Initials and Finals of Chinese b,p,m,f,d,,n,l,g,k,h,j,q,x
Tones Four 3.Chinese Syllables4.Tone S

UNIT II **9 Hours**

Thank you - Initials and Finals of Chinese - The Neutral Tone - Rules of Tone Marking and Abbreviation

UNIT III **9 Hours**

What"s your name - In the school; -In the classroom; -In the school - The Interrogative Pronoun 2 The Sentence3 Interrogative Sentences with

UNIT IV **9 Hours**

She is my Chinese teacher - In the library
The Interrogative Pronouns
The Structural Particle
The interrogative Particle

UNIT V **9 Hours**

Her daughter is 20 years old this year -
1.The Interrogative Pronoun
1. Numbers below 100
3.Indicating a Change
The Interrogative Phrase

Total: 45 Hours

18HSF01 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-dayscenarios

Programme Outcomes (POs)

PO10. Communication: 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.

Course Outcomes (COs)

1. To 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 languagetasks

Articulation Matrix

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

UNIT I 9 Hours

ENTRER EN CONTACT

La langue francaise, alphabets, les numeros, 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 - Les alphabets, 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, d'ecrire son voisin, s'informer sur un logement Lexique L'habitat, les pieces, l'equipement, la description physique

UNIT III **9 Hours**

VIVRE AU QUOTIDIEN

Grammaire - Articles contractes, verbes vouloir, pouvoir, devoir, adjective interrogative, 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 - OUVRIR -*Ãƒ?Ã‚Â* LA CULTURE

Grammaire - Verbes - Finir, Sortir, les adjectifs demonstratifs, le passe compose, l imparfait | Communication - Propose quelqu un de faire quelque chose, raconteur une sortie au passe parler unfilm |Lexique - Les sorties, la famille, 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 refuse rune invitation, donner des instructions, commander au restaurant | Lexique Les services et les commerces, les aliments, les ustensiles, argent

Total: 45 Hours

Reference(s)

1. Saison A1, Methode de francais
2. Hachette FLE

21MC001 MODELLING OF INDUSTRIAL ROBOTS 3 0 0 3

Course Objectives

- To understand the concepts of robot work-cell and types of end-effectors
  - To construct the kinematic, dynamic and trajectory motion model of a robotic manipulator.

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Conduct Investigations of Complex Problems: 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.
PSO1: Analyze, design and develop electro mechanical system using contemporary tools
PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. SCompare the characteristics of serial and parallel manipulators and select appropriate robot, workcell and accessories for a desired application.
2. Apply forward and inverse kinematics and DH convention for estimating the position and orientation of serial manipulator.
3. Analyze velocity propagation and static force transformations in robotic manipulators using Jacobians, singularity analysis, and workspace considerations.
4. Develop dynamic models of robotic systems using Lagrangian and Newton-Euler approaches.
5. Design and analyze trajectory planning techniques like polynomial and trigonometric trajectories, to optimize robot motion profiles.

Articulation Matrix

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

UNIT I **8 Hours**

ROBOTS AND END EFFECTORS

Robotics: A brief history, laws of Robotics Differentiate serial and parallel manipulator - concept of workcell selection of robot specification - classification of Industrial robot manipulator based on configuration end effector mechanism and types.

UNIT II **9 Hours**

KINEMATICS OF ROBOT MANIPULATOR

Representing position and rotation - Dot and Cross product - coordinate frames - rotation in plane rotation in three dimension - Rotational transformation - Translational transformation - Euler angle, Roll Pitch, Yaw angles Axis/angle representation - rigid motion - Homogeneous transformation - Denavit Hartenberg convention - inverse and forward kinematics and problems

UNIT III **10 Hours**

VELOCITY ANALYSIS AND STATIC FORCE ANALYSIS

Representation of Linear and Angular Velocity of Manipulator Links Skew Symmetric matrix representation Velocity Forward Propagation Velocity Manipulator JacobiaPSO2: Static Force Analysis:
Force transformation of robotic manipulators Force Jacobian Singularity Analysis, Workspace Singularities.

UNIT IV **9 Hours**

ROBOT DYNAMICS AND TRAJECTORY PLANNING

Introduction, Lagrangian mechanics, Effects of moments of Inertia, Euler- Lagrangian Dynamic Modelling, Newton-Euler Dynamic Modelling- Dynamic equation for two axis planar articulated robot.

UNIT V **9 Hours**

TRAJECTORY PLANNING

Overview on Trajectory Planning, One and multi-dimensional trajectory, basic motion profiles, analytic expressions of elementary trajectories- polynomial trajectory- cubic and fifth order polynomial trajectory Trigonometric trajectory, Parameters influencing the optimal trajectory planning of robots.

Total: 45 Hours

Reference(s)

1. Mikell P Groover & Nicholas G Odrey, Mitchell Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, Technology programming and Applications, 2nd Edition, Tata McGraw- Hill Education, 2017
2. S.K. Saha, Introduction to Robotics, 2nd Edition, Tata McGraw-Hill Education, 2014
3. J.J. Craig, Introduction to Robotics: Mechanics and Control, 3rd Edition, Prentice Hall Inc. / Pearson Education, 2014
4. Mark W Spong, Seth Hutchinson, M.Vidyasagar Robot Modeling and Control, Second Edition, Wiley India Edition, New Delhi., Feb, 2020.
5. Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, 3rd Edition, Wiley Press, Dec. 2019

21MC002 ROBOT CONTROL USING ROS 3 0 0 3

Course Objectives

- To understand the concepts of ROS data types and ROS communication.
- To implement the robot model in simulation and visualization of motion and data in ROS.
- To develop the mobile robot navigation algorithm and trajectory control for the industrial robot arm.

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Conduct Investigations of Complex Problems: 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.
PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Implement basic ROS nodes, topics, and services in a robotic system to facilitate communication between different modules.
2. Demonstrate the simulation and visualization of sensor data (e.g., LIDAR or camera data) in the ROS platform.
3. Use image processing concepts and integrate OpenCV with ROS for robot perception.
4. Implement a motion control algorithm to implement localization and navigation in autonomous mobile robots
5. Develop controllers (position, velocity, force) for robot arms in ROS, ensuring accurate movement and task execution.

Articulation Matrix

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

5	2	1	2	1	3	-	-	-	-	-	-	-	1	3

UNIT I **9 Hours**

ROS FOUNDATIONS

ROS concepts ROS data types and variables ROS packages Nodes ROS tools ROS message ROS communication: ROS topic, Service and action ROS custom messages Parameter server.

UNIT II **8 Hours**

ROBOT VISUALIZATION IN ROS

2D Robot simulator Modeling Unified Robot Description format URDF Gazebo Joint controller Building and simulating mobile robot model Coordinate transforms Rviz Displaying sensor value in RVIZ.

UNIT III **8 Hours**

ROBOT PERCEPTION

Transformation of camera coordinates Camera Calibration Opencv in ROS Depth Camera Simple point cloud node Loading, Saving and Interpreting point cloud images Object finder.

UNIT IV **10 Hours**

MOBILE ROBOT NAVIGATION IN ROS

Path Trajectories State publishing Robot state estimation Odometry Fusion of Odom, GPS and Inertial sensing unit Fusion of odometry and LIDAR Differential drive steering algorithms Map and path Making Move base Navigation stack.

UNIT V **10 Hours**

ROBOT ARM IN ROS

One-DOF Robot model Two-DOF Robot Model Position controller Velocity controller Force controller Trajectory message for Robot arms Trajectory Interpolation Forward kinematics Inverse kinematics Motion planning: Cartesian and Join space.

Total: 45 Hours

Reference(s)

1. Wyatt S. Newman, A Systematic Approach to Learning Robot Programming with ROS, CRC Press, 2018.
2. Lentin Joseph, Robot Operating System (ROS) for Absolute Beginners:Robotics Programming Made Easy, Apress; 1st ed. edition, 2018.
3. Anis Koubaa, Robot Operating System (ROS) The Complete Reference, Studies in Computational Intelligence, Springer, Volume 778, 2019.
4. Morgan Quigley, Brian Gerkey, and William D. Smart, Programming Robots with ROS: A Practical Introduction to the Robot Operating System, O Reilly Media, Inc, 2018.

21MC003 DRONE TECHNOLOGY 3 0 0 3

Course Objectives

- To apply the fundamental principles, historical evolution, classifications, and regulatory framework governing drone technology
- To analyze various drone configurations, programming techniques, flight operations, and stabilization methods..
- To select appropriate hardware and software components, including motors, batteries, propellers, autopilot systems, and relevant industry standards..

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO12. Life-long Learning: 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.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Evaluate the potential applications of drone technology across various domains.
2. Implement advanced ICT solutions for drone programming and establish key flight parameters.
3. Select appropriate hardware and software components to enhance drone performance.
4. Implement precautionary measures and pre-flight maintenance strategies for the safe operation of drones.
5. Apply guidance and trajectory control algorithms to ensure precise drone navigation along a projected path.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO DRONE TECHNOLOGY

Basic terminology. Drones principles of Flight Historical Development Classifications overview and technical characteristics of drone Components Laws & regulations level of autonomy assembly of drone.

UNIT II **9 Hours**

DRONE PROGRAMMING AND FLYING OPERATION

Drones configurations The methods of programming drone Multirotor Stabilization Flight modes Concept of operation for drone Flight modes Drone controls Flight operations management tools.

UNIT III **9 Hours**

HARDWARE AND SOFTWARE SUPPORT

Specifications and Characteristics of Motors and Batteries Selection of Propellers Autopilot system and operations- servos and actuators- Open source, DO178C and ARP4754A software design standards.

UNIT IV **9 Hours**

DRONE MAINTENANCE

Mission control Fully Autonomous take-off and landing system Types of sensors and data transmission Telemetry and Tracking system Integrated Global positioning system Maintenance Scheduled Maintenance Pre flight Inspections Unscheduled Maintenance Batteries and Payloads.

UNIT V **9 Hours**

DRONE CONTROL SYSTEM

Path planning algorithm waypoint trajectory guidance method Obstacles Avoidance Techniques Functional block of lateral and longitudinal guidance Structure of Ground control network system Flight Test. FOR FURTHER READING Drone commercial applications Case studies in the drone industry 3D mapping and aerial cinematography

Total: 45 Hours

Reference(s)

1. Mirosaw Adamski, "Power units and power supply systems in UAV", New Edition, Taylor and Francis Group publishers, 2014.
2. Reg Austin, "Unmanned Air Systems: UAV Design, Development and Deployment"First

Edition, Wiley Publishers, 2015.

3. Skafidas, "Microcontroller Systems for a UAV", KTH, TRITA-FYS 2002:51 ISSN 0280-316X. 34, 2002.

4. Droneprep, "Unmanned Aircraft Systems Logbook for Drone Pilots & Operators", Create Space Independent Publishing Platform, Latest Edition, 2015.

21MC004 ROBOTIC VISION 3 0 0 3

Course Objectives

- To transform the images and videos acquired by cameras mounted on robots into representations like features and optical flow.
- To determine 3D poses from 2D images for augmented reality tasks and visual odometry for robot localization
- To design robot vision systems that avoid collisions, safely work with humans and understand their environment.

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Conduct Investigations of Complex Problems: 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.
PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Demonstrate the image formation and camera calibration principles of a pin hole camera model
2. Use the edge detection and transformation techniques involved in projective transformation.
3. Compute the camera pose mounted on the end-effector using the point correspondences
4. Demonstrate a 3D reconstruction and bundle adjustment techniques using the point correspondences
5. Select the appropriate visual servoing techniques and SLAM algorithms for navigation of robots

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO IMAGE FORMATION

Elements of Visual Perception Image Sampling and Quantization Image transformations and geometric operations Image Formation Camera Models, Pin-Hole Camera Models, Focal length and Dolly zoom effect, Intrinsic Extrinsic parameters, Rotation & translations, Camera Calibration.

UNIT II **9 Hours**

PROJECTIVE TRANSFORMATIONS

Homogeneous transformation, Projective transformation, vanishing points, Cross ratio, Two view soccer metrology, Geometrical Transformation, Affine, Protective, Fourier Transforms, Image Convolution, Edge Detection, Image Convolution.

UNIT III **9 Hours**

POSE ESTIMATION

Visual features, Triangulation, Singular Value Decomposition, Point Correspondences, SIFT, SURF, Triangulation, Camera Pose Estimation, Pose from 3D point Correspondences, Pose from 3 Point correspondences P3P, Pose from n point correspondences (PnP).

UNIT IV **9 Hours**

MULTI-VIEW GEOMETRY

Epipolar Geometry, RANSAC, Non linear least squares, Optical flow 2D point correspondences, 3D velocities from optical flow, 3D motion and structure from multiple views, Fundamental & Essential matrix, Bundle Adjustment, 3D Reconstruction using stereo camera and multi-views.

UNIT V **9 Hours**

VISUAL SERVOING AND SLAM

Vision-based control, Position-based Visual Servoing, Image-based Visual Servoing, Visual Odometry, Simultaneous Localization and Mapping.Initialization, Tracking, Mapping, geometric SLAM formulations (indirect vs. direct error formulation, geometry parameterization, sparse vs. dense model, optimization approach).

Total: 45 Hours

Reference(s)

1. Peter C., Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011.
2. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, Digital Image Processing Using MATLAB, Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011
3. Horn B.K.P., Robot Vision, MIT Press, 1986.
4. An Invitation to 3-D Vision: From Images to Geometric Models, Yi Ma, Stefano Soatto, Jana Kosecka, and Shankar Sastry,Interdisciplinary Applied Mathematics #26, Springer, 2003.
5. Siegwart R. and Nourbakhsh I.R., Introduction to Autonomous Mobile Robots, MIT Press, Cambridge, MA, USA, 2004.Godfrey O., Mechatronics: Principles and Applications, Elsevier, 2005.

6. Lewis F.L., Dawson D.PSO1: and Abdallah C.T., Robot Manipulator Control: Theory and Practice, Marcel Dekker Inc., NY, USA, 2004.

21MC005 MEDICAL ROBOTICS 3 0 0 3

Course Objectives

- To understand the fundamental concepts in robotics and robotic control.
- To understand the applications of medical robotics in a range of scenarios including rehabilitation and surgery.
- To get adequate knowledge about links between robotic theory and the design of medical robots

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Conduct Investigations of Complex Problems: 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.
PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Select appropriate medical robots based on the concept of navigation and motion replication
2. Assess the robot design concepts used in MIS, considering factors like precision, portability, and flexibility in relation to patient safety.
3. Compare the medical imaging modalities (MRI, X-ray, CT, etc.) with robotic systems to guide surgical interventions with precision.
4. Evaluate the use of EMG, EEG, and ECG machines in monitoring rehabilitation progress and assess the effectiveness of manipulability analysis in rehabilitation robotics
5. Differentiate between various haptic feedback systems used in exoskeletons and robotic catheters, analyzing their impact on user experience and effectiveness in bio-medical applications.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Introduction to medical robotics (applications and paradigms), Different types of medical robots, Basic kinematics concepts (forward, inverse, remote center of motion), Basic control concepts (impedance, admittance).

UNIT II **9 Hours**

MINIMALLY INVASIVE SURGERY (MIS)

Human-machine interfaces, Teleoperation, Cooperative manipulation, Port placement for MIS, Robot design concepts, Video images in MIS, ARVR in MIS.

UNIT III **9 Hours**

IMAGE-GUIDED INTERVENTIONS

Medical imaging modalities (e.g., MRI, US, X-ray, CT), Robot compatibility with medical imagers, Image segmentation and modelling, Tracking devices, Frames and transformations, Surgical navigation, Calibration, Rigid and non-rigid registration, Radiosurgery.

UNIT IV **9 Hours**

REHABILITATION ROBOTICS

Exoskeletons Development and Control. Human Hand Biomechanics, Manipulability analysis, Redundancy resolutioPSO2: EMG, EEG and ECG Machines.

UNIT V **9 Hours**

BIO-MEDICAL ROBOTICS

Haptic Augmentation in Exoskeletons, Robotic Catheters for percutaneous interventions, Unsupervised leaning for mapping in Bio-Robots

FOR FURTHER READING

Position Control of a Hand Exoskeleton using Subjects Intention, Human Hand Biomechanics Study.

Total: 45 Hours

Reference(s)

1. Mark W. Spong, Seth Hutchinson, and PSO1: Vidyasagar, Robot Modeling and Control, Wiley Publishers, 2006.
2. Paula Gomes, Medical robotics- Minimally Invasive surgery, Woodhead, 2012.
3. AchimSchweikard, Floris Ernst, Medical Robotics, Springer, 2015.
4. Jocelyne Troccaz, Medical Robotics, Wiley-ISTE, 2012.
5. VanjaBonzovic, Medical Robotics, I-tech Education publishing,Austria,2008.
6. Daniel Faust, Medical Robots, Rosen Publishers, 2016. 5. Jocelyne Troccaz, Medical Robotics, Wiley, 2013.

21MC006 MOBILE ROBOTICS 3 0 0 3

Course Objectives

- To apply the forward and inverse kinematics of wheeled robot with Manoeuvrability
- To understand and demonstrate gaussian filters , Particle filter with Velocity, odometry model of mobile robot.
- To plan and control the path of mobile robot using path planning algorithm.

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Conduct Investigations of Complex Problems: 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.
PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Select appropriate robot locomotion technique based on the terrain and the navigation characteristics.
2. Apply forward and inverse kinematics and DH convention for estimating the position and orientation of mobile robot .
3. Use the gaussian filters to probablistically estimate the state of the mobile robot.
4. Apply robot localization techniques to navigate the mobile robot in an unknown environment.
5. Develop path planning and motion control algorithms for navigating mobile robots.

Articulation Matrix

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

UNIT -1 **9 Hours**

INTRODUCTION TO MOBILE ROBOTS

Locomotion: Key issues of locomotion - Legged mobile robots- configuration and stability - Wheeled mobile robot: design space and case studies - Aerial mobile robots: Aircraft configuration-VTOL (IO control).

UNIT -II **9 Hours**

KINEMATICS

Kinematic Models and Constraints: Robot Position - Forward and Inverse Kinematic Models - Manoeuvrability – Mobile Robot Manoeuvrability, Mobile Robot workspace, Motion Control.

UNIT-III **9 Hours**

PROBABILISTIC ROBOTICS & MODELS

Introduction: Uncertainty and need of Probability Theory - Recursive State Estimation- Bayes filters - Gaussian Filters: Kalman Filter ,EKF, UKF, Information Filter - Non parametric Filters: Particle Filters – Robot Model: Velocity Motion Model and Odometry Motion Model.

UNIT -IV **9 Hours**

LOCALIZATION & MAPPING

Markov Localization, EKF Localization Algorithm , EKF Localization with Unknown Correspondences Multi-Hypothesis Tracking. Mapping- Occupancy Grid Mapping- Learning Inverse Measurement Models - SLAM: EKF with known and Unknown Correspondence –The Graph SLAM–Fast SLAPSO1:

UNIT-V **9 Hours**

PLANNING AND MOTION CONTROL

Introduction-Path planning overview - Global path planning - A* Algorithm - local path planning - Road map path planning - Cell decomposition path planning-Potential field path planning - Obstacle avoidance–Path control.

Total: 45 Hours

REFERENCES:

1. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza , "Introduction to Autonomous Mobile Robots", Bradford Company Scituate, USA, 2011.
2. Sebastian Thrun, Wolfram Burgard, Dieter Fox , "Probabilistic Robotics", MIT Press, 2005.
3. Karsten Berns, Ewald Von Puttkamer , "Autonomous Land Vehicles Steps towards Service Robots", Vieweg Teubner Springer, 2009.
4. Howie Choset, Kevin Lynch Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, Sebastian Thrun , "Principles of Robot Motion-Theory, Algorithms, and Implementation", MIT Press, Cambridge, 2005.
5. Bruno Siciliano, Oussama Khatib , "Springer Hand Book of Robotics", Springer, 2008.

21MC007 CNC TECHNOLOGY 3 0 0 3

Course Objectives

- To understand the construction and principle of CNC machines
- To generate simple programs for CNC turning and machining centres

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long Learning: 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.

PSO1: Design, analyze and develop automation solutions for complex problems in diverse s ectors using modern tools.

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Interpret the evolution and working principle of CNC machine tools with its relevant applications
2. Construct the basic structure, construction, working and control of CNC machines over conventional units.

3. Generate real time program for producing desired products using CNC machines.
4. Select the appropriate various tool machines and work holding device of CNC
5. Make use of the maintenance and troubleshooting techniques in production industry

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO CNC MACHINE TOOLS

Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept classification of CNC Machines turning centre, machining centre, grinding machine, EDM, types of control systems, CNC controllers, characteristics, interpolators Computer Aided Inspection

UNIT II **9 Hours**

STRUCTURE OF CNC MACHINE TOOL

CNC Machine building, structural details, configuration and design, guide ways Friction, Anti friction and other types of guide ways, elements used to convert the rotary motion to a linear motion Screw and nut, re circulating ball screw, planetary roller screw, re circulating roller screw, rack and pinion, spindle assembly, torque transmission elements gears, timing belts, flexible couplings, Bearings

UNIT III **9 Hours**

CNC PROGRAMMING

Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, parametric programming, machining cycles, programming for machining, generation of CNC codes from CAM packages, CNC controllers

UNIT IV **9 Hours**

TOOLING AND WORK HOLDING DEVICES

Introduction to cutting tool materials Carbides, Ceramics- Cubic Boron Nitride, Polycrystalline Cubic Diamond- insert selection codes - PMK, NSH, qualified, semi qualified and preset tooling, tooling system for Machining centre and Turning centre, work holding devices for rotating and fixed work parts, economics of CNC

UNIT V **9 Hours**

CNC MAINTENANCE AND TROUBLE SHOOTING

Warnings-Check operation, Replacement, Parameters, Daily Maintenances - Caution, Note, Alarms, Maintenance Parts, Parameters. Trouble shooting-Causes and Remedies for failures Machine position, Reference Position, Manual operation, Automatic operation, Jog Operation, Feed rate, Spindle Speed, LCD Display, Abnormal Servo System

Total: 45 Hours

Reference(s)

1. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017
2. Warren S.Seamers, Computer Numeric Control, Fourth Edition Thomson Delmar, 2002
3. P. PSO2: Rao and PSO2: K. Tiwari, Numerical Control and Computer Aided Manufacturing, Tata McGraw-Hill Publishing company, New Delhi 2012
4. Tilak Raj, CNC technology & programming, Dhanpat Rai publishing company(p) ltd., N Delhi,2014
5. P. Radhakrishnan, Computer Numerical Control Machine & Computer Aided Manufacturing, New Academic Science Limited,England 2014
6. PSO1: Adithan & B. S. Pabla, CNC Machines, New Age International Publishers , N Delhi, 2018

21MC008 COMPUTER INTEGRATED MANUFACTURING 3 0 0 3

Course Objectives

- To introduce the basic concepts of Computer Integrated Manufacturing (CIM).
- To provide knowledge on Group Technology and Computer Aided Process Planning
- To impart knowledge on Shop Floor Control and Flexible Manufacturing Systems.
- To learn the various CIM implementation and data communication techniques
- To provide knowledge on the concept of Manufacturing automation protocol, Technical office protocol and database terminology.

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO12. Life-long Learning: 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.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Implement the basic concepts of Computer Integrated Manufacturing (CIM) in automotive assembly line automation.
2. Utilize Group Technology and Computer-Aided Process Planning to optimize aerospace component manufacturing.
3. Demonstrate the application of Shop Floor Control and Flexible Manufacturing Systems in electronics circuit board production.
4. Apply various CIM implementation strategies and data communication techniques in pharmaceutical packaging operations.
5. Use concepts of Manufacturing Automation Protocol, Technical Office Protocol, and database terminology for real-time monitoring in oil and gas refineries.

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION

The changing manufacturing and management scene, External communication, Islands of automation and software, dedicated and open systems, manufacturing automation protocol, introduction to CAD/CAM integration.

UNIT II **10 Hours**

GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING

Classification and coding - DCLASS, MICLASS and OPITZ coding systems. Facility design using G.T. Benefits of G.T cellular manufacturing. Process planning, role of process planning in CAD/CAM integration- approaches to computer aided process planning- variant approach and generative approaches.

UNIT III **9 Hours**

SHOP FLOOR CONTROL AND FMS

Shop floor control phases -factory data collection system -automatic identification methods- Bar code technology - automated data collection systePSO1: FMS- components of FMS- types -FMS workstation-material handling and storage systems- FMS layout-computer control systems-application and benefits

UNIT IV **9 Hours**

CIM IMPLEMENTATION AND DATA COMMUNICATION

System modelling tools- ICAM definition (IDEF) models, activity cycle diagram, CIM open system architecture (CIMOSA) -manufacturing enterprise wheel- CIM architecture- Product data management, implementation-software. Communication fundamentals- local area networks (LAN) - topology -LAN implementations - network management and installations.

UNIT V **9 Hours**

OPEN SYSTEM AND DATABASE FOR CIM

Open systems-open system inter-connection - manufacturing automation protocol and technical office protocol (MAP/TOP). Development of databases database terminology architecture of database systems data modeling and data associations -relational data bases database operators advantages of data base and relational database

Total: 45 Hours

Reference(s)

1. Mikell P Groover, Automation of production systems and computer integrated manufacturing, Pearson Education, United States of America, 2008.
2. Lee Kunwoo, CAD, CAM, CAE systems, Addison Wesley, United States of America, 1999
3. Kant Vajpayee S, Principles of Computer Integrated Manufacturing, Prentice Hall, New Delhi, 2003
4. Radhakrishnan P, Subramanyan S and Raju V, CAD, CAM, CIM, Second Edition New Age International Pvt. Ltd, New Delhi, 2000

21MC009 ADDITIVE MANUFACTURING 3 0 0 3

Course Objectives

- To analyze the generic steps of Additive Manufacturing (AM) techniques.
- To evaluate the concepts and applications of liquid and solid-based AM processes.
- To assess the working principles and impact of powder-based AM processes.
- To investigate the role of open-source 3D printers and rapid tooling in manufacturing.
- To explore emerging trends and advanced applications of Additive Manufacturing technology.

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including the design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO12. Life-long Learning: 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.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Analyze the generic steps and classification of Additive Manufacturing processes.
2. Evaluate and select the appropriate materials and AM processes based on specific applications.
3. Assess and apply suitable AM techniques for fabricating metallic components.
4. Design and develop an open-source 3D printer tailored to specific applications.
5. Implement reverse engineering techniques for prototyping and product development.

Articulation Matrix

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

4	3	-	3	-	3	-	-	-	-	-	-	3	3	-
5	3	-	3	-	3	-	-	-	-	-	-	3	3	3

UNIT I **7 Hours**

INTRODUCTION

Needs Impact of AM and Rapid Tooling on Product Development - Distinction between AM and CNC Machining- The Generalized AM Process chain - CAD Model - Input file formats - Generation and Conversion of STL file - File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - RP Benefits - Classification of RP systems

UNIT II **7 Hours**

LIQUID POLYMER AND SOLID BASED SYSTEMS

Stereolithography Apparatus (SLA), Digital Light Projection (DLP), Continuous Liquid Interface Production (CLIP), Photo polymerization process, Fused Deposition Modeling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Materials and Applications.

UNIT III **10 Hours**

POWDER BASED SYSTEMS

Selective Laser Sintering (SLS), Color Jet Printing, Direct Metal Deposition (DMD), Ballistic Particle Manufacturing (BPM), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS) - Working Principle, Construction, Process Variables, Materials and Applications

UNIT IV **11 Hours**

OPEN SOURCE PRINTER AND RAPID TOOLING

Concept of open source 3D printer - Structural details, Control mechanism - Materials and Applications. Introduction to rapid tooling (RT) - Direct and Indirect tooling - Silicone rubber moulding, Epoxy tooling, Spray Metal Coating, 3D printing direct, Electro Optical Sintering (EOS) - Working Principle, Materials and Applications

UNIT V **10 Hours**

REVERSE ENGINEERING AND APPLICATIONS OF ADDITIVE MANUFACTURING

Reverse Engineering - Application of CMM, Laser scanner, CT and MRI scan in acquiring point data - Software for STL file processing. Application of Rapid prototyping in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries. Leading manufacturer of RP systems

Total: 45 Hours

Reference(s)

1. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.

2. D. T. Pham and S. S. Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.

3. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Print ing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015 http://www.springer.com/978-1-4939-2112-6

4. L.W. Liou, F.W. Liou, Rapid Prototyping and Engineering applications: A toolbox for prototype development, CRC Press, 2013.

5. www.all3dp.com, www.3dprintingindustry.com, www.reprap.org, www.thingiverse.com

21MC010 NON-DESTRUCTIVE TESTING 3 0 0 3

Course Objectives

- To understand the basic principles of various NDT methods
- To be aware of applications and limitations of the NDT techniques
- To know the different types of service and process defects

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long Learning: 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.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Apply surface NDT techniques to carry out various testing & inspection in accordance with the established procedures
2. Analyze eddy current testing procedures for non-destructive testing
3. Apply principles of magnetism to investigate the service and processing defects
4. Choose right radiographic techniques and X-Rays for testing
5. Utilize ultrasonic testing as an NDT technique to investigate defects

Articulation Matrix

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

UNIT I **9 Hours**

VISUAL INSPECTION AND DYE PENETRANT TESTING

Introduction to NDT, Scope and advantages of NDT, Comparison of NDT with DT, Classifications of NDT. Equipment(s) used for visual inspection - Magnifying Glass, Magnifying Mirror, Microscope, Borescope, Endoscope. Liquid penetration testing - Introduction, Principle, Equipment, Procedures, Characteristics of penetrants. Developers - Evaluation - Hazards & Precautions, Advantages, Limitations and Applications.

UNIT II **9 Hours**

EDDY CURRENT TESTING

Eddy Current Testing- Principle, Advantages, Disadvantages, Factors Affecting Eddy Current Response Material Conductivity Permeability - Frequency- Geometry-Proximity (Lift off)-Faraday"s Law, Lenz"s law, Typical Applications, Limitations, Types of Probes.

UNIT III **9 Hours**

MAGNETIC PARTICLE TESTING

Principle of Magnetic Particle Testing-different methods to generate magnetic fields -Magnetic Particle Testing Equipment- Magnetic Particle Testing Procedures Method of De-Magnetization-Magnetic Particle Medium-Evaluation of Indications and Acceptance Standards- magnetic particle test-applications, advantagesand limitations

UNIT IV **9 Hours**

RADIOGRAPHIC TESTING

X- Ray properties and atomic scattering, X-ray radiography principle, equipment & methodology - Type of Industrial Radiation sources and Application-Radiographic exposure Factors and Technique - X-Ray Equipment- Radiographic Procedure - Radiograph Interpretation, Radiography Image Quality- Indicators Radiographic Techniques- Film Processing-Methods of Viewing Radiographs- Radiographic Testing Procedures for welds. Precautions against radiation hazards

UNIT V **9 Hours**

ULTRASONIC TESTING

Introduction, Principle of operation Type of Ultrasonic Propagation- Ultrasonic probes. Types of Transducers -Ultrasonic Testing Techniques. Method for Evaluating Discontinuities-Ultrasonic Testing Procedures for different component- advantages and limitations, Applications in inspection of castings, forgings, Extruded steel parts, bars, pipes, rails and dimensions measurements.

Total: 45 Hours

Reference(s)

1. J Prasad, C G K Nair, Non-Destructive Testing and Evaluation of Materials, Tata McGraw Hill Education Private Limited, 2017
6. Baldev Raj, PSO1: Thavasimuthu, and T. Jayakumar, Practical Non-destructive Testing, Alpha Science International Ltd, 2007
3. American Metals Society, Non-Destructive Examination and Quality Control, Metals Hand Book, Vol.17, 9th Ed, Metals Park, 1989
4. Bray, Don.E and Stanley, Roderic.K, Nondestructive Evaluation: A Tool in Design, Manufacturing, and Service. Revised, CRC Press New York, Edition, 1997
5. www.ndt-ed.org
6. https://nptel.ac.in/courses/112105125/

21MC011 DESIGN FOR MANUFACTURING AND ASSEMBLY 3 0 0 3

Course Objectives

- To learn the way of specifying geometric dimensioning and tolerancing in engineering drawing
- To familiarize the design considerations for designing components for the casting, welding and forming processes.
- To familiarize the design guidelines while designing components which are manufacturing by different machining processes.
- To learn the factors affecting easy assembly of parts into a final product
- To impart knowledge about the product life cycle assessments and environmental impact of materials, manufacturing methods and the way to minimize it

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mat hematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. Life-long Learning: 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.

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Apply geometric dimensioning and tolerancing techniques in engineering drawing
2. Select appropriate design considerations to minimize difficulty to produce components by casting, welding and forming processes
3. Use the design for manufacturing concept to reduce machining time and manufacturing cost
4. Analyze and design the parts for easy assembly using DFA guidelines
5. Design the components by considering the product life cycle and its environmental impact

Articulation Matrix

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

UNIT I **10 Hours**

GEOMETRIC DIMENSIONING AND TOLERANCING

Tolerance Chains and identification of functionally important dimensions. International Tolerance Grades, Surface finish, Attainable tolerance grades and different machining processes. G eometric Dimensioning and Tolerancing - Location, Form, profile, orientation, run out and Feature tolerance. Tolerance Limits for Assembly - Cumulative effect of Tolerances

UNIT II **10 Hours**

DESIGN CONSIDERATIONS FOR CASTINGS, WELDING AND FORMING

Casting - Pattern, Mould, Casting hole - cast, Cored and Machined holes, Parting line - Redesign of castings based on parting line considerations, Minimizing core requirements. Welding - Stresses in welding - Measures to combat contraction stresses - Welding sequence - Joints in Welding - Weldability of steel - Design of welded structures. Form design aspects for Forging and sheet metal components

UNIT III **8 Hours**

DESIGN FOR MANUFACTURE - MACHINING CONSIDERATIONS

Design for Manufacture Guidelines - Design features to facilitate machining - Drills - Milling cutters Keyways - Doweling procedures, Counter sunk screws - Reduction of machined area Simplification by separation - Simplification by amalgamatioPSO2: Design for Manufacture: Machinability, Economy, Clampability, Accessibility, Assembly. Redesign for Manufacture -Examples.

UNIT IV **8 Hours**

DESIGN FOR ASSEMBLY

Design for Assembly(DFA) Guidelines - Minimizing number of Parts - Insertion and Fastening - Design Guidelines for Part Handling - Effect of Part Symmetry, Part Thickness, Part Size, Weight on Handling Time - Types of Manual Assembly Methods - Effect of Assembly layout on Part Acquisition Time - Assembly Efficiency - DFA index.

UNIT V **9 Hours**

DESIGN FOR ENVIRONMENT

Environmental objectives - Global issues, Regional and local issues - Basic Design for Environment (DFE) methods - Design guide lines - Lifecycle assessment - AT&Ts (American Telephone and Telegraph Company) environmentally responsible product assessment, Weighted sum assessment method, Lifecycle assessment method - Techniques to reduce environmental impact - Design to minimize material usage - Design for disassembly, Recyclability, Remanufacture, Energy efficiency – Design to regulations and standards.FOR FURTHER READING Case studies - Design components for casting, welding, forging and machining processes. Design components for minimizing environmental impact.

Total: 45 Hours

Reference(s)

1. Gene R. Cogorno, Geometric Dimensioning and Tolerancing for Mechanical Design,McGraw-Hill Professional, New Delhi, 2011
2. Harry Peck, Designing for Manufacture, Pitman Publishing, London, 1973
3. Robert Matousek, Engineering Design - A Systematic Approach, Blackie and Son Limited, London, 1974.
4. PSO1: F. Spotts, Dimensioning and Tolerance for Quantity Production, Prentice Hall, New Jersey, 2007.
5. J.G. Bralla, Hand Book of Product Design for Manufacturing, McGraw-Hill Publications, New Delhi, 2000.
6. Kevin otto, Kristin wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson education, 2003.

21MC012 INDUSTRIAL ENGINEERING 3 0 0 3

Course Objectives

- To understand the use of forecasting, control of inventory, process of routing and scheduling for improving productivity
- To build and solve linear programming problem
- To analyse deterministic and probabilistic models of problems related to networks and queuing

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long Learning: 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.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with

mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Apply design principles, and identify work study methods, ergonomics and forecasting techniques, for industrial applications
2. Apply inventory control techniques and identify the need for material requirement planning in optimizing production processes.
3. Solve sequencing of jobs with two and more machines and also compute the characteristics of single server queuing models
4. Formulate linear programming problems and find the optimum solution.
5. Construct the network model and identify the critical path of deterministic and probabilistic models

Articulation Matrix

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

UNIT I **9 Hours**

PRODUCTION PLANNING AND CONTROL

Productivity - Productivity index -Productivity measurement - Job design - Job standard - Work study Method study - Operation process chart - Motion study - Motion economy - SIMO chart - Work measurement PMTS - Ergonomics - Industrial safety: losses due to accidents, causes, preventive measures - Forecasting Types - Accuracy of forecast -Sales forecasting techniques - Time series method: simple moving average weighted moving average, exponential smoothing. Production control dispatching

UNIT II **9 Hours**

INVENTORY CONTROL

Inventory control - Purpose - Inventory costs - EOQ - Deterministic models - Shortage model - Classification: ABC analysis, FSN analysis - Material Requirement Planning (MRP), KANBAN technique, lean manufacturing, Supply chain management - Material Handling Functions, Principles, Engineering and economic factors, Material handling equipment selection, maintenance and its types.

UNIT III **9 Hours**

SCHEDULING AND QUEUING

Introduction -Rules - Factors affecting - Master schedule - Gantt chart - Sequencing problem: Models with n jobs with 2 machines Models with n jobs with 3 machines - Queuing models - Queuing systems and structures Notation - Parameter - Poisson input - Exponential service - Constant rate service - Infinite population -Single server models

UNIT IV **9 Hours**

LINEAR PROGRAMMING

Introduction - Formulation - Graphical method, Simplex method Artificial Variable techniques: Big M method - Transportation Problems: North West corner method, least cost method, Vogel"s approximation method - MODI method - Assignment problems with Hungarian algorithm

UNIT V **9 Hours**

NETWORK MODELS

Network models - Shortest route - Minimal spanning tree - Maximum flow models - Project network – CPM and PERT networks - Critical path scheduling

Total: 45 Hours

Reference(s)

1. T. R. Banga, PSO2: K. Agarwal and S. C. Sharma, Industrial Engineering and Management Science, Khanna Publishers, Delhi, 1996
2. Prem Kumar Gupta and D. S. Hira, Operations Research, S. Chand and Co., New Delhi, 2014
3. S. B. Srivastava, Industrial Management, I. K. International Publishing House Pvt. Ltd., New Delhi, 2012
4. Hamdy A. Taha, Operation Research: An introduction, Pearson Publications., New Delhi, 2010
5. Frederick S. Hiller and Gerald J. Liberman, Operations Research: Concepts and cases, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2010

21MC013 ELECTRIC AND HYBRID VEHICLES 3 0 0 3

Course Objectives

- To introduce fundamental concepts and specifications of electric and hybrid vehicles
- To acquire knowledge technologies related to electric, hybrid and fuel cell powered vehicles
- To appreciate the role of electronics in providing improved control to a variety of vehicle systems

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse comp lex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO12. Life-long Learning: 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.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Implement strategies to address the demand for fossil fuels and mitigate automobile pollution in urban public transportation systems using next-generation vehicle technologies.
2. Apply the requirements of Electric Drive Trains in the design of commercial delivery fleets for logistics companies.
3. Select and integrate appropriate electric motors and drive controls for electric buses in metropolitan transit networks.
4. Evaluate the performance of energy storage systems in renewable energy-powered electric vehicle charging stations.
5. Apply suitable Fuel Cell Technology for long-haul freight transportation using EVs and HEVs.

Articulation Matrix

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

5	3	3	-	3	2	-	-	-	2	-	-	2	3	-

UNIT I **9 Hours**

INTRODUCTION

Usage Pattern of Automobiles in cities and highways, Air Pollution: NOx, CO, HC, PM emission, Global Warming Health Impacts, Petroleum Resources, Induced Costs, Importance of Different Transportation Development, Strategies to Future Oil Supply, Strategies for Next Generation Vehicles.

UNIT II **9 Hours**

ELECTRIC AND HYBRID VEHICLES

Configuration Layouts of early EVs and modern EVs, merits and demerits, Concept of Hybridization, Hybrid electric drive trains - types of hybrid drive train topologies, Speed & Torque Couplings, Types of HEVs, Regenerative braking strategies, Start/Stop in EVs and HEVs, Merits and demerits.

UNIT III **9 Hours**

PROPULSION SYSTEM FOR EVS

Basic concept of electric traction, Power-Torque Characteristic curves, Selection of Electric motors, Motors types: DC motor drives, induction motor drives, brushless DC PM motor drives, Switched Reluctance motor drives, starter/alternator, Electric Control Drives.

UNIT IV **9 Hours**

ENERGY MANAGEMENT SYSTEM FOR EVS

Energy storage requirements in HEVs and EVs, Energy storage techniques - battery based energy storage: Engine starter batteries, Traction Batteries, Super capacitor based energy storage and flywheel based energy storage, Hybridization of different energy storage devices.

UNIT V **9 Hours**

FUEL CELL TECHNOLOGIES

Fuel cell electric vehicles-operating principle, Fuel cell technologies- alkaline fuel cell- proton exchange Membrane, direct methanol fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, Fuel reformer, Hydrogen storage systems.

Total: 45 Hours

Reference(s)

1. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Boca Raton: CRC Press, 2018.
2. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, Boca Raton: CRC Press, 2011
3. AuliceScibioh PSO1: and Viswanathan B., Fuel Cells Principles and Applications, India: University Press, 2009.
4. Barbir F., PEM Fuel Cells: Theory and Practice, Burlington: Elsevier, 2012.
5. James Larminie and John Loury, Electric Vehicle Technology-Explained, New York: John Wiley & Sons Ltd., 2012.
6. https://nptel.ac.in/courses/108103009/

21MC014 AUTONOMOUS AND CONNECTED VEHICLES 3 0 0 3

Course Objectives

- The purpose of this course is to study the basics of electronics, emission controls and their importance in automobiles
- To study the various sensors and actuators used in automobiles for improving fuel economy and emission control
- To study the various blocks of control units used for control of fuel, ignition and exhaust systems

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long Learning: 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.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Apply emission standards to automobile manufacturing processes to ensure compliance with global environmental regulations and implement efficient starting and charging systems in commercial vehicle fleets.
2. Implement electronic fuel injection and ignition components in high-performance automotive engines for motorsport applications.
3. Select appropriate sensors or transducers for measuring mechanical quantities and temperature, and integrate suitable actuators in automated assembly lines for electric vehicle production.
4. Diagnose electronic engine control system issues using appropriate tools in automotive service centers for luxury car brands.
5. Apply vehicle chassis design and safety systems to enhance crashworthiness in autonomous vehicles.

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	1	1	-	1	2	2	2
2	2	3	2	2	2	3	2	2	1		1	2	2	2
3	2	2	2	3	2	2	2	1	1			2	2	2
4	2	2	3	2	2	3	2	2	1		1	2	2	2
5	2	2	2	3	2	2	2	1	1			2	2	2

UNIT I **8 Hours**

VEHICLENORMS, CHARGING AND STARTING SYSTEM

Evolution of electronics in automobiles - emission laws - introduction to Euro I, Euro II, Euro III, Euro IV, Euro V, Euro VI standards - Euro NCAP crash ratings Equivalent Bharat Standards. Charging systems Working and design of charging circuit diagram - Alternators – Requirements of starting system Starter motors and starter circuits

UNIT II **9 Hours**

IGNITION AND INJECTION SYSTEM

Ignition systems Ignition fundamentals Electronic ignition systems Programmed Ignition Distribution less ignition direct Ignition - Spark Plugs. Electronic fuel Control: Basics of combustion Engine fuelling and exhaust emissions - Types of exhaust hot end and cold end. Electronic control of carburetion - Petrol fuel injection - Diesel fuel injection Electric and Hybrid Engine

UNIT III **8 Hours**

SENSORS AND ACTUATORS

Working principle and characteristics of Airflow rate, Engine crankshaft angular position, Hall Effect Throttle angle, temperature, exhaust gas oxygen sensors - study on fuel injector, exhaust gas recirculation actuators, stepper motor actuator and vacuum operated actuator.

UNIT IV **10 Hours**

ENGINE CONTROL SYSTEM

Control modes for fuel control - Engine control subsystems Ignition control methodologies - Different ECUs used in the engine management - block diagram of the engine management systePSO1: In-vehicle networks CAN standard, the format of CAN standard - Diagnostics systems in modern automobiles

UNIT V **10 Hours**

CHASSIS AND SAFETY SYSTEM

Traction control system - Cruise control system - Electronic control of automatic transmission Antilock braking system - Electronic suspension system - Advanced Driver Assistance Systems - Working of airbag and role of MEMS in airbag systems - Centralized door locking system - Climate control of cars Introduction to driverless car

Total: 45 Hours

Reference(s)

1. Tom Denton, Automobile Electrical and Electronics Systems, Routledge Publishers, United Kingdom, 2017
2. William Ribbens, Understanding Automotive Electronics, Newnes Publishers, India, 2013.
3. BOSCH Automotive Handbook, Bentley Publishers, USA, 2005
4. Barry Hollembeak, Automotive Electricity, Electronics and Computer Controls, Delmar Publishers, USA, 2001
5. Ronald. K. Jurgon, Automotive Electronics Handbook, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 1999

21MC015 AUTOMOTIVE EMBEDDED SYSTEMS 3 0 0 3

Course Objectives

- To acquire knowledge on road vehicle dynamics, stability and handling To acquire knowledge on road vehicle dynamics, stability and handling
- To understand the technologies relevant to intelligent vehicle systems
- To appreciate the role of electronics in providing improved control to a variet y of vehicle systems

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Conduct Investigations of Complex Problems: 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.
PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Apply laws of mechanics to calculate dynamic, road loads and equation motion.
2. Demonstrate knowledge on intelligent sensors, vehicle control, navigation, and communications systems
3. Identify the recent trends in Vehicle Comfort System
4. Interpret the various security systems associated with vehicle system
5. Implement recent trends and intelligent technologies associated with modern day vehicles

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Vehicle and Earth fixed coordinate system, Euler angles, Dynamic axle loads - static loads on level ground - low speed acceleration, Loads on Grades. Road loads - rolling resistance - grade resistance.

Equation of motion for Forced Undamped and forced Damped Vibration, Single DOF, Two DOF and Multi DOF systems.

UNIT II **9 Hours**

TELEMATICS

Global positioning system, geographical information systems, navigation system, architecture, automotive vision system, road recognition.

UNIT III **9 Hours**

COMFORT SYSTEMS

Adaptive cruise control system, active suspension system, power steering, collapsible and tiltable steering column, power windows, eight way seating system and climate control system, Adaptive Lighting Systems , Automatic Wiper system

UNIT IV **9 Hours**

SECURITY SYSTEMS

Anti-theft technologies mechanical, electromechanical and electronic immobilizers, alarm system, stolen vehicle tracking system, remote keyless entry, smart card system, number plate coding.

UNIT V **9 Hours**

INTELLIGENT AND SAFETY SYSTEMS

Lane Departure Warning System, Adaptive Headlight Systems, Day time running lights (DRL), Active and Passive Safety, Airbags, Seat Belt Tightening System, Forward Collision Warning Systems, Child Lock, Antilock Braking System, Vehicle communication-Car to X communication.

Total: 45 Hours

Reference(s)

1. R.PSO2: Jazar, Vehicle Dynamics: Theory and Application, NY: Springer, 2017.
2. T.D. Gillespie, Fundamentals of Vehicle Dynamics, Michigan: SAE International, 1992.
3. Ronald K Jurgen, Navigation and Intelligent Transportation Systems - Progress in Technology, Automotive Electronics Series, Warrendale, PA: SAE International, 2014
4. Ozguner, TankutAcarman, Keith Redmill, Autonomous Ground Vehicles, London: Artech House Publishers, 2011.
5. Robert Bosch,Automotive Hand Book, Warrendale, PA: SAE International, 2014
6. Hong Cheng, Autonomous Intelligent Vehicles: Theory, Algorithms, and Implementation, Berlin: Springer, 2011.

21MC016 AUTOMOTIVE COMMUNICATION PROTOCOLS 3 0 0 3

Course Objectives

- To understand concept of autonomous and connected vehicle
- To learn about sensor technology of automated vehicle
- To understand about computer vision and deep learning
- To acquire knowledge on localisation and path planning
- Become familiar with the concept of connected vehicles

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long Learning: 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.

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Explain evolution of automotive electronic and connected vehicle concepts
2. Analyse sensors for automotive application
3. Apply knowledge of Computer Vision and Deep learning in autonomous vehicle
4. Apply fundamentals of Localization and Path planning in autonomous vehicle
5. Analyze fundamentals of connected vehicle

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Introduction to the Concept of Automotive Electronics-History & Evolution, Infotainment, Body, Chassis, and Powertrain Electronics, Advanced Driver Assistance Electronic Systems
Basic Control System Theory applied to Automobiles-Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy

UNIT II **9 Hours**

SENSOR TECHNOLOGY FOR AUTOMATED VEHICLES

Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems

UNIT III **9 Hours**

COMPUTER VISION AND DEEP LEARNING

Introduction, Computer Vision: - Computer Vision Fundamentals, Deep Learning:- Neural Networks, Deep Neural Networks, Convolutional Neural Networks, Keras ,TensorFlow, Sensor Fusion:- Kalman Filters

UNIT IV **9 Hours**

LOCALISATION AND PATH PLANNING

Introduction to Localization- Motion Models, Particle Filters, Implementation of a ParticleFilter, Path Planning: -search, prediction, behaviour planning, trajectory generation, Control-PID, System Integration-ROS Driverless Car Technology: - Moral, Legal, Roadblock Issues, Technical Issues, Security Issues

UNIT V **9 Hours**

CONNECTED CAR TECHNOLOGY

Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Wireless Security OverviewConnected Car Display Technology- Center Console Technology, Gauge Cluster Technology, Heads-Up Display Technology, Warning Technology-Driver Notification

Total: 45 Hours

Reference(s)

1. Markus Maurer, J. Christian Gerdes, Barbara Lenz, Hermann Winner , Autonomous Driving: Technical, Legal and Social Aspects, Springer,2016
2. Hod Lipson, Melba Kurman,Driverless: Intelligent Cars and the Road Ahead,MIT press, 2016
3. Michael E. McGrath , Autonomous Vehicles: Opportunities, Strategies,and disruptions, 2016
4. Vivekwadhwa , Alex salkever, The driver in the driverless car, 2017 G. Mullett, Wireless Telecommunications Systems and Networks, Thomson- DelmarLearning, ISNB 1-4018-8659-0, 2006
5. G. Mullett, Basic Telecommunications : The Physical Layer, Thomson-Delmar Learning, ISBN 1-4018-4339-5, 2003

21MC017 VEHICLE CONTROL SYSTEMS 3 0 0 3

Course Objectives

- To acquire knowledge on intelligent systems, focusing on those in-vehicle solutions specifically designed to improve driving and travelling energy efficiency
- To appreciate the role of electronics in providing improved control to a variety of vehicle systems
- To enable evaluation of appropriate methodologies and be aware of the design and implementation issues of advanced techniques

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Analyze the importance of modern trends in vehicle System
2. Apply the knowledge for selection of sensor and communication protocols for interfacing sensors
3. Apply the knowledge for understanding the traffic information in the surroundings
4. Compare the various intelligent systems used in automobiles and entertainment features inside the vehicle
5. Outline the intelligent systems associated with Autonomous vehicle

Articulation Matrix

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

UNIT I **7 Hours**

INTRODUCTION TO INTELLIGENT VEHICLE SYSTEMS

Definition, modern trends in Auto industry, various intelligent systems present in the vehicle, Need for IVS, Benefits, Advanced Driver Assistance System-Types/Levels, Next Generation Intelligent Vehicles, General Vehicle Control.

UNIT II **10 Hours**

IOT IN AUTOMOBILES

Developments on IoT in Automotive Sector, Connected Car Services and Applications- Infotainment, Vehicle and Smartphone Integration, Driving Insights- Analytics, On Board Diagnostics, Real Time Driver Monitor, Geo fencing and Speed Monitoring, Stolen Vehicle Tracking, Biometrics Information for Driver Identification, Vehicle Communication- V2V, V2X, V2R, IoT in Intelligent Transportation , Introduction to Autonomous Vehicle.

UNIT III **10 Hours**

TRAFFIC SURROUNDINGS

Modelling traffic and driver interactions, Simulation of driver and city interaction, Behavior and driving pattern, simulation of driver and highway interaction, Behavior and driving pattern, Application: Traffic alert - Real time road data on Navigation, Navigation System- Global Positioning System, Geographical Information Systems Architecture, Road Sign Recognition.

UNIT IV **9 Hours**

CONNECTED VEHICLE SYSTEMS

Introduction to CVS, Telematics control system architecture -driver information systems, Vehicle - vehicle interaction using TCS, Current trends in auto industry, In-Vehicle Entertainment System -

Mirror link, Web link, App link, Apple Car Play, Android Auto. Application: ecall system - design, functions and limitations.

UNIT V **9 Hours**

AUTONOMOUS VEHICLE COMFORT SYSTEMS AND APPLICATIONS

Introduction- Design overview, circuit diagram and Algorithm, Driver safety systems- ABS, Driver Aid system- ESP, Blind Spot monitoring system, Collision mitigation system, Adaptive Headlamps, Automatic parking system, Eight way seating system, Adaptive cruise control system, Collapsible and tiltable steering column, Lane Departure Warning.

Total: 45 Hours

Reference(s)

1. A. Perallos, U. Hernandez-jayo, E. Onieva and I. Garcia-Zuazola (Eds.), Intelligent Transport Systems: Technologies and Applications, Wiley publications, 2015.

2. A. Eskandarian (Ed.), Handbook of Intelligent Vehicles, Springer-Verlag London Ltd, 2012.

3. R. K. Jurgen, Navigation and Intelligent Transportation Systems - Progress in Technology, Automotive Electronics Series, Warrendale, PA: SAE International, 2014.

4. H. Cheng, Autonomous Intelligent Vehicles: Theory, Algorithms, and Implementation, Berlin: Springer, 2011.

5. P. C. Cacciabue (Ed.), Modelling Driver Behavior in Automotive Environments: Critical Issues in Driver Interactions with Intelligent Transport Systems, Springer-Verlag London Ltd, 2007.

21MC018 MACHINE LEARNING FOR AUTONOMOUS VEHICLES 3 0 0 3

Course Objectives

- To understand the Model-in-the-Loop (MIL), Software-in-The-Loop Simulations (SIL), and Hardware-in-the-Loop (HIL) concepts.
- To learn about various Real-Time Simulation concepts.

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long Learning: 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.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Develop mathematical models for system components and integrate them into larger systems.
2. Implement Model-in-the-Loop (MIL) simulations to analyze system behavior and optimize design.

3. Apply Software-in-the-Loop (SIL) and Hardware-in-the-Loop (HIL) simulations for real-time testing and validation.
4. Design and execute real-time experiments to collect and analyze system performance data.
5. Refine and validate system models by incorporating experimental data and comparing physical and simulated responses..

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO MODEL-BASED SYSTEM DESIGN

Introduction to Systems Engineering, Systems Engineering and the Life Cycle, Systems Engineering Process Overview, Business Impacts of Systems Engineering, Motor Model, Generator Model, Controller Model, Sim Driveline Introduction.

UNIT II **9 Hours**

REAL-TIME SIMULATIONS

Processor In The Loop Real-Time Simulations, Controller on Freescale Target, Plant on Real-Time Target, Data Collection of Performance. Model-in-the-Loop (MIL), Software-in-The-Loop Simulations (SIL), Hardware-in-the-Loop (HIL). Introduction to Simulink Simulations- Implement controller Explore the system response using different control methods, Tune the system, explore system limitations, Understand and refine motor models.

UNIT III **9 Hours**

MODEL VERIFICATION

Test controller on real system Observe system performance, Observe the effect of different contro methods Tune the systePSO1: Data Collection of Physical Model Response, Comparison of Physical Plant Response to Model Response.

UNIT IV **9 Hours**

DESIGN OF EXPERIMENTS

Automatically Generate Test Schedule to Obtain Data, Run Experiments and Collect Data, Generate Models for Components, Table Lookup, Curve Fits. Design of Experiments to Collect Experimental Data on Motor and Generator.

UNIT V **9 Hours**

MODEL REFINEMENT AND RE-VERIFICATION

Compliance Adjustment of models, Comparison of observed and simulated behaviours, Update Models to Include Measured Data, Comparison of Updated Physical Plant to Model.

Total: 45 Hours

Reference(s)

1. Practical Model-Based Systems Engineering, by Jose L. Fernandez, Carl Hernandez.
2. Effective Model-Based Systems Engineering, John PSO1: Borky, 2018.
3. Model-Based Systems Engineering, A. Wayne Wymore, CRC Press; 1st edition (April 5, 1993)
4. Model Based Systems Engineering: Fundamentals and Methods, Patrice Micouin, Wiley
5. https://in.mathworks.com/.

21MC019 APPLIED IMAGE PROCESSING 3 0 0 3

Course Objectives

- To understand with digital image fundamentals
- To get exposed to simple image enhancement techniques in the Spatial and Frequency domain.
- To learn concepts of degradation function and restoration techniques.
- To study image segmentation and representation techniques.
- To become familiar with image compression and recognition methods

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Develop the digital image processing model based on fundamental concepts
2. Apply different techniques of smoothing, sharpening and enhancement in images processing
3. Apply the concepts of restoration and filtering techniques in digital image processing methods
4. Analyze the impacts of segmentation, features extraction in images.
5. Compare the performance of image processing techniques used in robot vision applications

Articulation Matrix

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

4	2	2	2	2	2	-	-	-	-	-	2	-	-	2
5	2	1	2	2	2	-	-	-	-	-	2	-	-	2

UNIT I **9 Hours**

DIGITAL IMAGE FUNDAMENTALS

Steps in Digital Image Processing Components Elements of Visual Perception Image Sensing and Acquisition Image Sampling and Quantization Relationships between pixels Color image fundamentals RGB, HSI models, Two dimensional mathematical preliminaries, 2D transforms DFT, DCT.

UNIT II **9 Hours**

IMAGE ENHANCEMENT

transformations Histogram processing Basics of Spatial Filtering Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform Smoothing and Sharpening frequency domain filters Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.

UNIT III **9 Hours**

IMAGE RESTORATION

Image Restoration degradation model, Properties, Noise models Mean Filters Order Statistics Adaptive filters Band reject Filters Band pass Filters Notch Filters Optimum Notch Filtering Inverse Filtering Wiener filtering

UNIT IV **9 Hours**

IMAGE SEGMENTATION

Edge detection, Edge linking via Hough transform Thresholding Region based segmentation Region growing Region splitting and merging Morphological processing erosion and dilation, Segmentation by morphological watersheds basic concepts Dam construction Watershed segmentation algorithm.

UNIT V **9 Hours**

ROBOT VISION APPLICATION

Basic introduction to Robotic operating System (ROS) Real and Simulated Robots Introduction to OpenCV, OpenNI and PCL, ROS to OpenCV Line following tracking objectusing optical flow camshaft and meanshift.

Total: 45 Hours

Reference(s)

1. Kenneth R. Castleman Digital Image Processing, Pearson, 2006.
2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, Digital Image Processing using MATLAB, Pearson Education, Inc., 2011.
3. D,E. Dudgeon and RPSO1: Mersereau, Multidimensional Digital Signal Processing, Prentice Hall Professional Technical Reference, 1990.
4. William K. Pratt, Digital Image Processing, John Wiley, New York, 2002
5. Milan Sonka et al Image processing, analysis and machine vision, Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.

21MC020 FUZZY LOGIC AND ARTIFICIAL NEURAL NETWORK 3 0 0 3

Course Objectives

- To understand fuzzy logic and neural network concepts
- To equip with the latest application of soft computing

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Conduct Investigations of Complex Problems: 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.
PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communication: 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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12. Life-long Learning: 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.
PSO1: Analyze, design and develop electro mechanical system using contemporary tools
PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Develop the fuzzy set theory and its architectures.
2. Apply the knowledge based rules and its controller types for the given application
3. Carry out the design for fuzzy knowledge representation and multi objective decision making controllers
4. Implement machine learning through neural networks
5. Analyze the concept of artificial neural networks and their control applications.

Articulation Matrix

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

UNIT I **9 Hours**

FUZZY LOGIC SYSTEMS
Classical sets-fuzzy sets- fuzzy operation -fuzzy relations - fuzzification - defuzzification - if-then rules-Fuzzy Functions.

UNIT II **9 Hours**

FUZZY SYSTEMS
Membership function-knowledge base - data base - rule base -decision-making logic -fuzzy logic controller: Mamdani and Sugeno-Takagi architecture

UNIT III **9 Hours**

FUZZY RULES AND LOGIC
Representation of fuzzy knowledge - fuzzy inference systems - Fuzzy decision making - Multi Objective Decision Making-Fuzzy logic controller for inverted pendulum.

UNIT IV **9 Hours**

ARTIFICIAL NEURAL NETWORK
Introduction -biological neuron and their artificial models - neuron modeling- learning rules - types ofneural networks - single layer - multi layer feed forward network - back propagation - learning factors.

UNIT V **9 Hours**

NEURAL NETWORKS IN CONTROL APPLICATIONS
Feedback networks - Hopfield networks - Applications of neural networks - Process identification Artificial neuro controller for inverted pendulum

FOR FURTHER READING
ANN in mobile robots navigation and control, Neuro fuzzy approach in machine vision system for parts identification

Total: 45 Hours

Reference(s)

1. Jacek PSO1: Zurada, Introduction to Artificial Neural Systems, Jaico Publishing House, New Delhi,2012.
2. John Yen, Reza Langari, Fuzzy logic Intelligence, control and Information, Pearson Education,1999.
3. C T Jang, J S R Sun and E Mizutani , Neuro Fuzzy and Soft computing, Pearson Education,2006.
4. LaureneFauseett: Fundamentals of Neural Networks, PHI,2004
5. Timothy J.Ross: Fuzzy Logic Engineering Applications, McGrawHill, 2004
6. Yagnanarayanan, Artificial Neural Networks, Prentice Hall of India Ltd .,New Delhi.2012

21MC021 ARTIFICIAL INTELLIGENCE 3 0 0 3

Course Objectives

- To understand the various characteristics of intelligent agents
- To understand the different search strategies in AI
- To represent knowledge in solving AI problems and understand the different ways of designing software agents
- To know the various applications of AI

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Conduct Investigations of Complex Problems: 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.
PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communication: 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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a t eam, to manage projects and in multidisciplinary environments.
PO12. Life-long Learning: 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.
PSO1: Analyze, design and develop electro mechanical system using contemporary tools
PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with

mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Design a problem using first order and predicate logic
2. Select appropriate search algorithms for any AI problem
3. Choose the apt agent strategy to solve a given problem
4. Design software agents to solve a problem
5. Design applications for Natural Learning Process that uses Artificial Intelligence.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Introduction -Definition - Future of Artificial Intelligence - Characteristics of Intelligent Agents – Typical Intelligent Agents - Problem Solving Approach to Typical AI problems

UNIT II **9 Hours**

PROBLEM SOLVING METHODS

Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local Search Algorithms and Optimization Problems - Searching with Partial Observations - Constraint Satisfaction Problems Constraint Propagation - Backtracking Search - Game Playing - Optimal Decisions in Games - Alpha - Beta Pruning - Stochastic Games

UNIT III **9 Hours**

KNOWLEDGE REPRESENTATION

First Order Predicate Logic - Prolog Programming - Unification Forward Chaining-Backward Chaining Resolution - Knowledge Representation - Ontological Engineering-Categories and Objects - Events - Mental Events and Mental Objects - Reasoning Systems for Categories - Reasoning with Default Information

UNIT IV **9 Hours**

SOFTWARE AGENT

Architecture for Intelligent Agents Agent communication Negotiation and Bargaining -Argumentation among Agents Trust and Reputation in Multi agent systems

UNIT V **9 Hours**

APPLICATIONS

AI applications Language Models Information Retrieval Information Extraction Natural Language

Processing Machine Translation Robot Hardware Perception Planning Moving

Total: 45 Hours

Reference(s)

1. Gerhard Weiss, Multi Agent Systems, Second Edition, MIT Press, 2016.
2. Bratko, Prolog: Programming for Artificial Intelligence, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
3. David L. Poole and Alan K. Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2017
4. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, Third Edition, 2010
5. PSO1: Tim Jones, Artificial Intelligence: A Systems Approach(Computer Science), Jones and Bartlett Publishers, Inc.; First Edition, 2009
6. https://nptel.ac.in/courses/106105079

21MC022 DEEP LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- To impart basic knowledge of vision system and its process
- To acquire knowledge on image processing techniques
- To characterize and analyze the image using computational techniques.
- To implement and validate the various vision algorithms for object detections.
- To utilize the vision system for robotics applications

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long Learning: 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.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. To understand the concepts of vision system and its operations

2. To infer the concepts of image capturing and processing techniques.
3. To understand the concept for characterizing and analyzing the features in image
4. To apply a suitable vision algorithm to recognize the object.
5. To implement computer vision systems with emphasis on applications and problem solving

Articulation Matrix

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

UNIT I **9 Hours**

FUNDAMENTALS OF VISION SYSTEM

Introduction to Vision system- Need of vision system, Applications image acquisition illumination techniques Sensor Point, line, planar camera sensor and its characteristics camera calibration sampling and quantization image acquisition hardware

UNIT II **9 Hours**

IMAGE PROCESSING

Segmentation Point operation Neighborhood operation Geometric operations Mathematical morphology Shape and Pattern analysis Image filtering Image convolution Region growing Boundary detection Regionsplitting and merging

UNIT III **9 Hours**

IMAGE ANALYSIS

Inspection location and identification Template matching Decision-theoretic approaches Thresholding Hough transform Histogram analysis Image representation Image display Image Reconstruction Region of Interest template matching stereo reconstruction - color space conversion

UNIT IV **9 Hours**

MACHINE VISION ALGORITHMS

Images and regions Image enhancement image transformations Color detection contour detection line detection circle detection corner detection Edge detection Feature Detection Filters, SIFT, HOG.

UNIT V **9 Hours**

ROBOT VISION APPLICATION

Basic introduction to Robotic operating System (ROS) Real and Simulated Robots Introduction to OpenCV, OpenNI and PCL, ROS to OpenCV Line following - tracking object using optical flow camshaft and meanshift.

Reference(s)

Total: 45 Hours

1. Ramesh Jain, Rangachar Kasturi, Brian G. Schunck,Machine Vision McGraw-Hill, Inc., ISBN 0-07-032018-7, 1995.

2. Muthukumaran Malarvel, Soumya Ranjan Nayak, Surya Narayan Panda, Prasant Kumar Pattnaik Nittaya Muangnak, Machine Vision Inspection Systems: Image Processing, Concepts, Methodologies and Applications Volume 1, Scrivener Publishing LLC, 2020.

3. E. R. Davies, Machine Vision Theory, Algorithms, Practicalities Elsevier Publication, 3rd Edition - December 22, 2004

4. R.Patrick Goebel ROS by Example: A Do It Yourself Guide to Robot Operating System Volume I A Pi Robot Production, 2012

21MC023 SOFT COMPUTING 3 0 0 3

Course Objectives

- To provide an overview of soft computing techniques
- To provide a strong foundation of neural networks
- To introduce the applications of Fuzzy and Genetic algorithm.

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Conduct Investigations of Complex Problems: 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.
PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communication: 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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12. Life-long Learning: 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.
PSO1: Analyze, design and develop electro mechanical system using contemporary tools
PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Understand the various types of neural networks.
2. Interpret the pattern association algorithm in soft computing

3. Interpretthe ART and neural networks.
4. Demonstrate the use of fuzzy logic concepts in soft computing
5. Apply genetic algorithm in real time problems

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO NEURAL NETWORKS

Differences between Biological and Artificial Neural Networks Typical Architecture, Common Activation Functions, McCulloch Pitts Neuron, Linear Separability - Hebb Net, Perceptron, Adaline, Madaline Architecture, algorithm, and Simple Applications.

UNIT II **9 Hours**

PATTERN ASSOCIATION

Training Algorithms for Pattern Association Hebb rule and Delta rule, Hetero associative Auto associative and Iterative Auto associative Net, Bidirectional Associative Memory Architecture Algorithms.

UNIT III **9 Hours**

ADAPTIVE RESONANCE AND BACKPROPAGATION NEURAL NETWORKS

ART1 and ART2 - Basic Operation and Algorithm, derivation of earning Rules, Boltzmann Machine Learning - Architecture, Algorithm and Simple Applications.

UNIT IV **9 Hours**

CLASSICAL, FUZZY SETS AND RELATIONS

Properties and Operations on Classical and Fuzzy Sets, Crisp and Fuzzy Relations - Cardinality, Properties and Operations, Composition, Tolerance and Equivalence Relations - Simple Applications.

UNIT V **9 Hours**

GENETIC ALGORITHM

Working principles, Coding, fitness function, GA operators, Differences and similarities between GAs and traditional methods, GAs for constrained optimization, Real-coded Gas - Simple Applications.

Total: 45 Hours

Reference(s)

1. S.N.Sivanandam and S.N.Deepa, Principles of Soft Computing, Wiley India(P) Ltd,2011
2. Timothy J.Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 2011

3. Davis E.Goldberg, Genetic Algorithms: Search, Optimization and Machine Learning, Addison Wesley, N.Y., 1989

4. Jang.J.S.R., Sun.C.T.andMizutami.E, Neuro fuzzy and Soft computing, Prentice Hall, New Jersey 2015

21MC024 OPTIMIZATION TECHNIQUES 3 0 0 3

Course Objectives

- To provide students the knowledge of optimization techniques and approaches. Formulate a real-world problem as a mathematical model and finding solutions
- To enable the students to learn about revised simplex method and sensitivity analysis of LPP.
- To solve networking problems like transportation, Assignment, Maximal flow , Minimum spanning tree and shortest path problems.
- To learn about Decision making under uncertainty and certainty conditions.
- To learn various Queuing models.

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1: Design, analyze and develop automation solutions for complex problems in divers e sectors using

modern tools.
PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Formulate design optimization problem from real world applications.
2. Compute the solution for single variable unconstrained optimization problems
3. Design the solution for multivariable unconstrained optimization problems
4. Compute the solution for the constrained non-linear optimization problems
5. Apply non-traditional optimization techniques to solve engineering problems

Articulation Matrix

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

UNIT I **9 Hours**

LINEAR PROGRAMMING

Introduction to Operations Research assumptions of Linear Programming Problems Formulations of linear programming problem Graphical method. Solutions to LPP using simplex algorithm Two phase method Big M method

UNIT II **9 Hours**

ADVANCES IN LINEAR PROGRAMMING

Revised simplex method primal dual relationships Dual simplex algorithm Sensitivity analysis changes in RHS value changes in Coefficient of constraint Adding new constraint Adding new variable.

UNIT III **9 Hours**

NETWORK ANALYSIS

Transportation problems Northwest corner rule Least cost method Vogels approximation method stepping stone method MODI method Unbalanced transportation Assignment problem Hungarian algorithm Travelling salesman problem project management. Minimum spanning tree problem: prims algorithm, Kruskals algorithm Shortest path problem: Dijkstras algorithms, Floyds algorithm maximal flow problem : Maximal-flow minimum-cut theorem Maximal flow algorithm.

UNIT IV **9 Hours**

DECISION AND GAME THEORY

Decision making under certainty Decision making under risk Decision making under uncertainty Decision tree analysis Introduction to MCDM AHP. Game Theory Two person zero sum games, pure and mixed strategies Theory of dominance Graphical Solution Solving by LP.

UNIT V **9 Hours**

QUEUING THEORY

Queuing theory terminology Single server, multi server limited and unlimited queue capacity limited and unlimited population.

Total: 45 Hours

Reference(s)

1. Philips, Ravindran and Solberg, Operations Research principles and practices, John Wiley, 2007.
2. Ronald L Rardin, Optimisation in Operations Research, Pearson, 2018.
3. Srinivasan.. G, Operations Research Principles and Applications, PHI, 2017.

21MC025 MEDICAL MECHATRONICS 3 0 0 3

Course Objectives

- To recall the human physiological system associated with biological signal acquisition using ECG, EEG, EMG and EOG machines
- To represent the principle function and working of different sensor, transducers, and electronics interfaces such as signal conditioning, recording system related to biomedical field
- To illustrate the functional blocks and operation of some advanced patient monitoring and diagnostic instruments

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long Learning: 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.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with

mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Analyze the biological behavior of human cell and relate the resting and action potential associated with the principle of ECG, EEG, EMG and EOG Machines
2. Compare the features of different types of biomedical sensors and transducers
3. Compare the signal conditioning, recording and display systems associated with the biomedical devices.
4. Demonstrate the working of different biomedical patient measurement and monitoring systems
5. Assess the need for various diagnostic instruments used in biomedical instrumentation

Articulation Matrix

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

UNIT I **10 Hours**

INTRODUCTION

Cell structure - electrode - electrolyte interface, electrode potential, resting and action potential - electrodes for their measurement, ECG, EEG, EMG and EOG - - machine description methods of measurement, failures and troubleshooting, Stem cells

UNIT II **9 Hours**

BIO MEDICAL SENSORS AND TRANSDUCERS

Basic transducer principles, Introduction - resistive, inductive, capacitive related to health care, fiber-optic, photoelectric, chemical, active and passive transducers and their description and feature applicable for biomedical instrumentation, Bio, Nano sensors and application, smart sensors

UNIT III **9 Hours**

MONITORING SYSTEMS AND SIGNAL CONDITIONING

instrument power supply, Input isolation, introduction amplifiers, Arrhythmia and Ambulatory Monitoring Instruments, Foetal Monitoring Instruments, Oximeters, Pulmonary Function Analysers, Clinical Laboratory Instruments, basis of signal conversion and digital filtering, data reduction technique time and frequency domain technique.

UNIT IV **9 Hours**

MEDICAL MEASUREMENT AND HEALTH ASSIST SYSTEMS

Blood pressure measurement: by ultrasonic method plethysonography - blood flow measurement by electromagnetic flow meter, cardiac output measurement by dilution method phonocardiography - vector cardiography. Heart lung machine artificial ventilator - Anesthetic machine - Basic ideas of CT scanner - MRI and ultrasonic scanner - cardiac pacemaker defibrillator patient safety - electrical shock hazards Centralized patient monitoring system

UNIT V **9 Hours**

RECORDERS AND ADVANCED SYSTEMS

Oscillagraphic - galvanometric - thermal array recorder, photographic recorder, storage oscilloscopes, electron microscope. Biotelemetry, Diathermy, Audiometers, Dialyzers, Lithotripsy. FOR FURTHER READING Equipment failures and troubleshooting - ECG Analysis Centralized patent monitoring system -Biotelemetry - Bio, Nano sensors and application.

Total: 46 Hours

Reference(s)

1. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2011.
2. Cromwell, Weibell and Pfeiffer, Biomedical Instrumentation and Measurements, Prentice Hall of India Learning. Ltd., New Delhi, 2011
3. L. A. Geddes and Baker, L.E., Principles of Applied Bio-medical Instrumentation, John Wiley and Sons Publishing Company, New York, 1995
4. W. J. Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India Learning. Ltd., New Delhi, 2000.
5. Myer Kutz, Standard Handbook of Biomedical Engineering and Design, McGraw Hill Publisher, 2003

21MC026 VIRTUAL INSTRUMENTATION 3 0 0 3

Course Objectives

- To understand the fundamentals of virtual instrumentation, and basic concept of Graphical programming with their functions in LabVIEW.
- To know the various types Interfaces and Protocol used in VI
- To describe the components of typical DAQ and various tools in VI with their application

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Compare virtual instrumentation with conventional methods to optimize measurement for monitoring industrial processes
2. Make use of the concept of graphical programming and LabVIEW for data acquisition systems in research and development projects.
3. Experiment with the different types of protocols used in VI to integrate sensors, actuators, and control systems in automated industrial applications.
4. Analyze the interface requirements in data acquisition systems for accurate monitoring and control of research applications.
5. Examine the virtual instrumentation (VI) tools in measurements to implement real-time monitoring for testing and analysis in automotive environments.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO VI

Historical perspective and Traditional bench-top instruments General functional description of a digital instrument Block diagram of a Virtual Instrument Physical quantities and analog interfaces Hardware and Software Advantages of Virtual Instruments over conventional instruments Architecture of a Virtual Instrument and its relation to the operating system

UNIT II **9 Hours**

GRAPHICAL PROGRAMMING

Concepts of graphical programming LabVIEW software Concept of VIs and sub VI Error Handling Techniques Display types Digital Analog Chart and Graphs. Timers and dialog controls Loops structures Arrays Clusters. Local and global variables String and file I/O. State Machine Architecture Design pattern Producer Consumer pattern Master Slave pattern

UNIT III **9 Hours**

INSTRUMENT INTERFACES AND PROTOCOLS

RS232, RS422, RS485 and USB standards IEEE 488 standard Introduction to bus protocols of MOD bus and CAN bus. Electronic standards for signals noise and EMI effects. Signal conditioning chassis and extension modules. Image acquisition cards and Motion Controllers

UNIT IV **9 Hours**

DATA ACQUISITION SYSTEM

Introduction to data acquisition on PC, Sampling fundamentals. Concepts of Data Acquisition and terminology Installing Hardware and drivers Configuring and addressing the hardware Digital and Analog I/O function Real time Data Acquisition USB based DAQ. Common Instrument Interfaces Current loop RS 232C RS485 and Bus Interfaces.

UNIT V **9 Hours**

VI TOOLS

Mathematical tools for statistical calculation Signal processing tools Fourier transforms, power spectrum Windowing and filtering tools - Control system tools PID controller Applications. CRO function generator Illustration and case study Temperature controller.

Total: 45 Hours

Reference(s)

1. Jeffrey Travis, Jim Kring, LabVIEW for Everyone: Graphical Programming Made Easy and Fun (3rd Edition), Prentice Hall, 2012
2. Sanjeev Gupta, Virtual Instrumentation using LabVIEW, TMH, 2013
3. Gary W. Johnson, Richard Jennings, Lab-view Graphical Programming, McGraw Hill Professional Publishing, 2011
4. Robert H. Bishop, Learning with Lab-view, Prentice Hall, 2013
5. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newness, 2010
6. https://nptel.ac.in/courses/108105062/10

21MC027 INDUSTRIAL DRIVES AND CONTROL 3 0 0 3

Course Objectives

- To understand the working principle and performance characteristics of 3-Phase Induction motor
- To determine the operation, characteristics and performance parameters of converters
- To describe feedback control and basic components of control drive system

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long Learning: 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.

PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Analyze and compare various types of drive systems with different gear arrangements to determine their efficiency, performance, and suitability for specific applications.
2. Evaluate the operational principles of synchronous and asynchronous machines, identifying key differences, performance characteristics, and their impact on industrial applications.
3. Examine the characteristics of inverters and advanced control techniques to optimize performance in power electronics and motor drive applications.
4. Investigate various frequency patterns and control modes, assessing their impact on dynamic performance and stability in industrial automation.
5. Design and develop integrated positioning programming for diverse applications, ensuring precision, adaptability, and efficiency in real-time motion control systems

Articulation Matrix

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

UNIT I **8 Hours**

BASICS OF DRIVE SYSTEM AND GEARS

Drive system introduction, Comparison of drives Characteristic curves, Gears introduction, Gears sizes and Gear ratio, various types.

UNIT II **10 Hours**

BASICS OF ASYNCHRONOUS

Design and theory of operation Motor, poles Construction Enclosure Torque Vs Speed characteristics curve, Brakes Brake rectifiers, Encoder theory of operation, various types.

UNIT III **10 Hours**

TERNS BASICS OF FREQUENCY INVERTERS

Block diagram Components of inverter Brake chopper 4 quadrant operation accessories of invertors Energy recovery, Electromagnetic compatibility (EMC) affects, short Radio Frequency (RF) device, various communication types

UNIT IV **9 Hours**

FREQUENCY PATTERNS

Introduction to the voltage/ frequency (V/F) characteristic curve- 50 Hz pattern, 70 Hz pattern, 87 Hz pattern Open loop control modes variable frequency drive (VFC) closed loop control modes, introduction to field oriented control (FOC).

UNIT V **8 Hours**

IPOS PROGRAMMING, PARAMETER SET

Basics of IPOS programming commands, Sample programs, Touch probe, Compiler specific information, Various parameter sets, Various fault codes & its description

Total: 45 Hours

Reference(s)

1. Muhammad H. Rashid, Power Electronics - Circuits, Devices and Applications, Prentice Hall of India Learning. Ltd., New Delhi, 2013
2. G. K. Dubey, Fundamentals of Electrical Drives, Wiley Eastern Ltd., New Delhi, 2010
3. D.P.Kothari and J.J.Nagrath, Electric Machines, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2010
4. J.Nagrath and PSO1: Gopal, Control System Engineering, New Age International Publisher, New Delhi, 2017
5. SEW Study materials, practical workbooks

21MC028 CONTROL SYSTEM AND DRIVES FOR ELECTRIC VEHICLES 3 0 0 3

Course Objectives

- To impart knowledge in electric vehicles.
- To understand the control system of electric vehicles

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long Learning: 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.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Analyze the need for electric vehicles based on energy efficiency, environmental impact, and

technological advancements.

2. Compare battery technologies in terms of performance, energy density, lifespan, and cost.
3. Develop control strategies for electric drive units to improve efficiency and performance.
4. Examine control methods in electric vehicle design to enhance stability and safety.
5. Analyze power converter topologies for effective power management in electric vehicles.

Articulation Matrix

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

UNIT I **9 Hours**

ELECTRIC VEHICLES

Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption Concept of Electric Drive Trains, Architecture of Electric Drive Trains.

UNIT II **9 Hours**

ENERGY STORAGE FOR EV

Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basicvprinciple and operation, Types of Fuel Cells, proton exchange membrane fuel cell (PEMFC) and its operation, Modelling of PEMFC, Super Capacitors

UNIT III **9 Hours**

ELECTRIC DRIVES

EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives

UNIT IV **9 Hours**

DESIGN OF ELECTRIC VEHICLES

Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of battery, design of electric motor drive capacity, transmission design, energy storage design.

UNIT V **9 Hours**

POWER ELECTRONIC CONVERTER FOR BATTERY CHARGING

Charging methods for battery, Termination methods, charging from grid, The Z-converter, Isolated bidirectional DC-DC converter, Design of Zconverter for battery charging, High-frequency transformer based isolated charger topology, Transformer less topology

Total: 45 Hours

Reference(s)

1. PSO1: Ehsani, Y. Gao, S. Gay and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 2015
2. Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in HybridElectric Vehicles, Springer, 2018
3. C.C. Chan and K.T. Chau, Modern Electric Vehicle Technology, OXFORDUniversity Press, 20161.
4. Chris Mi, PSO1: AbulMasrur, David WenzhongGao, Hybrid Electric Vehicles Principles And Applications With Practical Perspectives, Wiley Publication, 2018

21MC029 PROCESS CONTROL 3 0 0 3

Course Objectives

- To analyze mathematical models for first-order and higher-order real-time systems and evaluate the concept of self-regulation.
- To evaluate the characteristics of various controller modes and implement suitable controller tuning methods.
- To apply appropriate control schemes to optimize performance in various industrial applications.

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Conduct Investigations of Complex Problems: 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.
PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12. Life-long Learning: 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.
PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Develop mathematical models for first-order and higher-order real-time systems.
2. Analyze the characteristics of various control modes and evaluate different control schemes.
3. Evaluate and compare various controller tuning methods to optimize control system performance.

4. Assess the construction, characteristics, and applications of different types of actuators.
5. Apply process control techniques to solve real-world industrial challenges.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Introduction to Process Control and Automation Elements of Feedback Control Introduction to Process Modeling-Stability and Performance Analysis Open loop Stability and Performance Analysis: Closed loop

UNIT II **9 Hours**

CONTROLLER CHARACTERISTICS

Basic control actions characteristics of On-Off, proportional, integral , derivative control modes and composite control modes: P+I, P+D and P+I+D control modes - selection of control mode for different processes - typical control schemes for level, flow, pressure and temperature processes.

UNIT III **9 Hours**

TUNING OF CONTROLLERS AND MULTI-LOOP CONTROL

Optimum controller settings Evaluation criteria-IAE, ISE and ITAE decay ratio Tuning of controllers by process reaction curve method, damped oscillation method, Ziegler-Nichols tuning Feed forward control ratio control, cascaded control, averaging control, inferential and split range control.

UNIT IV **9 Hours**

FINAL CONTROL ELEMENT

Pneumatic and electric actuators valve positioner control valve, characteristics of control valves- type of valves: globe, butterfly, diaphragm, ball valves control valve sizing cavitation and flashing in control valves. Response of control valves, electric and electro pneumatic valves. Selection of control valves

UNIT V **9 Hours**

SELECTED UNIT OPERATIONS

Case study: control of CSTR, control of heat exchanger, Steam boiler: drum level control and combustion control. Distillation column control of top and bottom product compositions reflux ratio

Total: 45 Hours

Reference(s)

1. George Stephanopoulos, Chemical Process Control, Prentice Hall of India learning Pvt. Ltd., New Delhi, 2012
2. B. Wayne Bequette, Process Control: modeling, design, and simulation, Prentice Hall of India Learning Pvt.Ltd., New Delhi, 2008
3. Donald P. Eckman, Automatic Process Control, Wiley-India Pvt. Ltd., New Delhi, 200
4. Dale E. Seborg, D. A. Mellichamp and Thomas F Edgar, Process Dynamics and Control, Wiley-India, 2010
5. Peter Harriott, Process Control, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2008
6. Hill PublishingCo. Ltd., New Delhi, 2008

21MC030 ADVANCED INDUSTRIAL AUTOMATION 3 0 0 3

Course Objectives

- To understand the various automation hardware for the given application.
- To review various control aspects of automation
- To obtain knowledge about capability of Industrial Automation

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Conduct Investigations of Complex Problems: 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.
PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO11. Project Management and Finance: 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.
PO12. Life-long Learning: 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.
PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

Course Outcomes (COs)

1. Analyze automation principles, strategies, and transfer mechanisms to determine suitable automation solutions for industrial applications.
2. Evaluate material handling and identification technologies to optimize efficiency in manufacturing and logistics.
3. Assess automated manufacturing systems, including GT, FMS, and cellular manufacturing, for improved production planning and implementation.
4. Apply industrial control technologies to develop automation strategies for discrete and process industries.
5. Construct mathematical models and simulations for plant automation using modern tools, with applications in cement, thermal, water treatment, and steel industries.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Automation in Production System - Principles and Strategies of Automation - Basic Elements of an Automated System - Advanced Automation Functions - Levels of Automations - Flow lines & Transfer Mechanisms - Fundamentals of Transfer Lines.

UNIT II **9 Hours**

MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES

Overview of Material Handling Systems - Principles and Design Consideration - Material Transport Systems - Storage Systems Overview of Automatic Identification Methods.

UNIT III **10 Hours**

AUTOMATED MANUFACTURING SYSTEMS

Components - Classification and Overview of Manufacturing Systems - Manufacturing Cells - GT and Cellular Manufacturing FMS - FMS and its Planning and Implementation. Quality Control Systems: Traditional and Modern Quality Control Methods - SPC Tools - Inspection Principles and Practices - Inspection Technologies.

UNIT IV **9 Hours**

CONTROL TECHNOLOGIES IN AUTOMATION

Industrial Control Systems - Process Industries Versus Discrete-Manufacturing Industries - Continuous Versus Discrete Control - Computer Process and its Forms

UNIT V **8 Hours**

MODELING AND SIMULATION FOR PLANT AUTOMATION

Introduction - need for system Modeling - Building Mathematical Model of a Plant, Modern Tools & Future Perspective. Industrial Control Applications: Cement Thermal Water Treatment & Steel Plants. SLE: Case Studies minimum one for Cement - Thermal - Water Treatment & Steel Plants applications

Total: 45 Hours

Reference(s)

1. Krishna Kant, Computer Based Industrial Control, PHI, 2nd edition, 2011

2. M.P.Groover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education.5th edition, 2009.

3. Tiess Chiu Chang Richard A. Wysk, An Introduction to Automated Process Planning

Systems, Longman Higher Education, 2015

4. Viswanandham, Performance Modeling of Automated Manufacturing Systems, PHI, 1st edition, 2009.

21MC031 IOT PROTOCOLS AND INDUSTRIAL SENSORS 3 0 0 3

Course Objectives

- To analyze the fundamental principles, architectures, and design methodologies of IoT systems.
- To evaluate IoT communication protocols across different network layers for reliable data exchange.
- To integrate advanced sensor technologies into real-time industrial and smart applications.

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: 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.

PO11. Project Management and Finance: 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.

PO12. Life-long Learning: 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.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Apply IoT architecture, physical and logical design principles, and enabling technologies.
2. Evaluate the working principles and functionalities of IoT communication protocols.
3. Analyze transport and application layer protocols for IoT-based systems.
4. Integrate various sensors into automotive and mechatronics applications.
5. Assess the working principles, characteristics, and applications of force, magnetic, and heading sensors.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO IOT

Architectural Overview- IoT applications- Sensing - Actuations -Basics of Networking - M2M and IoT Technology fundamentals - Devices and gateways - Design of Internet of Things: Physical Design of IoT, Logical Design of IoT - IoT Enabling Technologies.

UNIT II **9 Hours**

IOT COMMUNICATION PROTOCOLS

IoT Data Link Layer & Network Layer Protocols, PHY/MAC Layer -3GPP MTC, IEEE 802.11, IEEE 802.15 - Wireless HART, ZWave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - NetworkLayer-IPv4, IPv6, 6LoWPAN.

UNIT III **9 Hours**

TRANSPORT

Transport Layer Protocols-Application Protocols for IoT: UPnP, CoAP, MQTT, XMPP, SCADA, Authentication Protocols; IEEE 802.15.4, REST and Websocket.

UNIT IV **9 Hours**

MOTION, PROXIMITY AND RANGING SENSORS

Motion Sensors - Potentiometers, Resolver, Encoders - Optical, Magnetic, Inductive, Capacitive, LVDT, RVDT

- Synchro, Microsyn, Accelerometer, GPS, Bluetooth, Range Sensors - RF beacons, Ultrasonic Ranging, Reflective beacons.

UNIT V **9 Hours**

CASE STUDIES/INDUSTRIAL APPLICATIONS

IoT applications in home appliances, infrastructures, buildings, security, Industries 4.0

Total: 45 Hours

Reference(s)

1. Vijay Madisetti, Arshdeep Bahga, Internet of Things, A Hands on Approach, University Press.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.
3. Peter Waher, Learning Internet of Things, Packt Publishing, UK, 2015.
4. Adrian McEwen, Hakim Classically, Designing the Internet of Things, Wiley Publishing, 2015.
5. Dieter Uckelmann, Mark Harrison and Florian Michahelles, Architecting the Internet of Things,Springer, NewYork, 2011.

21MC032 IOT PROCESSORS **3 0 0 3**

Course Objectives

- To learn embedded system architecture with its application software.
- To understand ARM and cortex-m3 Architecture
- To learn about various Cortex exception handling and interrupts
- To build simple cortex-m3/m4 programming.
- To understand cortex-m3/m4 development and debugging tools

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Conduct Investigations of Complex Problems: Use research-based knowledge and researchmethods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Describe the embedded system architecture with its application software.
2. Analyze ARM and cortex-M3 architecture and bus
3. Analysis cortex exception handling and interrupts
4. Apply concept of Cortex-M3/M4 Programming for a simple application
5. Analyze Cortex-M3/M4 Development and Debugging Tools.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO EMBEDDED CONCEPTS

Introduction to embedded systems, Application Areas, Categories of embedded systems, Overview of embedded system architecture, Specialties of embedded systems,recent trends in embedded systems. Hardware architecture,Software architecture.

UNIT II **9 Hours**

OVERVIEW OF ARM AND CORTEX M3

Background of ARM Architecture, Processor Naming, Instruction Set Development, Thumb-2 and Instruction Set Architecture.Cortex-M3 Instruction Sets.Cortex-M3 Implementation Overview. Pipeline,Block Diagram, Bus. Interfaces on Cortex-M3,I-Code Bus,D Code Bus,System Bus.

UNIT III **9 Hours**

CORTEX EXCEPTION HANDLING AND INTERRUPTS

Exceptions:Exception Types,Priority,Vector Tables,Interrupt Inputs and Pending Behavior,Fault Exceptions,NVIC:Nested Vectored Interrupt Controller Overview,Basic Interrupt Configuration,Software Interrupts,Interrupt/Exception Sequences.

UNIT IV **9 Hours**

CORTEXM3/M4 PROGRAMMING

Cortex M3/ M4 Programming: Overview, Typical Development Flow,Using C,CMSIS (Cortex Microcontroller Software Interface Standard). Exception Programming: Using Interrupts, Exception Interrupts, Exception/Interrupt Handlers. Memory Protection Unit, MPU Registers, Setting Up the MPU

UNIT V **9 Hours**

CORTEXM3/M4 DEVELOPMENT AND DEBUGGING TOOLS

STM32L15xxx ARM Cortex M3/M4 Microcontroller: Memory and Bus Architecture, Power Control.STM32L15xxx, Peripherals: GPIOs, System Configuration Controller, Comparators USART. Development and Debugging Tools: Software and Hardware tools like Cross Assembler, Compiler, Debugger.

Total: 45 Hours

Reference(s)

1. Joseph Yiu,The Definitive Guide to the ARM Cortex-M3,Second Edition,Elsevier Inc.2010.
2. Andrew N Sloss,Dominic Symes,Chris Wright,ARM System Developers Guide Designing and Optimizing System Software,Elsevier Publications,2006
3. Steve Furber,ARM System-on-Chip Architecture,2nd Edition, Pearson Education,India ISBN:9788131708408,8131708403,2015
4. Dr.K.V.K.Prasad,Embedded/Real Time Systems:Concepts,Design and Programming Black Book,New edition (MISL-DT) Paperback 12 Nov 2003
5. David Seal ARM Architecture Reference Manual Addison Wesley England Morgan Kaufmann Publishers 2001

21MC033 IOT SYSTEM DESIGN 3 0 0 3

Course Objectives

- To learn how to design and implement IoT applications that manage big data, streaming data,and/or distributed data.
- To understand Smart Objects and IoT Architectures.
- To learn about various IOT-related protocols.
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT.
- To develop IoT infrastructure for popular applications.

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Conduct Investigations of Complex Problems: Use research-based knowledge and researchmethods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1: Analyze, design and develop electro mechanical system using contemporary tools
PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Describe the term IoT in different contexts.
2. Analyze various protocols for IoT.
3. Design a PoC of an IoT system using Rasperry Pi/Arduino.
4. Apply data analytics and use cloud offerings related to IoT.
5. Analyze applications of IoT in real time scenario.

Articulation Matrix

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

2	2	3	2		2								2	
3	2	3	2		2								3	2
4	2	2	2		2								3	2
5	2	1		3									3	2

UNIT I **9 Hours**

FUNDAMENTALS OF IOT

Evolution of Internet of Things, Enabling Technologies, IoT Architectures: Simplified IoT Architecture and Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Sensors, Actuators, Smart Objects and Connecting Smart Objects.

UNIT II **9 Hours**

IOT PROTOCOLS

IoT Access Technologies: IEEE 802.15.4, 802.15.4e, Zigbee protocol, IP versions, CoAP and MQTT.Modern databases: No SQL, New SQL, MongoDb.

UNIT III **9 Hours**

DESIGN AND DEVELOPMENT

Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks, Arduino Board details, IDE programming, Raspberry Pi and Interfaces.

UNIT IV **9 Hours**

DATA ANALYTICS AND SUPPORTING SERVICES

Role of Machine Learning: Hadoop Ecosystem, Edge Streaming Analytics and Network Analytics, Google Spreadsheet for IoT & Analytics, ThingSpeak and Firebase, Cloud for IoT, Python Web Application Framework.

UNIT V **9 Hours**

CASE STUDIES/INDUSTRIAL APPLICATIONS

Cisco IoT system, IBM Watson IoT platform, Power Utility in Industry, Smart and Connected Cities: Smart Lighting, Smart Parking Architecture and Smart Traffic Control.

Total: 45 Hours

Reference(s)

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.

2. Arshdeep Bahga, Vijay Madisetti, Internet of Things - A hands-on approach, Universities Press,2015

3. Olivier Hersent, David Boswarthick, Omar Elloumi , The Internet of Things Key applications and Protocols, Wiley, 2012

4. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand, DavidBoyle, From Machine-to-Machine to the Internet of Things Introduction to a New Age of Intelligence, Elsevier, 2014.

5. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), Architecting the

Internet of Things, Springer, 2011.

6. Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects,2nd Edition, O Reilly Media, 2011.

21MC034 WIRELESS SENSOR NETWORK DESIGN 3 0 0 3

Course Objectives

- To understand the fundamentals of wireless sensor networks and its application to critical realtime scenarios
- To familiarize with learning of the Architecture of WSN
- To understand the concepts of Networking and Networking in WSN
- To study the design consideration of topology control and solution to the various problems.
- To introduce the hardware and software platforms and tool in WSN.

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Conduct Investigations of Complex Problems: Use research-based knowledge and researchmethods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1: Analyze, design and develop electro mechanical system using contemporary tools

Course Outcomes (COs)

1. Understand basics and technologies for wireless networks
2. Analyze and compare various architectures of Wireless Sensor Networks
3. Understand Design issues and challenges in wireless sensor networks
4. Establishing infrastructure and simulations
5. Explain the concept of programming the in WSN environment

Articulation Matrix

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

2	2	3	2	2	2								2	
3	2	3	2		2								2	
4	2	2	2	2	2								2	
5	2	1		3									2	

UNIT I **10 Hours**

OVERVIEW OF WIRELESS SENSOR NETWORKS

Introduction: Fundamentals of wireless communication technology, SingleNode Architecture, Network Characteristics, characteristics of wireless channels, modulation techniques, Types of wireless sensor networks.

UNIT II **10 Hours**

ARCHITECTURES

Network Architecture, Sensor Networks Scenarios, Design Principle, Physical Layer and Transceiver Design Considerations, Optimization Goals and Figures of Merit, Gateway Concepts, Operating Systems and Execution Environments, Internet to WSN Communication.

UNIT III **9 Hours**

NETWORKING SENSORS

Routing protocols, MAC Protocols for Wireless Sensor Network, Low Duty Cycle Protocols And Wakeup Concept, SMAC IEEE 802.15.4 standar, Wakeup Radio Concepts, Address and Name Management Assignment of MAC Addresses, Routing Protocols Energy Efficient Routing, Geographic Routing.

UNIT IV **8 Hours**

INFRASTRUCTURE ESTABLISHMENT

Topology Control, Clustering Time Synchronization Localization and Positioning Sensor Tasking and Control Real-time traffic support and security protocols.

UNIT V **8 Hours**

SENSOR NETWORK PLATFORMS AND TOOLS

Sensor Node Hardware Berkeley Motes Programming Challenges, Nodelevel software platforms Node level Simulators, StateÃ‚Âcentric programming.

Total: 45 Hours

Reference(s)

1. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks",John Wiley, 2005.
2. Feng Zhao and Leonidas J.Guibas, Wireless Sensor Networks An Information Processing Approach, Elsevier, 2007.
3. Waltenegus Dargie , Christian Poellabauer, Fundamentals of Wireless Sensor Networks Theoryand Practice, John Wiley and Sons Publications, 2011
4. K. Akkaya and PSO1: Younis, A survey of routing protocols in wireless sensor networks, ElsevierAd Hoc Network Journal, Vol. 3, no. 3, pp. 325--349
5. Philip Levis, TinyOS Programming
6. Anna Hac, Wireless Sensor Network Designs, John Wiley & Sons Ltd,

21MC035 INDUSTRIAL IOT AND INDUSTRY 4.0 3 0 0 3

Course Objectives

- To analyze the evolution and significance of Industrial IoT in the context of Industry 4.0.
- To evaluate Industrial IoT reference architectures, business models, and automation frameworks.
- To integrate key enabling technologies and data analytics for smart factory implementations and industrial applications.

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: Use research-based knowledge and researchmethods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. Life-long Learning: 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.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Analyze the evolution of Industry 4.0 and its impact on smart factories and cyber-physical systems.
2. Evaluate industrial automation systems, including networking, sensing, and control processes.
3. Assess industrial IoT reference architectures and business models with key enabling technologies.
4. Analyze industrial IoT data while ensuring security, threat mitigation, and privacy protection.
5. Implement industrial IoT technologies in various sectors through case studies in smart industries.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION AND KEY TECHNOLOGIES

Industrial revolutions. Cyber physical systems and Next generation sensors. On-site key technologiesin Industry 4.0, AR-VR, Big data Analytics, Smart factories and Lean Manufacturing system.

UNIT II **9 Hours**

INDUSTRIAL AUTOMATION AND IOT

Evolution of IT and OT convergence. Industrial sensing, Industrial Processes and Industrial Network. Business models and IIRA Reference architecture of IIOT, Industrial internet Consortium (IIC).

UNIT III **9 Hours**

INDUSTRIAL DATA TRANSMISSION AND COMPUTING

Foundation Fieldbus, Profibus, CC-link, MODBUS, DigitalSTROM, CAN, DeviceNet, ISA 100.11a, Wireless HART, NB-IoT. Edge and Fog Computing solutions. Cloud services.

UNIT IV **9 Hours**

DATA ANALYTICS AND SECURITY

Necessity of Analytics and IIOT Data Analytics. Machine Learning and Data Science applications in Industries. Artificial Intelligence for IIOT, IoT Security- Vulnerabilities, Threat Analysis, Security model for IoT.

UNIT V **9 Hours**

APPLICATIONS OF IIOT

Healthcare Applications, Inventory Management and Quality Control. Case studies in Manufacturing

Industry, Automotive Industry, Mining Industry, Textile Industry.

Total: 45 Hours

Reference(s)

1. Industry 4.0: The Industrial Internet of Things, by Alasdair Gilchrist (Apress), 2017.
2. Industrial Internet of Things: Cybermanufacturing Systems, by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), 2017
3. Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018.
4. Misra, Sudip, Chandana Roy, and Anandarup Mukherjee. Introduction to industrial Internet of Things and industry 4.0. CRC Press, 2021.
5. Ortiz, JesÃƒÂºs HamiltoPSO2: "Industry 4.0: Current status and future trends." (2020).
6. Ustundag, Alp, and Emre CevikcaPSO2: Industry 4.0: managing the digital transformation.Springer, 2017.

21MC036 PYTHON FOR IOT DATA ANALYTICS 3003

Course Objectives

- To understand the basics of nature of data
- To understand basic operation in data analysis using python
- To understand data manipulation using pandas library
- Data visualization using different types of charts
- To understand basic python program for IoT application

Programme Outcomes (POs)

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

PO2. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: 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.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO1: Analyze, design and develop electro mechanical system using contemporary tools

PSO2: Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Analyze the nature of the data processing quantitatively and qualitatively using python
2. Analyze the various data operations performed using NumPy library
3. Analyze the data manipulation process using pandas library in python
4. Apply data visualization techniques to interpret the data with various parameters
5. Construct IoT projects using python and RaspberryPi

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO DATA ANALYSIS AND PYTHON

Data Analysis, Knowledge Domains of the Data Analyst, Understanding the Nature of the Data, The Data Analysis Process, Quantitative and Qualitative, Data Analysis Python and Data Analysis, Installing Python, and writing Python Code, IPython, The IDEs for Python SciPy.

UNIT II **9 Hours**

BASIC OPERATIONS USING PYTHON

The NumPy Library, The NumPy Installation, Basic Operations Indexing, Slicing, and Iterating Conditions Conditions and Boolean Arrays, Shape Manipulation, Array Manipulation, General Concepts, Structured Arrays, Reading and Writing Array Data on Files.

UNIT III **9 Hours**

DATA ANALYSIS

The Python Data Analysis, Library Pandas, Introduction to pandas, Data Structures, operations between data structures, Function application and mapping, Sorting and Ranking, Not a Number data, Reading and Writing data, Reading data in CSV or Text files, Excel files.

UNIT IV **9 Hours**

DATA MANUPULATION

Data Manipulation, Data Preparation, loading, assembling, merging, Concatenating, combining, reshaping, removing, Data Transformation, removing duplicates, mapping, Detecting and filtering outliers, random sampling, String Manipulation, Data Aggregation, Group Iteration, Chain of Transformation, functions on groups

UNIT V **9 Hours**

DATA VISUALIZATION

Matplotlib Installation, pyplot, using the Kwargs, Adding further elements to the chart, Handling Date Values, Line chart, Histogram, Bar Chart, Pie Charts, Advanced charts mplot3d, Multi panel plots, Case study, Meteorological data, Recognizing Handwritten Digits

Total: 45 Hours

Reference(s)

1. Fabio Nelli, Python Data Analytics, APRESS, 2015
2. Gary Smart, Practical Python Programming for IoT, PACKT Publishing, Birmingham, UK,2020
3. Samir Madhavan, Mastering Python for Data Science, PACKT Publishing, Birmingham, UK,2015
4. Peters Morgan, Data Analysis from Scratch with Python, AI Sciences, 2016
5. Charles Bell, MicroPython for the internet of Things, Apress, 2017
6. Agus kurniawan, Micropython for ESP8266 Development workshop, PE PRESS, 2016

18MC0XA COMMUNICATION PROTOCOLS 0 0 0 1

Course Objectives

- To understand the importance of industrial communication protocols and acquire basic knowledge on various industrial communication standards used in automation industries

Programme Outcomes (POs)

PO3. Design/ Development of Solutions: 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.

Course Outcomes (COs)

1. To understand the importance of industrial communication protocols and acquire basic knowledge on various industrial communication standards used in automation industries

Reference(s)

1. Miroslav Popovic, Communication Protocol Engineering, CRC Press, 2006
2. Richard Zurawski, Industrial Communication Technology, CRC Press, 2017

18MC0XB AC/DC DRIVES 1 0 0 1

Course Objectives

- To study the various power electronics devices and their characteristics
- To understand the real time application in AC/DC DRIVES
- To practically study the various AC/DC Drives foe speed control application

Brief Basic Power Electronics (including Thyristors, Power-Transistors & IGBTs). DC Motor Basics (construction, principle of operation, T-N Characteristic etc). DC Drives Basics (Block diagram, 1Q-4Q principle of operation, T-N Curves etc) Selections, Calculations & applications of typical DC drives. Siemens DC Drives (6RA70) - Ratings, Specs, features, options & applications. AC Motor Basics (construction, principle of operation, T-N Characteristic etc). AC Drives Basics (Block diagram, 1Q-4Q principle of operation, T-N Curves etc) Selections, Calculations & applications of typical AC drives. AC Drives (Micromaster-MM4)-Ratings, Specs, features, options
& applications. AC Drives (Master Drive-VC): Ratings, Specs, features, options & applications.

AC Drives (Sinamics-G)-Ratings, Specs, features, options & applications in brief. MEDIUM VOLTAGE (MV Drives & Motors): MV Motor types & Fundamentals (including starting methods, options/features), MV Motor offers from Germany (separately for Induction & Synchronous Motor), MV Converter Basics & types (Voltage, Current Source & Cyclo- converters), Siemens MV Converters (Sinamics GM, Simovert-S and Perfect Harmony), Selection, configuration &
Applications of MV Drive systems

Total: 15 Hours

Reference(s)

1. G. K. Dubey, Fundamentals of Electrical Drives, Wiley Eastern Ltd., New Delhi, 2007.
2. S. K. Pillai, A First Course on Electrical Drives, New Age International Pvt. Ltd., New Delhi, 2012.
3. Vedam Subrahmaniam, Electric Drives (concepts and applications), Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2007

18MC0XC ADVANCED METROLOGY AND QUALITY CONTROL 1 0 0 1

Course Objectives

- Understand and explain the relevance of metrology in industries
- Recapitulate the need of various measuring instruments and the way it supports accuracy
- Examine and provide solution on measurements for a given industrial part/component

Advanced measuring machines, CNC systems, Laser vision, In-process gauging, 3D metrology, metrology softwares, Nano technology instrumentation, stage position metrology, testing and certification services, optical system design, lens design, coating design, precision lens assembly techniques, complex opto mechanical assemblies, contact bonding and other joining technologies. Statistical Methodologies: Graphical methods, Statistical control charts, Regression analysis, Analysis of variance, Sampling and acceptance. Quality and Calibration Techniques : Size and scale, Predictable accuracy, Trace-ability of measurement, Measurement uncertainty, surface texture, roundness. Metrology of machine tools: Alignment and practical tests. Case studies:

Inspection and Validation practices adopted in various industries.

Total: 20 Hours

Reference(s)

1. Kalpakjian, S. and Steven R. Schmid, Manufacturing, Engineering & Technology, Pearson.
2. G. T. Smith, Industrial Metrology, Springer, ISBN: 9781852335076, 2012.
3. D. J. Whitehouse, Hand book of surface and nanometrology, 2nd Edition, CRC Press, ISBN: 9781420082012, 2012.
4. John W. Greve, Frank W. Wilson, Hand book of industrial metrology, PHI Publisher, New Delhi
5. Khare MK, Dimensional Metrology, OXFORD-IBH Publishers

18MC0XD INDUSTRIAL HYDRAULICS 1 0 0 1

Course Objectives

- To study the various standards and principles in hydraulics and pneumatics
- To understand the real time application in hydraulics andpneumatics
- To practically study the various hydraulics and pneumatics components and their manufactures

An Introduction to Hydraulics and its Principles - Hydraulic Fluids: Contamination control and fluid conductors - Cartridge Valves - Proportional and Servo Valves - Pressure switches and Pressure gauges - Measuring equipments: Flow , Temp , Oil level - Sound Dampening devices - Filters and other Tank Accessories - Oil coolers - Hydraulic Symbols - Calculations for designing a Hydraulic Systems - Analyzing the Hydraulic circuits - Basics to be considered while Assembling the Hydraulic systems - Standards for Hydraulics - Trouble shooting in Hydraulic Systems - Maintenancerequirements in Hydraulic Systems - Application and usage of Hydraulics in Industries
- Manufacturers of Hydraulic elements - Manufacturers of Hydraulic Machines - Scope and Future for Hydraulic Industry

Total: 15 Hours

Reference(s)

1. Henry PSO1: Morris and James PSO1: Wiggert., "Applied Hydraulics in Engineering", John Wiley & Sons Publications., New York, 1972.
2. John H. Pippenger, Tyler G. Hicks., "Industrial Hydraulics", Gregg Division McGraw-Hill., New York, 1979
3. Majumdar .S.R., "Oil Hydraulic Systems: Principles and Maintenance"., McGraw-Hill Education, New York 2003

18MC0XE DESIGN AND ASSEMBLY OF ELECTRONICS COMPONENTS IN PCB 1 0 0 1

Course Objectives

- To study various standards and principles related with Electronics Manufacturing Service Industries.
- To understand the process methodologies and safety pre-cautions in EMS industries.
- To acquire practical knowledge about various electronic components, Printed Circuit Boards, assembly of Components, Inspection, Testing and Packing standards.

Introduction to EMS companies Operating Principles of machines in EMS - Electronics component SMT components - THT components other packages. Process methodologies - flowchart for solder paste and SMD glue with through hole component. THT electronics assembly floor: pre-forming cutting placing smaller and bigger components wave soldering fluxing pre heating lead bathing. SMD solder paste process kitting storage screen printing PCB with Solder paste SMD component stuffing or placement pre soldering inspection and correction reflow soldering post soldering inspection rework SMD glue with through hole components - kitting storage screen printing PCB with Solder paste SMD component stuffing or placement pre soldering inspection and correction glue curing glue curing inspection correction through hole stuffing through hole inspection correction wave soldering post soldering inspection and correction cleaning final inspection and correction SMD electronics assembly floor: Kitting stacking of PCBs in PCB loader printing using stencils role of stencils use of glue and solder paste selection criteria pick and place machine - automatic component health monitoring and rejection of defective components introduction to magazines and feeders role of colour in feeders (yellow, red and white) oven reflow ramp stage soak stage TAL stage cleaning materials used in cleaning. Inspection standards in ems need for such standards - IPC standards (Institute for Printed Circuits) -MDA testing automated optical inspection X ray inspection Testing methods and process - functional testing cleanliness testing workmanship standards - IPC A 610 - Packing and shipping anti static packaging Code of conduct - Nature of job for electronics / Mechatronics engineers in EMS companies- skills set expected in EMS industries fromfresh engineering graduates.

Total: 15 Hours

Reference(s)

1. Documents available at http://www.ipc.org - IPC - The global trade association serving the printed board and electronics assembly industries, their customers and suppliers.
2. Handbook - The Course of IPC-A-610 and IPC-J-STD-001 -Standard for Electronics Assemblies from IPC.

3. Handbook In-Plant Training at Electronic Manufacturing Service Industries by Sanjay Technologies, Coimbatore Private Circulation.

18MC0XF CNC SERVICING 1 0 0 1

Course Objectives

- Understand and explain the System Configuration of CNC Machine System
- Analyze the root cause for the machine failures.
- Evaluate and rectify the failures occurred in various Machine Functions
- Generate the safety instructions in handling CNC Machine

Manufacturing CNC Machine Structures, CNC State Display, Configuration Screens- Software, Module, ID Information, Alarm history, Maintenance Information screen, Color and Contrast Setting, Periodic Maintenance Screen,

Hardware Configuration, Connection diagrams, Mounting and De mounting -Connectors, Card and Power supply, DIMM module, PCBs Replacement procedure- Battery, LCD, Fuses.Diagnostic display, Servo Parameter alarm, Machine position, Reference Position, position Deviation, Displacement Detection, Motor temperature.Causes and Remedies for failures Machine position, Reference Position, Manual operation, Automatic operation, Jog Operation, Feed rate, Spindle Speed , LCD Display, Abnormal Servo System.Warnings-Check operation, Replacement, Parameters, Daily Maintenances - Caution, Note, Alarms,
Maintenance Parts, Parameters.

Total: 20 Hours

Reference(s)

1. Daniel D Nelson, The CNC Toolbox: Top Service for Machine Tools, Aero Publishing, 2nd Edition 1999
2. Fanuc Series oi-Model C, Maintenance Manual, Fanuc Series, 2016.
3. B S Pabla and M Adithan, CNC Machines, New age International Publishers, 2005

18MC0XG SMART FACTORY

1 0 0 1

Course Objectives

- Understand and explain the relevance of automation in manufacturing industries
- Summarize the machine to machine communications and how it enables efficiency and accuracy
- Analyze and provide solution on automation for a given industrial problem

Manufacturing Life cycle model, Growth of automation in manufacturing industry, Need for automation, Smart Factory Relevance to manufacturing, Opportunity and Benefits -Concept of machine communication, Fundamentals, Variables and Drivers in Smart Factory, Characteristics,Development of automation industry, Process Flow -Infrastructure needs in Smart Factory, Data parameters, Data Quantum, Data Usage & Flow in Industrial environment, Data Storage, Data Analytics, Feedback mechanism -Conceptualization of Machine Learning, Elements and Drivers,Application of Machine learning in Smart Factory, Predictive Maintenance, Efficiency & Accuracy, Development of machine learning concepts- Digital India Initiatives, Infrastructure needed towards connectivity, Role of Digital India in Smart Factory, Scalability of resources

Total: 15 hours

References

1. Shiyong Wang, Jiafu Wan, Di Li, Chunhua Zhang, Implementing Smart Factory ofIndustrie 4.0: An Outlook, 2016
2. Manojit Bose, SKILLS ARE THE KEY TO UNLOCKING DIGITAL INDIAPOTENTIAL: INDIA INC., 2015

18MC0XH ONLINE WEB MONITORING 1 0 0 1

Course Objectives

- To understand the tools of online web monitoring system

Basic of Computer networks; LAN, WAN; Concept of Internet; Applications of Internet; connecting to internet; What is ISP; Knowing the Internet; Basics of internet connectivity related troubleshooting, World Wide Web;Web Browsing softwares, Search Engines; Understanding URL; Domain name; IP Address using e-governance website

Total: 15 Hours

Reference(s)

1. Holger Karl,Andreas Willig,Protocols And Architectures for Wireless Sensor Networks,John Wiley, 2005
2. Feng Zhao,Leonidas J,J Guibas,Wireless Sensor Networks An Information Processing Approach,Elsevier, 2007

18MC0XI ELECTRONIC ENGINE MANAGEMENT SYSTEM 1 0 0 1

Course Objectives

- To understand the application of sensors in engine management system
- To impart knowledge on automobile engine calibration

Automotive Electronics: current trends in modern automobiles - open & closed loop systemscomponents for electronic engine management systePSO1: Sensors and Actuators: Basic sensor arrangement, Types of sensors O2 sensor, Crank Angle Position sensor, Vehicle speed sensor, Manifold pressure sensor, Intake air temperature sensor,Engine oil temperature sensor, Mass air flow sensor, etc.Types of Actuators Solenoid stepper motor, Ignition coil, Fuel injectors.Introduction to feedback carburetor systems, Throttle body, Single & multi point fuel injection,Electronicignition systems.Engine Calibration: Engine Cranking, Idling & warm up control & cold start, Acceleration anddecelerationand FTP. Open loop and closed loop calibration.

Total: 15 Hours

Reference(s)

1. W.B.Ribbens, Understanding Automotive Electronics, Oxford: Butterworth-HeinemannElsevier Ltd, 2012.
2. E.Chowanietz, Automobile Electronics, SAE International, 1995

18MC0XJ IOT USING RASPBERRY PI 1 0 0 1

Course Objectives

- To understand the concepts of IoT using Raspberry Pi

Introduction to IoT - PYTHON Programming - Accessing Internet - SMTP mail server - Camera Interfacing and its Applications - Creating a project on security - HTML Programming - Interfacing of Analog Sensors - IoT based Location Finder with Map Integration - IoT based Electrical Applications (Demo) - Linking MATLAB and Raspberry Pi

Total: 15 Hours

Reference(s)

1. Simon Monk, Programming the Raspberry Pi: Getting Started with Python, McGraw Hill,2013.

18MC0XK INDUSTRIAL DATA COMMUNICATIONS PROTOCOLS 1 0 0 1

Course Objectives

• To gain fundamental requirements and challenges in Industrial data communication protocols and its response.

Course Outcomes (COs)

On Completions of the course, the students will be able to do

- CO1 Demonstrate the basic network requirements for Industrial automations
- CO2 Infer the data requirements fundamentals and OSI reference models
- CO3 Explain HART and MDOBUS protocols in Industrial automations
- CO4 Infer the FIELDBUS and PROFIBUS for Industrial automations

Contents: **20 Hours**

Introduction to Networks in Industrial Automations-Information flow requirements-network requirements-OSI reference model-IP Classes-Types of High speed ethernet cable's-network topologies. EIA 232 interface standard – EIA 485 interface standard – EIA 422 interface standards -TCP/IP – Bridges Routers – Gateways. HART communication protocol – Communication modes – HART Networks– HART commands – HART applications – MODBUS protocol structure –transmission modes – function codes – troubleshooting. General Fieldbus architecture, basic requirements of Fieldbus standard, Fieldbus topology, Interoperability and Interchangeability. Profibus: Introduction, Profibus protocol stack, Profibus communication model, Communication objects, System operation and Troubleshooting – Foundation fieldbusversus Profibus

References:

1. Bela G. Liptak & Halit Eren, "Instrument Engineers Handbook: Process Software and Digital Networks", 4th Edition, CRS Press, New York.

2. Mackay S., Wright E., Reynders D. & Park J., "Practical Industrial Data Networks: Design, Installation and Troubleshooting", Newnes Publication, Burlington.

3. Jonas Berge, "Field Buses for Process Control: Engineering, Operation, and Maintenance", ISA Press, New York.

18MC0XL PRODUCTION LINE ARCHITECTURE DESIGN AND METHODOLOGY 1 0 0 1

Course Objectives:

On Completions of the course, the students will be able to do

- CO1 to outline the different techniques of work and time study in LEAN
- CO2 Apply appropriate approaches to design of assembly line
- CO3 Understanding and applying the working concept of 8 steps approach to LADM
- CO4 Enable student to design production line layout

Contents: **Total: 20 Hours**

Industrial work-study time-study-background – lean Principles-Industrialization Assembly contribution to PMP – 8 step approach to LADM (Line Architecture Design Methodology) – Specifications-Demand and Capacity-Cmax Calculations-Product and Process- DFA-Assembly Chronology-Late Differentiations -Process Flow-Calculations-work measurement Techniques-Balancing and Elasticity-Process balancing-and MPH- Table and work sheet Calculations-Value Stream Mapping Inventory valuations- -Layout Design-Line flow architecture-Management – Principle of Motion economy-Specific principles in assembly line - Evaluations

Text Book:

- Jeffrey Liker, The Toyota Way, Tata McGraw-Hill, 2004

References:

- James P. Womack, Daniel T. Jones, Lean Thinking, Free press business, 2003.
- Liker, J. K., & Convis, G. L. (2012). The Toyota way to lean leadership. McGraw-Hill.

18MC0XM ROBOT OPERATING SYSTEM 1 0 0 1

- To educate students with a comprehensive understanding of the Robot Operating System (ROS) and its application in the field of robotics, enabling them to develop and deploy robotic systems effectively.

Course Outcomes (COs)

1. Apply Robot Operating System (ROS) as a foundational framework for developing and implementing Artificial Intelligence-based solutions in the field of robotics.
2. Design and deploy Expert System solutions using ROS, leveraging its communication mechanisms, libraries, and tools to address complex problems in robotics.

5 Hours

ROS ESSENTIALS AND ROBOT ENVIRONMENT SETUP

Introduction to ROS1 / ROS2 Topics, Services, Actions, and Nodes, Interacting with the course, simulation environment, Building a software representation of a robot using Unified Robot, Description Format (URDF), Utilizing the ROS parameter server, Adding real-world object representations to the simulation environment

5 Hours

AUTONOMOUS NAVIGATION AND MANIPULATION

Map creation using the GMapping package, Autonomous navigation of a known map using ROS navigation, Motion planning for manipulation tasks, Pick and place behaviors using industrial robots with ROS MoveIt, Applying filters for sensor data to enhance performance

5 Hours

BEHAVIOR TREE AND MOBILE ROBOT NAVIGATION IN ROS2

Creating a behavior tree for mobile robot navigation, Exploring different algorithms for behavior tree implementation, Configuring all behaviors of mobile robot navigation in ROS2.

Total: 15 Hours

Reference(s)

1. Quigley, M., Gerkey, B., & Smart, W. D. (2015). Programming Robots with ROS: A Practical Introduction to the Robot Operating SystePSO1: O'Reilly Media.
2. Pratt, G., & Deeb, A. (2017). Learning ROS for Robotics Programming: Second Edition. Packt Publishing.
3. Quigley, M., Gerkey, B., & Smart, W. D. (2019). Mastering ROS for Robotics Programming: Second EditioPSO2: Packt Publishing.

18MC0XN MODERN UI DESIGN FOR INDUSTRIAL AUTOMATION CONTROLLER USING .NET 1 0 0 1

Course Objectives

- To educate the students with the necessary skills and knowledge to design modern user interfaces (UI) for industrial automation controllers using the .NET framework, enabling them to develop user-friendly and efficient interfaces for industrial control systems.

Course Outcomes (COs)

1. Develop user-friendly and intuitive user interfaces (UI) for industrial automation controllers using the .NET framework, incorporating modern design principles and best practices.
2. Apply effective information visualization techniques and interactive elements in UI design to enhance the usability and efficiency of industrial automation controllers, improving the user experience for operators and technicians.

5 Hours INTRODUCTION TO VISUAL STUDIO, WPF, AND BASIC PROGRAMMING CONCEPTS Visual Studio: Installation and setup, overview of the Community Version, Introduction to WPF (Windows Presentation Foundation) for UI design, Routed events and event handling in WPF, Overview of controls in WPF and their usage, Data binding in WPF for seamless interaction with data sources, Debugging techniques and exception controls in .NET

5 Hours

PROGRAMMING FUNDAMENTALS AND OBJECT-ORIENTED CONCEPTS

C# language basics: Variables, strings, data types, Control structures: Loops (while, switch case, for), conditional statements (if else), Introduction to methods: Creating and using methods, parameters, and method overloading, Classes and objects: Understanding object-oriented programming principles, Members and access modifiers in C# classes, Inheritance and polymorphism concepts in object- oriented programming

5 Hours

INDUSTRIAL COMMUNICATION PROTOCOLS AND HANDS-ON IMPLEMENTATION
Introduction to industrial communication protocol MODBUS, Register address and communication parameters in MODBUS, PLC settings for communication, Hands-on software coding: Creating a UI using C# for industrial automation controller, Implementing communication with a PLC and actuating registers through software coding.

Total: 15 Hours

Reference(s)

1. Tapadiya, P. (2002). .NET Programming: A Practical Guide Using C#. Hewlett-Packard Professional Books.
2. Sharp, J. (2018). Microsoft Visual C# Step by Step. Developer Reference.
3. Schildt, H. (2010). C# 4.0 The Complete Reference.

18MC0XO CLOUD SERVICES AND IOT PLATFORMS 1 0 0 1

Course Objectives

- To educate the students on Internet of Things Based tools using IoT Networking followed in the industry for various IoT based product development.

Course Outcomes (COs)

1. Identify IoT based problems
2. Provide solutions to Smart Factory problems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		2	2											
2			2	2										

3 Hours

IOT SYSTEM COMPONENTS

IoT Devices-IoT Gateways-Cloud Access-Cloud Components- Cross connectivity across IoT system Components-Device to Gateway –Short Range Wireless- Cell Phone as Gateway-Dedicated Wireless Access Point.

3 Hours

GATEWAY TO CLOUD- LONG RANGE CONNECTIVITY

Wired-Cellular-Satellite-WAN-Direct Device to Cloud connectivity IoT Device Power Constraints-Powered and Unpowered Sensors-Power Harvesting-Energy Storage Technologies.

9 Hours

IOT NETWORKING

Networking Architectures-Star-Mesh-Tree Networking Protocols-TCP/IP-6LowPan-RPL-Thread - IoT Devices Application Level Protocols-MQTT-CoAP.IOT with Microsoft AZURE :IoT and Cloud deployment, Azure IoT Hub components, Azure IoT Hub Service API.

Total: 15 Hours

Reference(s)

1. KamleshLakhwani,Hemant Kumar Gianey, Joseph Kofi Wireko, Kamal Kant Hiran, Internet of Things (IoT): Principles, Paradigms and Applications of IoT. India, BPB Publications, 2020.
2. Bharat Bhushan, BhuvanUnhelkar, Lamia Karim, Muhammad FazalIjaz, Sudhir Kumar Sharma, Internet of Things: Frameworks for Enabling and Emerging Technologies. United States, CRC Press, 2022.

18MC0XP DIGITAL TRANSFORMATION TO INDUSTRY 5.0 **1 0 0 1**

Course Objectives

- To educate the students on Industry 4.0based tools using IIOT followed in the industry for various Industry 5.0 based product development.

Course Outcomes (s)

1. Identify Industry 5.0 based problems
2. Provide solutions to Next Generation Industrial Revolution Problems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		2	2											
2			2	2										

Digitalisation and the Networked Economy - Drivers, Enablers, Compelling Forces and Challenges for Industry 5.0 - Comparison of Industry 5.0 Factory and Today's Factory - Trends of Industrial Big Data and Predictive Analytics for Smart Business TransformatioPSO2: Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services - Smart Manufacturing - Smart Devices and Products - Smart Logistics - Smart Cities - Predictive Analytics.- Fourth Revolution – Sustainability assessment of Manufacturing Industry – Lean Production system – Smart and connected business perspective – smart factories – cyber-physical systems – collaboration platforPSO1: HANDS ON MECHATRONICS: Dissection and assembly of consumer appliances, Programmable logic controller (PLC) and Pneumatic circuits, Programmable logic controller for material handling system (conveyor belt), Quanser CUBE servo control design with QUARC real time interface, Sensors and Internet of
things project, MATLAB SIMULINK simulations

Total: 15 Hours

Reference(s)

1. Gilchrist, Alasdair. Industry 4.0: The Industrial Internet of Things. United States, Apress, 2016.

2. Kumar, Kaushik, et al. Industry 4.0: Developments Towards the Fourth Industrial RevolutioPSO2: Germany, Springer Nature Singapore, 2019

18GE0XA ETYMOLOGY 1 0 0 1

Course Objectives

- To increase vocabulary and enhance use, knowledge, and understanding of theEnglishlanguage
- To stimulate an appreciation for the English language, including how it developed, how new wordsenter the language, and how it continues to be dynamic
- To demonstrate the importance of a broad-based vocabulary for effective oral and written communication

Course Outcomes (COs)

1. Examine prefixes, roots, and suffixes of Latin, Greek, Germanic, and Anglo-Saxon origin.
2. Explore the historical aspects of language, including the infusion of Indo-European languages, semantic changes, and the influence of world events

7 Hours

CONVENTIO NS

Acronyms, Abbreviations, Initialises, Jargon Neologisms - Idiomatic Expressions, Euphemisms Spoonerisms Malapropisms ; Mondegreens - Words Derived from Latin - Words Derived from Greek Words Derived from - Germanic/Anglo-Saxon - Abstract word Acronym - Affix Analogy Antonym Apheresis - Blend word Assimilation - Colloquial language Clipped word

8 Hours

WORD ANALYSIS

Concrete word Derivative - Dialect Diminutive suffix - Dissimilation Doublet - Etymology Euphemism Figurative word Homonym - Hybrid word Inflection - Informal language Infusion - Jargon Linguistics Loan words Metathesis ; Modify - Philology Onomatopoeia - Romance language Prefix - Semantics - Root-base word - Suffix Slang - Word component Synonym

Total: 15 Hours

Reference(s)

1. Norman, Lewis. Word Power Made Easy,Goyal Publisher. Edition 2.2014.

2. C T Onions. The Oxford Dictionary of English Etymology.Volume 11, Issue 1.70, Wynford Drive, Don Mills, Ont.Oxford University Press.1965.
3. Nurnberg W, Maxwell and Rosenblum, Morris, How to build a better Vocabulary, Completely Revised and Updated, Popular Library.1961

18GE0XB GENERAL PSYCOLOGY 1 0 0 1

Course Objectives

- To provide a basic understanding of psychology
- Defining Psychology and the subject matter of psychology
- To provide an awareness of various methods and branches of psychology
- To explain social and work psychology of people and the need for mental health

Course Outcomes (COs)

1. Understand the basics of human behavior in the workplace and society at large
2. Understand the different fields of psychology and its uses
3. Deal people effectively in their personal and social life

15 Hours

GENERAL PSYCOLOGY

Psychology - Introduction - Mind body relationship - Methods and Scope of Psychology Motivation- Types of Needs- Motivational Cycle- Intelligence: Concept of Intelligence and IQ- measurement - Social psychology: individual behavior and group behavior - Group dynamics- group formation- social influence- social cognition, stereotypes- prejudice- discrimination - Definitions, formation of attitude, factors of attitude formation-change of attitude

Total: 15 Hours

Reference(s)

1. Atkinson & Atkinson, Introduction to Psychology, 6th Ed McGraw-Hill Publications. 1975
2. Mishra, B. K, Psychology: The study of human behavior, 2nd Ed New Delhi: Prentice Hall of India Learning Pvt. Ltd. 2016
3. Baron, R.A., Branscombe. N.R, Social Psychology, 14th Ed. New Delhi; Pearson Education.2016
4. Morgan, C.T., King, R.A., Weisz, J.R., & Schopler, J. Introduction to Psychology, 7th Ed. New Delhi: Tata McGraw Hill. 1993

18GE0XC NEURO BEHAVIOURAL SCIENCE 1 0 0 1

Course Objectives

- To provide an introduction to the Cognitive Neuro Science of languages
- To provide an understanding of the Cognitiveprocesses

Course Outcomes (COs)

1. Identify the psychological problems that will impact mental health
2. Value ethical conduct in professional and personal life
3. Recognize the need for rationale and evidence in decision-making

15 Hours

NEURO BEHAVIOURAL SCIENCE

Introduction to physiology - Anatomy - Neuro Biology - Psycho Neuro Science Behaviour and Hormones - Behaviour Modifications - Relaxation Therapy - Psycho Education for minds

Total: 15 Hours

Reference(s)

1. Beck, Robert. Handbook of Physiology. Vol I. Oxford University Press March 15,1996
2. Horon C Philip. Sexology and Mind. Academic Press. 1993
3. Blatteis M.Clark and Melvin J. Fregly. Handbook of Physiology Sect 4, Oxford University Press. March 15, 1996

18GE0XD VISUAL MEDIA AND FILM MAKING 1 0 0 1

Course Objectives

- To acquire fundamental knowledge on development of film making as an art, and video production
- To provide students a basic understanding of the techniques and nuances of visual medium
- To inculcate an ability to plan and produce a short film

Course Outcomes (COs)

1. Understand the significance and techniques of visual medium
2. Analyse and produce visual clippings

15 Hours

ART OF FILMMAKING

History of Cinema (Origin and Narrative) Cinema as a visual medium -Significance of Editing Styles of Editing Editing as a methodology (Hollywood s Invisible Editing) Technical Aspects of Editing (Final Cut Pro (FCP), AVID and Premire Pro) - Basics of video production (pre-production to post- production) Different types of shots and angles Film style and Narrative (Italian Neo-realism, Avant Garde, Russain Formalism, Alternative Cinema etc.,) Regional Cinema to National Cinema Basics of Script Writing (Double and Single Column) Basics of Video Production (script to screen) Final submission of a script for five minutes short film

Total: 15 Hours

Reference(s)

1. Monaco, James, How to Read a Film: Movies, Media, and Beyond. Auckland: OUP, 2009
2. Belavadi, Vasuki, Video ProductioPSO2: India: OUP, 2013

18GE0XE YOGA FOR HUMAN EXCELLENCE 1 0 0 1

Course Objectives

- To know about the history and schools of yoga
- To know the difference between supreme consciousness and individualconsciousness
- To apply the knowledge by the way of practice andintrospection

Course Outcomes (COs)

1. Understand the historical aspects and schools of yoga
2. Ensure their physical & mental wellness through yoga practice
3. Develop the power to concentrate and have stress free mind

15 Hours

YOGA FOR HUMAN EXCELLENCE

What is Yoga , History of Yoga - Yoga in todays scenario- Schools of Yoga - Eight Limbs of Yoga - Sathvic, Rajasic, Tamasic Foods and Thoughts - Science of Yoga Loosening Exercises - Yogasanas & Benefits - Super Brain Yoga - Surya Namaskar Standing Asanas - Sitting Asanas - Prone Asanas - Supine Asanas - MudrasRelaxation
Pranayama - Meditation

Total: 15 Hours

Reference(s)

1. Vethathiri Publications, Yoga Practices-2, Erode, 2012
2. Iyengar B.K.S. Yoga: Wisdom & Practice, B.K.S. Iyengar, 2009
3. Ramesh Partani, The Complete Secret, Ru Education, 2013
4. http://www.sarvyoga.com/
5. http://www.wikihow.com/Do-Superbrain-Yoga

18GE0XF VEDIC MATHEMATICS 1 0 0 1

Course Objectives

- To improve their calculation speed, analytical thinking and numerical skills

Course Outcomes (COs)

1. Solve problems creatively in mathematics and its applications

15 Hours

VEDIC MATHEMATICS

Addition- Subtraction- System of Multiplication- Squaring numbers- Cube roots- Square roots- Solution of simultaneous equations- Solutions of Quadratic equations

Total: 15 Hours

Reference(s)

1. Dhaval Bathia, Vedic Mathematics, JAICO Publishing House, 29th Edition, Mumbai, 2014
2. Jagadguru Swami Sri Bharathi Krsna Tirthaji Maharaja, Vedic Mathematics, Motilal Banarsidass Publishers Private Limited, New Delhi, 1997

18GE0XG HEALTH AND FITNESS 1 0 0 1

Course Objectives

- To understand the fundamental concepts about physical fitness & its types, training and assessment of physical fitness

Course Outcomes (COs)

1. Acquire the knowledge and training of the individual physical, mental and social concepts
2. Understand the fundamental concepts of yogic practice and physical fitness
3. To acquire the knowledge about nutrition and health consciousness

5 Hours

FITNESS

Meaning & Definition, Need & importance of Physical fitness Types Physical fitness - Exercise, Training and Conditioning and it is important

5 Hours

YOGA AND MEDITATION

Meaning and definition; Principles of practicing;
Basic Asana and it important, Pranayama and
Meditation - Relaxation Techniques

5 Hours

NUTRITION AND BALANCE DIET

Nutrition and Balance Diet: Needs and Important, Significant of Nutritional Food - Tips for balance diet. Common Diseases for IT professionals: Common diseases – cause, prevention First aid for common sports injuries.

Total: 15 Hours

Reference(s)

1. Anderson, Bob., Pearl, Bill.,&Burke, Edmund R., (2001). Getting in Shape WorkoutPrograms for Men&WomePSO2: Mumbai: Jaico Publishing House
2. Baechle, Thomas. R, & Earle, Roger. W., (2000). Essentials of Strength Training and Conditioning. Champaign: Human Kinetics
3. Iyengar, BKS., (2003). The Art of Yoga. New Delhi: Harper Collins Publishers
4. Singh, Hardayal, (1995). Science of Sports training. New Delhi: D.V.S. Publications
5. Begum, Raheena. M., (2002). A Textbook of Foods, Nutrition and Dietetics. New Delhi:Sterling Publishers Private Limited

18GE0XH CONCEPT, METHODOLOGY AND APPLICATIONS OF VERMICOMPOSTING 1 0 0 1

Course Objectives

- To understand the importance of safe methods of treating solid wastes generated through various human activities
- To appreciate the skills / devices / practices associated with the compact proceedures of biodegradation of unwanted solid residues

Course Outcomes (COs)

1. Understand the role of recycling of garbage leading to the sustenance of our health and environment.
2. Recognize the organic farming practices and production of healthy food products.
3. Prepare and maintain tips for small scale compost units and thereby becoming more environmentally conscious

15 Hours

VERMICOMPOSTING TECHNOLOGY

Ecological roles and economic importance of earthworms - need for earthworm culture, scope and importance of vermiculture , limiting factors - types of worm culturing and the relative benefits Small scale and commercial methods: process & advantages , Vermicomposting equipments, devices, Design and maintenance of vermi bed - Products from vermiculture (matter & humus cycle), vermicastings in organic farming/horticulture - Marketing the products of vermiculture quality control, market research, marketing techniques , Applied vermiculture: use of urban solids & farm/ industrial residues for vermicomposting - Constraints of vermiculture and its future perspectives Artificial Earthworm as a standalone biodegradation assembly.

Total: 15 Hours

Reference(s)

1. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised EditioPSO2: Other India Press, Goa, India.4
2. Vermiculture Technology; Earthworms, Organic Wastes and Environmental Management, 2011, Edited by Clive A Edwards, Norman Q Arancon & Rhonda Sherman, CRC Press
3. www.organicgrowingwithworms.com.au
4. New York Times , Scientists Hope to Cultivate and Immune System for Crops

18GE0XI BLOG WRITING

1 0 0 1

Course Objectives:

- To sharpen and improve writing skills, including draft writing, voice, and format.
- To develop general and global knowledge.
- To experiment with non-written forms of online communications, including images, audio andvideo.
- To be able to add content to your website without the assistance of a webdesigner.

Course Outcome (COs):

Students will be able to:

1. Understand the flow of language in natural manner.
2. Understand the elements of a blog and be able to use them effectively.
3. Find a niche for a long-term blog.
4. Gain insight into the strategies, methods and writing of successful bloggers.
5. Develop their creativity thinking.

Unit I **7 Hours**

Concept: What is blog writing? Types of blog posts—personal experience, opinion, reviews, advice, news/updates. Focusing your blog—concept, audience, uniqueness, posts. Company blogs. **Structure:** Types of structure—inverted pyramid, feature article, list, story, other options. Creating effective openings. Planning a post.

Unit II **8 Hours**

Voice: Defining and achieving voice. Exploring various voices. Stylistic tips—rhythm, verbs, interesting words, senses, emphasis. Smartness and sarcasPSO1: **Reliability** - accuracy, provability, specificity. Transparency about payments. Sample Blogs and Activities

Total: 15 hours

References:

1. The Elements of Blogging: Expanding the Conversation of Journalism, by Mark Leccese and Jerry LansoPSO2: (Taylor & Francis, 2015) ISBN: 978-1-13-802154-9. $29.95 paperback.
2. *Blogging Heroes,* by Michael Banks. Choose 15 of the 30 interviews/profile segments to read, be sure to include the segments on Chris Anderson and Brian Lam.
3. Huffington Post Complete Guide to Blogging.

16GE0XJ INTERPERSONAL SKILLS **1 0 0 1**

Course Objectives:

- To communicate and work effectively, both individually and in groups
- To be able to understand and manage one's own and other's emotions
- To define and solve problems by making decisions about the best course of action

Course Outcome (COs):

Students will be able to:

1. Express themselves clearly and confidently
2. Listen to others completely and with empathy
3. Assert an opinion without diminishing other's opinion
4. Be responsible and timely with a willingness to collaborate
5. Develop innate personality traits to handle certain social situations

Unit I **7 Hours**

Conversational Skills – Active Listening – Team working – Empathy – Emotional Intelligence

Unit II **8 Hours**

Conflict Resolution and Mediation skills – Decision-making and Problem Solving – Negotiation and Persuasion skills

Total: 15 hours

References:

1. Stephen P. Robbins, Phillip L. Hunsaker, Training in Interpersonal Skills, Pearson, 2015
2. Robert B. Cialdini, Influence: The Psychology of Persuasion, Harper Business; Revised Edition, 2006
3. Suzanne C De Janasz, Karen O Dowo & Beth Z Schneder, Interpersonal Skills in Organisations, McGraw-Hill Education; 5th Edition, 2014

18GE0XK COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT **1 0 0 1**

Course Objectives

- understand the basic concepts of National Service Scheme and its activity
- identify the needs and problems of the community and involve them in problemsolving
- develop competence required for group living and acquire leadership qualities

Course Outcomes (COs)

1. understand the community in which they work and render their service
2. develop among themselves a sense of social and civic responsibility

Community service and leadership development

Introduction and Basic Concepts of NSS: History-philosophy-aims & objectives of NSS- Emblem, flag, motto, song, badge- Organizational structure – roles and responsibilities functionaries. NSS Programmes and Activities: Concept of regular activities, special camping, DayCamps-Basisofadoption of village/slums-Methodology of conducting Survey -Financial pattern ofthescheme -Coordination withdifferent agencies-Maintenance oftheDiary. Community Mobilization: Mapping of community stakeholders-Designing the message in the context of the problem and the culture of the community- Identifying methods of mobilization-Youth-adult partnership.Health, Hygiene & Sanitation: Definition, needs and scope of health education- Food and Nutrition - Safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan). Entrepreneurship Development: Definition & Meaning - Qualities of good entrepreneur - Steps/ways in opening an enterprise -Role of financial and support service Institutions.

Total : 15 Hours

Reference(s)

1. A Hand book on National Service Scheme, Anna University, Chennai, 2012
2. http://nss.nic.in/intro.asp
3. Delgado-Gaitán and Concha, The Power of Community: Mobilizing for Familyand SchoolingNew York: Rowman& Littlefield Publishing, Inc. 2001
4. James Bailey,Guide to Hygiene and Sanitation in Aviation, World healthorganization, 2nd edition. 1980
5. AnuradhaBasu, Mark Casson, Nigel wadeson and Bernard Yeung, The oxford hand book of entrepreneurship, Oxford Press. 2009

18GE0XL NATIONAL CADET CORPS 1 0 0 1

Course Objectives

- To understand the importance of NCC and its organization.
- To realize the skills in the applications of drill and weapon training.
- To analyze the factors in National unity
- To identify the utility of smart materials in engineering applications.

Course Outcomes (COs)

- Recall the motto and aim of NCC.
- Implement synergy in disaster management.
- Execute an example patriotic leader to serve nation.

NCC ORGANIZATION

National Cadet Corps: Aim and Objectives - Administrative and Organizational pattern - NCC flag and NCC song - Duties, Responsibilities and Conduct by NCC Cadets - Badges of ranks in NCC and Armed forces- Types of NCC camps - Eligibility conditions for writing B and C certificate examinations. Cadet welfare society and Career opportunities for NCC cadets.

DRILL AND WEAPON TRAINING

Drill: Aims of drill - Types of drill - Foot drill, Arms drill and Ceremonial drill. Word of commands, Guard of honour. Weapon training - Rifles used in NCC: Parts and Characteristics of 0.22" and INSAS – Stripping, Assembling and Cleaning of weapons.

NATIONAL INTEGRATION AND SOCIAL AWARENESS

National Integration: Introduction - Constitution of India- Importance and Necessity - Factors affecting National integration - Role of NCC in National integratioPSO2: Social service and its need - Rural development programs - NGO's role and Contribution - Social Security schemes.

PERSONALITY DEVELOPMENT AND LEADERSHIP

Personality Development: Introduction - Factor influences in personality development. Leadership: Leadership traits and Skills - Indicator of good leader - Honour code concept - Type of leaders - Case studies of effective leader.

DISASTER MANAGEMENT AND FIRST AID

Disaster types - Natural and Manmade disasters. Role of NCC cadets in disaster management. Civil defence: Civil defence measures - Civil defence services. First aid: First aid kits and Equipments - First aid for snake bite, Sun stroke and Drowning - Respiration -Types of respiration.

Total: 20 Hours

REFERENCES

1. Cadet's Hand book Common subject, DG NCC, New Delhi.
2. Cadet's Hand book Special subject, DG NCC, New Delhi.
3. Misra R.C and Sanjaykumar Mishra "A HAND BOOK OF NCC'' (English), Kanti Prakashan,2016.
4. Gupta R. K, NCC: Handbook of NCC Cadets for 'A', 'B' and 'C' Certificate Examinations (English) RPH Editorial Board, 2018.

18GE0XM NEW AGE INNOVATION AND ENTREPRENEURSHIP 1 0 0 1

Course Objectives

- To make the participants understand as to how to get along with the task of setting independentbusiness units and on the various facets of running a business
- To get thebudding young entrepreneurs to appreciate the structured knowledge of the dynamics of operationalizing a business opportunity

Programme Outcomes (POs)

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. 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.
f. 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.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Understanding entrepreneurship as an important career option
2. Concept and methodology of idea translation to viable start-ups
3. Events to occur in the building of a technology based venture for students or workingprofessionals or women
4. Overview of Indian trends in the start-up scene

Articulation Matrix

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

UNIT I **15 Hours**

NEW AGE INNOVATION AND ENTREPRENEURSHIP

Introduction to Entrepreneurship - Opportunity Identification ideation -MVPPositioning as an Entrepreneur Starting own Business - Developing Effective Business Model - Industry and Competitor Analysis - Building Business PlanMentoring Session with Investors- Legal and Ethical Foundation for Startup. Types of startups and licensing systems - MSME -Evaluating the Financial Strength of a New Venture/Project - Getting Funding - Types of Sources VCs, Angel funding, PE etc. -Marketing Strategies for New Ventures - IT Systems - IPR - Strategies for New Venture Growth - Talent Acquisition and Management for New Ventures - Valuation Challenge in Entrepreneurship Intrapreneurship Sustainability - Exit strategiesand Start-up trends in India.

Total: 15 Hours

Reference(s)

1. Kathleen R. Allen, Launching New Ventures, South-WesternCengage Learning, 6th Edition,2012
2. Alex Osterwalder and Yves Pigneur, Business Model Generation, publishedby the authors, 2010
3. BransoPSO2: R. Business stripped bare, New York, Penguin books, 2011
4. Moris MH, Kuratko DF and Covin JG, Corporate entrepreneurship and innovation, 3 edition, Mason, Oh; CENGAGE/SOUTH WESTERN publisher, 2

18GE0XN DISRUPTIVE INNOVATION BASED START UP ACTIVITIES 1 0 0 1

Course Objectives

- To make the participants understand as to how to get along with the task disruptionledinnovations.
- To get the budding young entrepreneurs to appreciate the structured knowledge of the dynamics of operationalizing creativity based disruption strategy

Course outcomes

- Understanding contemporary entrepreneurship as an important careeroption
- Concept and methodology of creative disruption to viable start-ups
- Events to occur in the building of a technology based venture for students or workingprofessionals or women with disruptive technology option
- Overview of Indian trends with reference to disruptive innovation based start-ups

Unit I 15 Hours

Creativity linked innovation – Differences between Disruptive & incremental Innovations - Historical, theoretical, and practical evolution of disruptive innovation (DI). - Idea generation & communication of creativity leading to DI. Innovation management concepts in DI based entrepreneur generation - How do firms bring in new business models and get new products and services to the market? – Investor preferences in core versus new or disruptive business models - disruptors and the disrupted frameworks for assessing company's capabilities and rethinking product, market and strategy - Right customers for DI: strategy in a world that is changing so rapidly – Application of disruptive theories to complex problems and opportunities.

Total 15 Hours

References

1.
https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.15
40-5885.2005.00177.x

2. http://www.brinq.com/workshop/archives/2005/01/08/what-is-disruptive-innovation
3. https://hbr.org/2006/12/disruptive-innovation-for-social-change

18GE0XO SOCIAL PSYCHLOGY

1 0 0 1

Course Content

Introduction-Ice breaker, TIme Line , Tasks and Challenges of the age(Erik Erikson),
Introduction to Reproductive Health, Student Questions
Reproductive Organs, Menstruation, Changes during Puberty, Difference between Sex and Gender
Introduction to the origins of Patriarchy, Gender
Images of Beauty and Body Image, Introduction to Media, Feedback Attraction,
Friendship , Differences and Similarities
Sexuality
Boundaries
Relationships, Marriage, Love, Emotional Health
Sexual Abuse and Safety
Role of Media
Abortions, Contraception,
Wrapping up the Course

Total: 20 Hours

1 0 0 1

18GE0XP FM RADIO BROADCASTING TECHNOLOGY

Course Objectives

- The course focuses on community radio technology and various programproductions techniques for FM Radio Broadcasting.

Course Outcomes (COs)

- Understand the hardware required for field recording and setting up a studio and carryout studio and field recording.
- Examine the available options for telephony interfaces for radio.
- Demonstrate proper techniques of wiring, fixing of connectors, soldering and use of tools and equipment for studio work.

UNIT I **3 Hours**
INTRODUCTION TO AM/ FM RADIO
History of Radio-Types of Radio and its Reach- Entertainment Radio- Community Radio- Internet Radio-Satellite Radio. Evolution of Community Radio (CR) in India- principles behind setting up of FM/CR- policy guidelines and their impact on technology and content of a CR station- fundamental principles behind deciding the technology for a CR station.

UNIT II **3 Hours**
STUDIO TECHNOLOGY
Use of Microphones-Console handling-OB Recordings & Live Shows-Properties and components of sound-difference between analogue and digital audio-hardware required for field recording and setting up a studio-fundamental principles for setting up an audio studio.

UNIT III **3 Hours**
AUDIO PRODUCTION
Concept of recording and storing audio-hardware related to audio recording-open source software solutions for audio production-telephony interfaces for radio- audio Post ProductioPSO2: Voice Culture Exercise-Radio Production Techniques & Tools.

UNIT IV **3 Hours**
STUDIO OPERATIONS
Wiring, fixing of connectors, soldering and use of tools and equipment- preventive and corrective maintenance of studio and equipment.

UNIT V **3 Hours**
RADIO TRANSMISSION TECHNOLOGY

Components of the FM transmission chain- FM transmitter-different types of FM antenna - coaxial cable-propagation and coverage of RF signals-FM transmitter setup- Radio audience - measurements systems.

Total: 15 Hours

Reference(s)

1. UNESCO (2001). Community Radio Handbook.
2. Vinod Pavarala, Kanchan K Malik, Other Voices: The Struggle for Community Radio in India,SAGE Publications India, 2007.
3. Steve Buckley, Mark Raboy, Toby Mendel, Kreszentia Duer, Monroe E. Price, Sean O Siochru, Broadcasting, Voice, and Accountability: A Public Interest Approach to Policy, Law, and Regulation, University of Michigan Press, 2008.
4. www.floridasound.com
5. www.mediacollege.com
6. www.mediacollege.com

21OCE01 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
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. DrydePSO2: 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.

21OCS01 OBJECT ORIENTED PROGRAMMING 3 0 0 3

Course Objectives

- Understand the concepts of Object Oriented Programming
- Study the concepts of objects and classes.
- Familiarize in the types of constructors.

Course Outcomes (COs)

1. Identify the characteristics and data types of C++ language.
2. Develop programs using objects and classes for real world applications
3. Construct programs to implement operator overloading and inheritance techniques
4. Apply Polymorphism and File streams concepts to develop C++ program
5. Design applications using templates and apply exception handling mechanisms

Articulation Matrix

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

UNIT I **8 Hours**
INTRODUCTION

Need for object oriented programming - Procedural Languages vs. Object oriented approach - Characteristics Object oriented programming - C++ Programming Basics: Basic Program Construction - Output Using cout - Input with cin - Data types- Variables and Constants - Operators - Control Statements-Manipulators - Type conversioPSO2: Function Prototyping- call by reference, return by reference- Inline function- Default arguments - Function overloading.(sona)

UNIT II **8 Hours**
OBJECTS AND CLASSES

Objects and Classes Simple Class - C++ Objects as Physical Objects - C++ Object as Data types-CONSTRUCTORS: Parameterized Constructors - Multiple Constructors in a Class - Constructors with Default Arguments - Dynamic Initialization of Objects - Copy and Dynamic Constructors - Destructors(PSG) - Structures and Classes - Arrays and Strings

UNIT III **OPERATOR OVERLOADING AND**

INHERITANCE **9 Hours**

Operator Overloading and Inheritance Need of operator overloading- Overloading Unary Operators-Overloading binary Operators - Overloading Special Operators - Data Conversion Inheritance: Derived Class and Base Class - Derived Class Constructors-Overriding Member Functions-Class Hierarchies- Public and Private Inheritance-Levels of Inheritance-Multiple Inheritance.

UNIT IV

POLYMORPHISM AND FILE STREAMS **10 Hours**

Polymorphism and File Streams Virtual Function - Friend Function - Static Function-Assignment and Copy Initialization- Memory Management: new and delete Pointers to Objects, this Pointer- Streams - String I/O - Character I/O - Object I/O - I/O with Multiple Objects - File Pointers - Disk I/O with Member Functions- Error Handling in File I/O.

UNIT V **10 Hours**

TEMPLATES AND EXCEPTION HANDLING

Templates: Introduction - Function Templates - Overloading Function Templates-, user defined template arguments(sona) - Class Templates - Exception Handling - Syntax, multiple exceptions, exceptions with arguments.

Total: 45 Hours

Reference(s)

1. Deitel & Deitel, C++ How to program, Prentice Hall,2005
2. Robert Lafore, Object Oriented Programming in-C++, Galgotia Publication.
3. D.S.Malik, C++ Programming, Thomson, 2007.
4. K.R. Venugopal, Rajkumar and T.Ravishankar, Mastering C++, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2006.
5. E.Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill Publishing.

21OCS02 JAVA FUNDAMENTALS 3 0 0 3

Course Objectives

- Implement applications based on core Java Concepts with examples
- Construct application using inheritance, packages and exception handling for real time problems.
- Integrate the Java I/O concepts to handle input and output operations.
- Develop programs to perform string manipulation in java.
- Design GUI with Java for event handling and database applications.

Course Outcomes (COs)

1. Demonstrate applications based on core Java Concepts with examples
2. Construct application using inheritance, packages and exception handling for real time problem
3. Explain the Java I/O concepts to handle input and output operations.
4. Develop programs to perform string manipulation in Java.
5. Design GUI with Java for event handling and database applications.

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

Articulation Matri x

UNIT I **9 Hours**
BASICS OF JAVA

The Genesis of Java - Overview of Java - Data Types, Variables, and Arrays - Operators – Control Statements - Introducing Classes - Methods and Classes.

UNIT II
INHERITANCE, PACKAGES AND **EXCEPTIONS**

9 Hours

Inheritance: Basics - Using Super - Creating a Multilevel Hierarchy - Method overriding - Using Abstract Classes - Packages and Interfaces: Packages - Access Protection - Importing Packages- Interfaces Definitions and Implementations - Exception Handling: Types - Try and Catch - Throw.

UNIT III **9 Hours**

EXPLORING JAVA

I/O

I/O Basics - Reading Console Input -Writing Console output - Native Methods - I/ O Classes and Interfaces - File - The Byte Streams - The Character Streams - Using Stream I/ O - Serialization.

UNIT IV **9 Hours**
JAVA STRINGS

String Handling: Special String operations and Methods - String Buffer - Exploring java.lang: Simple type Wrappers - System - Math - Collections Framework: Collections Interfaces and Classes – Utility Classes: String Tokenizer - Date and Time.

UNIT V **9 Hours**
GUI WITH JAVA

Applet Basics - Applet Architecture - Applet Display Methods - Parameter Passing - Event Handling Mechanisms - Event Classes - Event Listener - Working with Windows, Graphics, Colors and Fonts - AWT Controls - Layout Managers and Menus – JDBC

Total: 45 Hours

Reference(s)

1. Herbert Schildt, Java 2-Complete Reference, Tata Mc Graw Hill, 2015.
2. Deitel & Deitel, Java How to Program, Prentice Hall of India, 2010.
3. Gary Cornell and Cay S.Horstmann, Core Java Vol.1 and Vol.2, Sun Microsystems Press, 2008.

21OCS03 KNOWLEDGE DISCOVERY IN DATABASES 3 0 0 3

Course Objectives

- Introduce the basic concepts of data warehousing.
- Impart knowledge about the data mining functionalities.
- Assess the strengths and weaknesses of association mining and cluster analysis.

Course Outcomes (COs)

1. Explain the concepts of Data Warehousing architecture and business analysis process.
2. Illustrate the process of Data Mining and preprocessing techniques for data cleansing.
3. Apply the association rules for mining the various kinds of data
4. Analyze Classification and Clustering algorithms for various problems with high dimensional data.
5. Illustrate the various data mining techniques on complex data objects

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

Articulation Matrix

UNIT I 9 Hours

DATA WAREHOUSING AND
BUSINESS ANALYSIS

Data warehousing Components -Building a Data warehouse -Data Warehouse and DBMS-Metadata-Multidimensional data model - Data Extraction, Cleanup and Transformation Tools - Reporting, Query tools and Applications - OLAP vs OLTP - OLAP operations - Data Warehouse

Schemas: Stars, Snowflakes and Fact constellations.

UNIT II **8 Hours**
INTRODUCTION TO DATA MINING

Introduction - Steps in knowledge discovery from databases process - Architecture of a Typical Data Mining Systems - Data Mining Functionalities - Classification of Data Mining Systems - Data mining on different kinds of data - Different kinds of pattern - Task Primitives - Integration of a Data Mining System with a Data Warehouse - Major issues in Data mining.

UNIT III **9 Hours**
ASSOCIATION RULE MINING

Market Basket Analysis- Frequent Item Set Mining methods: Apriori algorithm - Generating Association Rules - A Pattern Growth Approach- Pattern mining in multilevel and multidimensional space - Mining Various Kinds Of Association Rules - Association Analysis to Correlation Analysis - Constraint Based Association Mining.

UNIT IV **9 Hours**
CLASSIFICATION AND CLUSTERING

Decision Tree Induction - Bayesian Classification - Rule Based Classification - Classification by Back propagation - Support Vector Machines - Clustering: Types of data - Partitioning methods: k-means, k-medoid - Hierarchical Methods: distance based agglomerative and divisible clustering, BIRCH – Density Based Method: DBSCAN - Grid Based Method: STING.

UNIT V **10 Hours**
DATA MINING APPLICATIONS

Mining complex data objects - Text Mining - Graph mining - Web mining - Spatial Data mining -Application and trends in data mining - Social impacts of Data mining.

Total: 45 Hours

Reference(s)

1 Jiawei Han, Micheline Kamber and Jian Pai , Data Mining: Concepts and Techniques, Morgan Kauffman, 3rd Edition, 2013.
2 Alex Berson and Stephen J Smith, Data Warehousing, Data Mining, and OLAP, Tata Mcgraw- Hill, 1997.
3 David Hand, Heikki Manila, Padhraic Symth, Principles of Data Mining, MIT Press, 2001.
4 Margaret H.Dunham, Data Mining: Introductory and Advanced Topics, Pearson Education 2003.

21OCS04 E-LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- Understand the technologies involved in e-learning.
- Gain the fundamentals of e-learning techniques
- Determine the characteristics of Teaching-Learning Process

Course Outcomes (COs)

1. Acquire knowledge about the basic concepts of e-learning.
2. Explain the technology mediated communication in e-learning
3. Exemplify of e-learning and content the process management.
4. Analyze the teaching and learning processes in e-learning environment.
5. Assess the various applications of e-learning.

Articulation Matrix

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

UNIT I **9 Hours**
INTRODUCTION

Evolution of Education - Generations of Distance Educational Technology - Role of E-Learning - Components of e-learning: CBT, WBT, Virtual Classroom - Barriers to e-Learning Roles and Responsibilities: Subject Matter Expert - Instructional Designer - Graphic Designer - Multimedia Author - Programmer - System Administrator - Web Master

UNIT II **9 Hours**
TECHNOLOGIES

Satellite Broadcasting - Interactive Television - Call Centers - Whiteboard Environment - Teleconferencing: Audio Conferencing - Video Conferencing -Computer Conferencing. Internet: E-mail, Instant Messaging, Chat, Discussion Forums, Bulletin Boards, Voice Mail, File Sharing, Streaming Audio and Video.

UNIT III **9 Hours**
MANAGEMENT

Content: E-Content, Dynamic Content, Trends - Technology: Authoring, Delivery, Collaboration - Services: Expert Service, Information Search Service, Knowledge Creation Service - Learning

Objects and E-Learning Standards. Process of E-Learning: Knowledge acquisition and creation, Sharing of knowledge, Utilization of knowledge - Knowledge Management in E-Learning.

UNIT IV **9 Hours**
TEACHING-LEARNING PROCESS

Interactions: Teacher-Student - Student-Student - Student-Content - Teacher- Content - Teacher-Teacher - Content-Content Role of Teachers in E-Learning - Blended Learning -Cooperative Learning
- Collaborative Learning - Multi Channel learning -Virtual University - Virtual Library.

UNIT V **9 Hours**
APPLICATIONS

Customer service training - Sales training - Customer training - Safety training - IT training – Product training - Healthcare training.

Total: 45 Hours

Reference(s)

1. E-Learning: An Expression of the Knowledge Economy, Gaurav Chadha, S.PSO1: Nafay Kumail, Tata McGraw-Hill Publication, 2002.
2. E-Learning: New Trends and Innovations, P.P. Singh, Sandhir Sharma, Deep & Deep Publications, 2005. 4. 4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002
3. E-Learning: Concepts, Trends and Applications, Epignosis LLC, LLC publications, 2014.
4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002.

21OCS05 SOCIAL TEXT AND MEDIA ANALYTICS **3 0 0 3**

Course Objectives

- Understand the basic ideas of Text mining.
- Analyze the methods and approaches used in analytics.
- Gain knowledge on various types of analytics like web, social network, and social media

Course Outcomes (COs)

1. Demonstrate the concepts and applications of text mining
2. Explain Content analysis and Sentiment analysis
3. Illustrate web analytics with a suitable model
4. Illustrate social network analytics with suitable example.
5. Illustrate social media analytics with suitable example.

Articulation Matrix

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

UNIT I **7 Hours**
TEXT MINING

Introduction, Core text mining operations, Preprocessing techniques, Categorization, Clustering, Information extraction, Probabilistic models for information extraction, Text mining applications.

UNIT II **9 Hours**
METHODS

Content Analysis-Natural Language Processing-Clustering & Topic Detection-Simple Predictive Modeling-Sentiment Analysis; Sentiment Prediction.

UNIT III **9 Hours**
WEB ANALYTICS

Web analytics tools-Clickstream analysis-A/B testing, online surveys-Web search and retrieval-Search engine optimization-Web crawling and Indexing-Ranking algorithms-Web traffic models.

UNIT IV SOCIAL NETWORK ANALYTICS **10 Hours**

Social contexts: Affiliation and identity - Social network analysis - Social network and web data and methods. Graphs and Matrices - Basic measures for individuals and networks

UNIT V **10 Hours**
SOCIAL MEDIA ANALYTICS

Information visualization - Making connections: Link analysis - Random graphs and network evolution.

Total: 45 Hours

Reference(s)

1. Ronen Feldman and James Sanger, The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, 2006.
2. Hansen, Derek, Ben Sheiderman, Marc Smith. Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Morgan Kaufmann, 2011.
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21OEC01 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.

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

Articulation Matrix

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 ConversioPSO2: Shift registers, Counters. Memories Structure: address and data bus. ROM, PROM, EPROM and flash RAPSO1: Volatiles Memories: RAM, SRAM, DRAPSO1: 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 . ResolutioPSO2: 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)

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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.
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