

B.E. (MECHATRONICS)
2022 Regulations, Curriculum & Syllabi (2022-2026)



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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CONTENTS

	Page No.
Vision and Mission	1
PEOs	1
POs	2
Mapping of PEOs and POs	4
Connectivity Chart	5
Curriculum 2022	6
Syllabi	14
Electives	100

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. To impart adequate technical knowledge and skills in the area of mechanical, electrical and electronic systems to solve problems pertaining to mechatronics
- II. To adapt multidisciplinary approach for product design, development and manufacturing using contemporary tools.
- III. To exhibit research aptitude and life-long learning in the working environment with professional and ethical responsibility.

PROGRAMME OUTCOMES (POs)

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **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.
3. **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.
4. **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.
5. **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.
6. **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.
7. **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.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **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.

11. **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.
12. **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

PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools
2. Perform multidisciplinary activities in the mechatronics systems to solve real world problem.

MAPPING OF PEOs AND Pos

POs	a	b	c	d	e	f	g	h	i	j	k	l	PSO 1	PSO 2
PEO1	X	X											X	X
PEO2			X	X	X		X						X	X
PEO3						X		X	X	X	X	X		X

DEPARTMENT : Mechatronics										
Minimum Credits to be Earned : 165										
I SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
22MA101	Engineering Mathematics I	3	1	0	4	4	40	60	100	BS
22PH102	Engineering Physics	2	0	2	3	4	50	50	100	BS
22CH103	Engineering Chemistry I	2	0	2	3	4	50	50	100	BS
22GE001	Fundamentals of Computing	3	0	0	3	4	40	60	100	ES
22GE003	Basics of Electrical Engineering	2	0	2	3	4	50	50	100	ES
22HS001	Foundational English	1	0	2	2	3	100	0	100	HSS
22GE005	Engineering Drawing	1	0	2	2	3	100	0	100	ES
22MC108	Comprehensive Work	0	0	2	1	2	100	0	100	EEC
Total		14	1	12	21	28				-
II SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
22MA201	Engineering Mathematics II	3	1	0	4	4	40	60	100	BS
22PH202	Electromagnetism and Modern Physics	2	0	2	3	4	50	50	100	BS
22CH203	Engineering Chemistry II	2	0	2	3	4	50	50	100	BS
22GE002	Computational Problem Solving	3	0	0	3	4	40	60	100	ES
22GE004	Basics of Electronics Engineering	2	0	2	3	4	50	50	100	ES
22HS002	Startup Management	1	0	2	2	3	100	0	100	EEC
	Language Elective	1	0	2	2	3	100	0	100	HSS
*22HS003	தமிழர்மரபு / Heritage of Tamils	1	0	0	1	1	100	0	100	EEC
Total		14	1	12	21	28				-

* The lateral entry students have to complete this course during IV semester.

III SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
22MC301	Transforms and Partial differential equations	3	1	0	4	4	40	60	100	ES
22MC302	Electrical circuits and Machines	3	1	0	4	4	40	60	100	PC
22MC303	Digital Logic Circuit Design	3	0	2	4	4	50	50	100	PC
22MC304	Fluid Mechanics and Machineries	3	0	2	4	4	50	50	100	PC
22MC305	Engineering Mechanics	3	1	0	4	4	40	60	100	ES
22HS004	Human Values and Ethics	2	0	0	2	3	100	0	100	HSS
22HS005	Soft Skills and Effective Communication	0	0	2	1	1	100	0	100	HSS
22HS006	தமிழரும் தொழில் நுட்பமும் Tamil and Technology	1	0	0	1	1	100	0	100	EEC
Total		17	3	6	23	26				-
IV SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
22MC401	Probability, Statistics and Random Process	3	1	0	4	4	40	60	100	ES
22MC402	Sensors and Transducer	3	0	2	4	5	50	50	100	PC
22MC403	Strength of Materials	2	1	2	4	5	50	50	100	PC
22MC404	Theory of Machines	3	0	2	4	5	50	50	100	PC
22MC405	Embedded System	3	0	2	4	5	50	50	100	PC
	Professional Elective I	3	0	0	3	3	40	60	100	PE
22HS007	Environmental Science	2	0	0	-	2	100	0	100	HSS
22HS008	Advanced English and Technical Expression	0	0	2	1	2	100	0	100	HSS
Total		19	2	10	24	31				-

V SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
22MC501	Robotics and Machine Vision	2	1	2	4	5	50	50	100	PC
22MC502	Manufacturing Technology	2	0	2	3	4	50	50	100	PC
22MC503	Thermodynamics and Heat Transfer	3	0	2	4	5	50	50	100	PC
22MC504	Control Systems	3	1	0	4	4	40	60	100	PC
	Professional Elective II	3	0	0	3	3	40	60	100	PE
	Open Elective	3	0	0	3	3	40	60	100	PE
22MC507	Mini Project I	0	0	2	1	2	100	0	100	EEC
Total		17	2	8	23	27				-
VI SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
22MC601	Design of Mechatronics System	3	0	2	4	5	50	50	100	PC
22MC602	Power Electronics and Drives	3	0	2	4	5	50	50	100	PC
22MC603	Fluid Power System	2	1	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
22MC607	Mini Project II	0	0	2	1	2	100	0	100	EEC
Total		17	1	8	22	26				-

VII SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
22MC701	Industrial Automation and IoT	3	0	2	4	5	50	50	100	ES
22MC702	Machine Learning Techniques	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
22MC707	Project Work I	0	0	4	2	4	60	40	100	EEC
Total		18	0	6	21	24				-
VIII SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
22MC801	Project Work II	0	0	20	10	20	60	40	100	EEC
Total		0	0	20	10	20				-

ELECTIVES										
LANGUAGE ELECTIVES										
Code No.	Course	L	T	P	C	Hours /Week	Maximum Marks			Category
							CA	ES	Total	
22HS201	Communicative English II	1	0	2	2	3	100	0	100	HSS
22HSH01	Hindi	1	0	2	2	3	100	0	100	HSS
22HSG01	German	1	0	2	2	3	100	0	100	HSS
22HSJ01	Japanese	1	0	2	2	3	100	0	100	HSS
22HSC01	Chinese	1	0	2	2	3	100	0	100	HSS
22HSF01	French	1	0	2	2	3	100	0	100	HSS
PROFESSIONAL ELECTIVES										
VERTICAL I – APPLIED ROBOTICS										
22MC001	Modelling of Industrial Robots	3	0	0	3	3	40	60	100	PE
22MC002	Robot Control Using ROS	3	0	0	3	3	40	60	100	PE
22MC003	Drone Technology	3	0	0	3	3	40	60	100	PE
22MC004	Robotic Vision	3	0	0	3	3	40	60	100	PE
22MC005	Medical Robotics	3	0	0	3	3	40	60	100	PE
22MC006	Mobile Robotics	3	0	0	3	3	40	60	100	PE
VERTICAL II – DESIGN AND MANUFACTURING										
22MC007	CNC Technology	3	0	0	3	3	40	60	100	PE
22MC008	Computer Integrated Manufacturing	3	0	0	3	3	40	60	100	PE
22MC009	Additive Manufacturing	3	0	0	3	3	40	60	100	PE
22MC010	Non - Destructive Testing	3	0	0	3	3	40	60	100	PE
22MC011	Design For Manufacturing And Assembly	3	0	0	3	3	40	60	100	PE
22MC012	Industrial Engineering	3	0	0	3	3	40	60	100	PE
VERTICAL III – SMART MOBILITY										
22MC013	Electric And Hybrid Vehicles	3	0	0	3	3	40	60	100	PE
22MC014	Autonomous And Connected Vehicles	3	0	0	3	3	40	60	100	PE
22MC015	Automotive Embedded System	3	0	0	3	3	40	60	100	PE
22MC016	Automotive Communication Systems	3	0	0	3	3	40	60	100	PE
22MC017	Vehicle Control Systems	3	0	0	3	3	40	60	100	PE
22MC018	Machine Learning For Autonomous Vehicles	3	0	0	3	3	40	60	100	PE

VERTICAL IV – INTELLIGENT SYSTEMS										
22MC019	Applied Image Processing	3	0	0	3	3	40	60	100	PE
22MC020	Fuzzy Logic and Artificial Neural Network	3	0	0	3	3	40	60	100	PE
22MC021	Artificial Intelligence	3	0	0	3	3	40	60	100	PE
22MC022	Deep Learning Techniques	3	0	0	3	3	40	60	100	PE
22MC023	Soft Computing	3	0	0	3	3	40	60	100	PE
22MC024	Optimization Techniques	3	0	0	3	3	40	60	100	PE
VERTICAL V – AUTOMATION										
22MC025	Medical Mechatronics	3	0	0	3	3	40	60	100	PE
22MC026	Virtual Instrumentation	3	0	0	3	3	40	60	100	PE
22MC027	Industrial Drives And Control	3	0	0	3	3	40	60	100	PE
22MC028	Control System And Drives For Electric Vehicles	3	0	0	3	3	40	60	100	PE
22MC029	Process Control	3	0	0	3	3	40	60	100	PE
22MC030	Advanced Industrial Automation	3	0	0	3	3	40	60	100	PE
VERTICAL VI – SENSOR TECHNOLOGIES AND IOT										
22MC031	IOT Protocols and Industrial Sensors	3	0	0	3	3	40	60	100	PE
22MC032	IOT Processors	3	0	0	3	3	40	60	100	PE
22MC033	IOT System Design	3	0	0	3	3	40	60	100	PE
22MC034	Wireless Sensor Network Design	3	0	0	3	3	40	60	100	PE
22MC035	Industrial IOT and Industry 4.0	3	0	0	3	3	40	60	100	PE
22MC036	Python for IOT Data Analytics	3	0	0	3	3	40	60	100	PE

OPEN ELECTIVES										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
22OCE01	Energy Conservation and Management	3	0	0	3	3	40	60	100	OE
22OCS01	Object Oriented Programming	3	0	0	3	3	40	60	100	OE
22OCS02	JAVA Fundamentals	3	0	0	3	3	40	60	100	OE
22OCS03	Knowledge Discovery in Databases	3	0	0	3	3	40	60	100	OE
22OCS04	E-Learning Techniques	3	0	0	3	3	40	60	100	OE
22OCS05	Social Text and Media Analytics	3	0	0	3	3	40	60	100	OE
22OEC01	Basics of Analog and Digital Electronics	3	0	0	3	3	40	60	100	OE
22OEC02	Microcontroller Programming	3	0	0	3	3	40	60	100	OE
22OEC03	Principles of Communication Systems	3	0	0	3	3	40	60	100	OE
22OEC04	Principles of Computer Communication and Networks	3	0	0	3	3	40	60	100	OE
22OEI01	Programmable Logic Controller	3	0	0	3	3	40	60	100	OE
22OEI02	Sensor Technology	3	0	0	3	3	40	60	100	OE
22OEI03	Fundamentals of Virtual Instrumentation	3	0	0	3	3	40	60	100	OE
22OEI04	Optoelectronics and Laser Instrumentation	3	0	0	3	3	40	60	100	OE
22OME01	Digital Manufacturing	3	0	0	3	3	40	60	100	OE
22OME02	Industrial Process Engineering	3	0	0	3	3	40	60	100	OE
22OME03	Maintenance Engineering	3	0	0	3	3	40	60	100	OE
22OME04	Safety Engineering	3	0	0	3	3	40	60	100	OE
22OBT01	Biofuels	3	0	0	3	3	40	60	100	OE
22OFD01	Traditional Foods	3	0	0	3	3	40	60	100	OE
22OFD02	Food Laws and Regulations	3	0	0	3	3	40	60	100	OE
22OFD03	Post Harvest Technology of Fruits and Vegetables	3	0	0	3	3	40	60	100	OE
22OFD04	Cereal, Pulses and Oil Seed Technology	3	0	0	3	3	40	60	100	OE
22OFT01	Fashion Craftsmanship	3	0	0	3	3	40	60	100	OE
22OFT02	Interior Design in Fashion	3	0	0	3	3	40	60	100	OE
22OFT03	Surface Ornamentation	3	0	0	3	3	40	60	100	OE
22OPH01	Nanomaterials Science	3	0	0	3	3	40	60	100	OE
22OPH02	Semiconductor Physics and Devices	3	0	0	3	3	40	60	100	OE
22OPH03	Applied Laser Science	3	0	0	3	3	40	60	100	OE

22OPH04	Bio-photonics	3	0	0	3	3	40	60	100	OE
22OPH05	Physics of Soft Matter	3	0	0	3	3	40	60	100	OE
22OCH01	Corrosion Science and Engineering	3	0	0	3	3	40	60	100	OE
22OCH02	Polymer Science	3	0	0	3	3	40	60	100	OE
22OCH03	Energy Storing Devices	3	0	0	3	3	40	60	100	OE
22OMA01	Graph Theory and Combinatorics	3	0	0	3	3	40	60	100	OE
22OGE01	Principles of Management	3	0	0	3	3	40	60	100	OE
22OGE02	Entrepreneurship Development I	3	0	0	3	3	40	60	100	OE
22OGE03	Entrepreneurship Development II	3	0	0	3	3	40	60	100	OE
22OGE04	Nation building: Leadership and Social Responsibility	3	0	0	3	3	40	60	100	OE

22MA101 ENGINEERING MATHEMATICS I

3 1 0 4

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

9 Hours

MATHEMATICS MODELING OF LINEAR FUNCTIONS

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

UNIT II

9 Hours

MATHEMATICAL MODELING OF QUADRATIC FUNCTIONS

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

UNIT III

9 Hours

MATHEMATICAL MODELING OF POWER AND POLYNOMIAL FUNCTIONS

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

UNIT IV

9 Hours

MATHEMATICAL MODELING OF EXPONENTIAL FUNCTIONS

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

UNIT V

9 Hours

MATHEMATICAL MODELING OF MULTIVARIABLE FUNCTIONS

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

Total: 60 Hours

Reference(s)

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

22PH102 ENGINEERING PHYSICS

2 0 2 3

Course Objectives

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

Course Outcomes (COs)

1. Illustrate the concept and principles of energy to understand mechanical systems
2. Exemplify the types of mechanical oscillations based on vibrational energy
3. Infer the concept of propagation of energy as transverse and longitudinal waves
4. Analyze the exchange of energy and work between the systems using thermodynamic principles
5. Apply the concept of energy and entropy to understand the mechanical properties of materials

Articulation Matrix

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

UNIT I

6 Hours

CONSERVATION OF ENERGY

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

UNIT II

5 Hours

VIBRATIONAL ENERGY

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

UNIT III

6 Hours

PROPAGATION OF ENERGY

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

UNIT IV

7 Hours

EXCHANGE OF ENERGY

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

UNIT V	6 Hours
ENERGY IN MATERIALS	
Elastic energy - Structure and bonding - Stress - strain - Tension and compression - elastic limit - Elastic Modulus - Stress - strain diagram - ductility - brittleness - rubber elasticity and entropy	
	5 Hours
EXPERIMENT 1	
Determination of resultant of system of concurrent coplanar forces - Parallelogram law of forces	
1	5 Hours
EXPERIMENT 2	
Determination of moment of inertia - Torsional pendulum	
2	5 Hours
EXPERIMENT 3	
Determination of thickness of a thin wire using interference of light - Air wedge method	
3	4 Hours
EXPERIMENT 4	
Determination of AC frequency using Meldes apparatus	
4	3 Hours
EXPERIMENT 5	
Determination of thermal conductivity of a bad conductor using Lees disc method	
5	4 Hours
EXPERIMENT 6	
Wavelength of ultrasonics in a liquid medium (ii) velocity of ultrasonic waves in the given liquid (iii) compressibility of the given liquid using ultrasonic interferometer	
6	4 Hours
EXPERIMENT 7	
Determination of Youngs modulus of a given material- Non uniform bending method	
	Total: 60 Hours

Reference(s)

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

22CH103 ENGINEERING CHEMISTRY I

2 0 2 3

Course Objectives

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

Course Outcomes (COs)

1. Understand nuclear transmutation reactions that lead to the formation of elements in the universe
2. Illustrate atomic structure of elements in the periodic table and interpret the periodic trends in properties of elements with its anomaly
3. Apply the conditions for the formation of different types of chemical bonds and predict the minimum energy required for a reaction to occur
4. Analyse endothermic and exothermic processes and exchange of energy during chemical reactions
5. Analyse whether the given matter is a solid, liquid, gas, or plasma and interpret the arrangement of atoms

Articulation Matrix

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

UNIT I

5 Hours

ORIGIN OF ELEMENTS

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

UNIT II

7 Hours

ATOMIC STRUCTURE AND PERIODICITY

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

UNIT III

6 Hours

CHEMICAL BONDING

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

UNIT IV

6 Hours

REACTION THERMODYNAMICS

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

UNIT V	6 Hours
STATES OF MATTER	
Solid - liquid - gas - plasma - quantum dots - arrangement of atoms/ions/molecules in different phases	
1	2 Hours
EXPERIMENT 1	
Lab safety rules and guidelines for students - OSHA Guidelines	
2	3 Hours
EXPERIMENT 2	
Estimation of dissolved oxygen content in water sample(s) by Winkler's method	
3	4 Hours
EXPERIMENT 3	
Determination of Fe(II) in a sample using spectrophotometer	
4	3 Hours
EXPERIMENT 4	
Estimation of chromium content in water sample by volumetric analysis	
5	3 Hours
EXPERIMENT 5	
Estimation of chloride present in the given water sample by argentometric method	
6	3 Hours
EXPERIMENT 6	
Conductometric titration of mixture of acids	
7	4 Hours
EXPERIMENT 7	
Estimation of magnesium ions in given solution by EDTA method	
8	4 Hours
EXPERIMENT 8	
Preparation of salt of fatty acid by saponification process	
9	4 Hours
EXPERIMENT 9	
Recrystallization of aspirin from water/ethanol	
	Total: 60 Hours

Reference(s)

1. Peter Atkins, Physical Chemistry, Oxford university press, 2019
2. Rose Marie Gallagher and Author Paul Ingram, Complete Chemistry Cambridge IGCSE, Oxford university press, 2020
3. P L Soni, Text book of inorganic chemistry, Chand publishers, New Delhi, 2017
4. J.D. Lee, Concise inorganic chemistry, Blackman Science Ltd, France, Wiley-India, 5th edition (Reprint), 2016
5. Gareth Price, Thermodynamics of chemical processes, Oxford university press, 2019
6. D Tabor, Gases, liquids and solids and other states of matter, Oxford University press, 2018

22GE001 FUNDAMENTALS OF COMPUTING

3 0 0 3

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

8 Hours

CODES AND COMBINATIONS

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

UNIT II

9 Hours

COMPUTATION USING COMPUTER

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

UNIT III

11 Hours

ASSEMBLY LANGUAGE PROGRAMMING

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

UNIT IV

9 Hours

OPERATING SYSTEM AND APPLICATION GENERATION

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

UNIT V

8 Hours

SOFTWARE DEVELOPMENT

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

Total: 45 Hours

Reference(s)

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

22GE003 BASICS OF ELECTRICAL ENGINEERING

2 0 2 3

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

5 Hours

ELECTRIC CHARGE

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

UNIT II

7 Hours

ELECTRIC FIELD

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

UNIT III

7 Hours

MAGNETIC FIELDS

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

UNIT IV

6 Hours

FORCE ON CHARGES

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

UNIT V **5 Hours**

ELECTRO MECHANICAL ENERGY CONVERSION

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

1 **15 Hours**

EXPERIMENT 1

Analyze and design of Electromechanical energy conversion system.

2 **15 Hours**

EXPERIMENT 2

Develop an electrical machine and analyze its performance with supplied input of AC from 0 V to 230 V.

Total: 60 Hours

Reference(s)

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

22GE005 ENGINEERING DRAWING

1 0 2 2

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

7 Hours

FUNDAMENTALS OF ENGINEERING DRAWING

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

UNIT II

9 Hours

PROJECTION OF POINTS AND LINES

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

UNIT III

9 Hours

PROJECTION OF PLANES AND SOLIDS

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

UNIT IV

9 Hours

SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES

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

UNIT V

11 Hours

ORTHOGRAPHIC PROJECTIONS AND ISOMETRIC VIEW

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

Total: 45 Hours

Reference(s)

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

22MA201 ENGINEERING MATHEMATICS II

3 1 0 4

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

9 Hours

FIRST ORDER LINEAR DIFFERENTIAL EQUATIONS

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

UNIT II

9 Hours

SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS

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

UNIT III

9 Hours

VECTOR DIFFERENTIAL CALCULUS

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

UNIT IV

9 Hours

VECTOR INTEGRAL CALCULUS

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

UNIT V

9 Hours

COMPLEX FUNCTIONS

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

Total: 60 Hours

Reference(s)

1. Richard E. Williamson, Introduction to Differential Equations and Dynamical Systems, McGraw Hill Companies. Inc, 1997
2. Michael Greenberg, Advanced Engineering Mathematics, 2/e, Pearson, 2018
3. George B. Thomas, Maurice D. Weir and Joel Hass Thomas Calculus, 13/e, Pearson Publishers, 2013
4. Erwin Kreyszig, Advanced Engineering Mathematics Wiley, 10th editi5. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017on ,2015
5. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017

22PH202 ELECTROMAGNETISM AND MODERN PHYSICS

2 0 2 3

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

6 Hours

ELECTRICITY

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

UNIT II

6 Hours

MAGNETISM

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

UNIT III

6 Hours

ELECTROMAGNETIC WAVES AND LIGHT

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

UNIT IV

6 Hours

MODERN PHYSICS

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

UNIT V **6 Hours**

ENERGY BANDS IN SOLIDS

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

1 **5 Hours**

EXPERIMENT 1

Determination of V-I characteristics of a solar cell

2 **5 Hours**

EXPERIMENT 2

Determination of Hall voltage of a given specimen by Hall Effect method

3 **5 Hours**

EXPERIMENT 3

Determination of wavelength of a given laser source - Grating method

4 **4 Hours**

EXPERIMENT 4

Determination of particle size using diode laser

5 **3 Hours**

EXPERIMENT 5

Determination of refractive index of a given solid medium and liquid medium

6 **4 Hours**

EXPERIMENT 6

Determination of energy loss per cycle of a ferromagnetic material using hysteresis curve

7 **4 Hours**

EXPERIMENT 7

Determination of band gap energy of a given semiconducting material

Total: 60 Hours

Reference(s)

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

22CH203 ENGINEERING CHEMISTRY II

2 0 2 3

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

6 Hours

ELECTROCHEMISTRY

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

UNIT II

6 Hours

ENERGY STORING DEVICES

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

UNIT III

6 Hours

METAL CORROSION AND ITS PREVENTION

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

UNIT IV

6 Hours

CATALYSIS

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

UNIT V **6 Hours**

NUCLEAR REACTIONS

Radioactive and stable isotopes - Variation in properties between isotopes - Radioactive decay (alpha, beta and gamma) - Half-life period - Nuclear reactions - Radiocarbon dating

1 **4 Hours**

EXPERIMENT 1

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

2 **4 Hours**

EXPERIMENT 2

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

3 **4 Hours**

EXPERIMENT 3

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

4 **5 Hours**

EXPERIMENT 4

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

5 **4 Hours**

EXPERIMENT 5

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

6 **4 Hours**

EXPERIMENT 6

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

7 **5 Hours**

EXPERIMENT 7

Determination of rate constant of acid catalyzed hydrolysis of ester

Total: 60 Hours

Reference(s)

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

22GE002 COMPUTATIONAL PROBLEM SOLVING

3 0 0 3

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

6 Hours

VISUAL PROCESS MODELING

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

UNIT II

12 Hours

ALGORITHMIC DESIGN THINKING

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

UNIT III

12 Hours

DATA ORGANIZATION

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

UNIT IV

7 Hours

DATA STORAGE

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

UNIT V

8 Hours

NETWORKING ESSENTIALS

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

Total: 45 Hours

Reference(s)

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

22GE004 BASICS OF ELECTRONICS ENGINEERING

2 0 2 3

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

6 Hours

ENERGY TRANSFER AND SIGNALS

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

UNIT II

8 Hours

SIGNAL CONDITIONING USING DIODE

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

UNIT III

6 Hours

SIGNAL CONDITIONING USING TRANSISTOR

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

UNIT IV **6 Hours**

LOGIC SYNTHESIS USING DIODE AND TRANSISTORS

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

UNIT V **4 Hours**

DEVICES FOR SPECIAL REQUIREMENTS

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

1 **4 Hours**

EXPERIMENT 1

Design and Implement a simple device to communicate basic information between two different small distance points using wired and wireless methods.

2 **6 Hours**

EXPERIMENT 2

Design and Implement different wave shaping Circuits using PN Junction Diodes.

3 **4 Hours**

EXPERIMENT 3

Design and Implement Voltage Multiplier Circuit using PN Junction Diodes and Capacitors.

4 **4 Hours**

EXPERIMENT 4

Design and Implement a three Stage Circuit to convert 220V 50Hz AC mains supply to 12V DC supply.

5 **4 Hours**

EXPERIMENT 5

Design and Implement a BJT Amplifier Circuit to amplify audio input signal.

6 **4 Hours**

EXPERIMENT 6

Design and Implement Basic Logic Gates using PN Junction Diodes.

7 **4 Hours**

EXPERIMENT 7

Design and Implement Basic Logic Gates using BJTs.

Total: 60 Hours

Reference(s)

1. Thomas L. Floyd, Electronic Devices: Electron Flow Version, Ninth Edition, Prentice Hall, 2012.
2. J Millman, C. Halkias & Satyabrata Jit, Electronic Devices and Circuits, Tata McGraw-Hill, 2007.
3. L Robert Boylestead, Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education 2006.
4. David A. Bell, Electronic Devices and Circuits, Prentice Hall of India, 2003.
5. Adel S. Sedra & Kenneth C. Smith, Micro Electronic Circuits Theory and Applications, Sixth Edition, Oxford University Press, 2013.
6. Behzad Razavi, Microelectronics, Wiley India Pvt. Ltd.; 2nd edition (2018)

22HS002 STARTUP MANAGEMENT

1 0 2 2

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

3 Hours

BUSINESS MODELS AND IDEATION

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

UNIT II

3 Hours

UNDERSTANDING CUSTOMERS

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

UNIT III

3 Hours

DEVELOPING PROTOTYPES

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

UNIT IV

3 Hours

BUSINESS STRATEGIES AND PITCHING

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

UNIT V	3 Hours
COMMERCIALIZATION Implementation: Prototype to Commercialization, Test Markets, Institutional Support, Registration Process, IP Laws and Protection, Legal Requirements, Type of Ownership, Building and Managing Teams, Defining role of investors	
1	1 Hours
EXPERIMENT 1 Analysis of various business sectors	
2	2 Hours
EXPERIMENT 2 Developing a Design Thinking Output Chart	
3	1 Hours
EXPERIMENT 3 Creating Buyer Personas	
4	3 Hours
EXPERIMENT 4 Undertake Market Study to understand market needs and assess market potential	
5	2 Hours
EXPERIMENT 5 Preparation of Business Model Canvas	
6	15 Hours
EXPERIMENT 6 Developing Prototypes	
7	2 Hours
EXPERIMENT 7 Organizing Product Design Sprints	
8	2 Hours
EXPERIMENT 8 Preparation of Business Plans	
9	2 Hours
EXPERIMENT 9 Preparation of Pitch Decks	
	Total: 45 Hours

Reference(s)

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

22HS003 HERITAGE OF TAMILS

1 0 0 1

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

3 Hours

LANGUAGE AND LITERATURE

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

UNIT II

3 Hours

HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE

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

UNIT III

3 Hours

FOLK AND MARTIAL ARTS

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

UNIT IV

3 Hours

THINAI CONCEPT OF TAMILS

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

UNIT V

3 Hours

CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE

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

Total: 15 Hours

Reference(s)

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

22HS006 TAMILS AND TECHNOLOGY

1 0 0 1

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

3 Hours

WEAVING AND CERAMIC TECHNOLOGY

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

UNIT II

3 Hours

DESIGN AND CONSTRUCTION TECHNOLOGY

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

3 Hours

UNIT III

MANUFACTURING TECHNOLOGY

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

3 Hours

UNIT IV

AGRICULTURE AND IRRIGATION TECHNOLOGY

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

3 Hours

UNIT V

SCIENTIFIC TAMIL & TAMIL COMPUTING

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

Total: 15 Hours

Reference(s)

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

22MC301 TRANSFORMS AND PARTIALDIFFERENTIAL

3 1 0 4

EQUATIONS

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

9 Hours

FOURIER SERIES

Introduction-Periodic functions-Dirichlets conditions - General Fourier series - Odd and even functions - Parsevals identity-Root mean square value- Harmonic analysis

UNIT II

9 Hours

FOURIER TRANSFORM

Fourier integral theorem- Fourier transform and inverse Fourier transform- Sine and cosine transforms - Properties - Transforms of simple functions = Convolution theorem - Parsevals identity.

UNIT III **9 Hours**

LAPLACE TRANSFORM

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

UNIT IV **9 Hours**

Z TRANSFORM

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

UNIT V **9 Hours**

APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS

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

Total: 60 Hours

Reference(s)

1. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi, 2016.
2. Peter V O Neil., Advanced Engineering Mathematics, 7th Edition, TBH Publishers, 2013.
3. James Glyn, Advanced Modern Engineering Mathematics, Pearson, 3rd edition 2014.
4. Michael D Greenberg., Advanced Engineering Mathematics, Pearson Education, 2nd Edition 2002.
5. B. S. Grewal, Higher Engineering Mathematics, Forty third Edition, Khanna Publications, New Delhi 2015.

22MC302 ELECTRICAL CIRCUITS AND MACHINES

3 1 0 4

Course Objectives

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

Course Outcomes (COs)

1. Understand the fundamental laws to electric circuits and compute the different alternating quantities.
2. Analyze the resonance frequency, bandwidth, Q factor and RL, RC response time constants.
3. Compare the excitation and magnetization characteristics of DC Machines
4. Compute the essential parameters for slip-speed characteristics of induction motor.
5. Identify the special electrical machines for specified application.

Articulation Matrix

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

UNIT I

10 Hours

BASIC CIRCUITS AND SIMPLIFICATION TECHNIQUES

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

UNIT II

8 Hours

RESONANCE

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

UNIT III

9 Hours

DC MACHINES

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

UNIT IV **10 Hours**

AC MOTORS

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

UNIT V **8 Hours**

SPECIAL MACHINES

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

Total: 60 Hours

Reference(s)

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

22MC303 DIGITAL LOGIC CIRCUIT DESIGN

3 0 2 4

Course Objectives

- To acquire the basic knowledge of digital logic levels and applications to understand digital electronic circuits
- To design and analyse the combinational logic circuits
- To design and analyse the sequential logic circuits

Course Outcomes (COs)

1. Understand the concepts of weighted and non weighted number systems
2. Analyze boolean laws and K map for minimization of logic circuits.
3. Design and analyze the combinational logic circuits along with its applications.
4. Design and analyze sequential logic circuits along with its applications.
5. Design and analyze synchronous & asynchronous logic circuits and also Realize them without hazards.

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	1	1		1	1	2	2
2	2	2	1	2	2	1	2	1	2		1	2	2	2
3	2	2	2	2	2	1	2	1	2		1	1		
4	3	2	1	2	2	2	1	1	2		2	2		
5	3	1	2	2	2	2	2	1	2		2	2		

UNIT I

9 Hours

NUMBER SYSTEMS AND CODE

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

UNIT II

9 Hours

BOOLEAN THEOREMS AND LOGIC REDUCTION

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

UNIT III

9 Hours

COMBINATIONAL LOGIC CIRCUIT AND DESIGN

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

UNIT IV

9 Hours

SEQUENTIAL LOGIC CIRCUITS

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

UNIT V	9 Hours
COUNTERS, PROGRAMMABLE LOGICS AND LOGIC FAMILIES Design of Synchronous & Asynchronous Counters, shift register counters, Hazards in logic circuits, Logic Families-RTL, DTL, ECL, TTL, CMOS, Programmable Logic Devices	
1	3 Hours
EXPERIMENT 1 Design and construct combinational circuit to implement two way connection for staircase light application	
2	3 Hours
EXPERIMENT 2 Design a circuit for Conveyor belt transporting bottled products to packaging, where a deflector plate is activated to deflect bottles into a reject bin if either the weight is not within certain tolerances or there is no cap on the bottle	
3	3 Hours
EXPERIMENT 3 Design a calculator circuit with a seven segment display using encoder, decoder	
4	3 Hours
EXPERIMENT 4 Design a Logic Gate-Based Data Routing System: Multiplexer	
5	3 Hours
EXPERIMENT 5 Design the comparator circuit to compare the number of products/boxes/objects for packaging industries using magnitude comparator	
6	3 Hours
EXPERIMENT 6 Design circuit based on direction of data movement and the way data is loaded and unloaded for shopping complex	
7	3 Hours
EXPERIMENT 7 Design and implement automated car parking system using flip flop - counters	
8	3 Hours
EXPERIMENT 8 Conversion of one flip-flop into another flipflop	
9	3 Hours
EXPERIMENT 9 Design and implementation of Shift register (SISO, SIPO,PIPO) using Flip flops	
10	3 Hours
EXPERIMENT 10 Design and implementation of Up, Down and Up/down counters using flip flops.	
	Total: 75 Hours

Reference(s)

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

22MC304 FLUID MECHANICS AND MACHINERIES

3 0 2 4

Course Objectives

- To impart knowledge on the fluid properties and fluid statics principles
- To introduce the basic concept of fluid kinematics and dynamics.
- To calculate the rate of flow and energy losses in flow through pipes and open channels
- To emphasize the concepts of boundary layer theory and the importance of dimensional analysis
- To impart the knowledge of pumps and turbines

Course Outcomes (COs)

1. Explain the fundamental properties of fluids and methods of pressure measurement in fluid statics
2. Infer fundamentals of fluid kinematics and dynamics and their applications in hydraulic experiments
3. Apply the concept of the boundary layer, Dimensional analysis, and Modal analysis to the fluid structures
4. Assess the performance of a model by dimensional analysis and similitude
5. Compute the efficiency and performance of pumps and turbines

Articulation Matrix

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

UNIT I

6 Hours

FLUID PROPERTIES AND FLUID STATICS

Concept of Continuum Properties of Fluid Classification of fluids Types of fluid flow Streamline Streamlines and path line. Pascal's Law and Hydrostatic Law, Pressure and its variation in a static Fluid, Measurement of fluid pressure Manometers Buoyancy and metaCentre Stability analysis and applications.

UNIT II

6 Hours

FLUID KINEMATICS AND DYNAMICS

Continuity equation Velocity Potential and Stream function Bernoulli's equation, and its applications Impulse Momentum principle Impact of Jet Velocity triangle.

UNIT III

6 Hours

FLOW THROUGH PIPES AND CHANNELS

Laminar and turbulent flows in circular pipes Major and Minor losses in pipes, Darcy Weisbach equation, Hagen Poiseuille equation Multi reservoir problems, pipe network design, Types of open Channel flows Measurement of discharge in open channels Notches - Most economical channel section

UNIT IV

6 Hours

DIMENSIONAL ANALYSIS AND MODEL TESTING

Buckingham s pi theorem and Application of theorem in fluid flow Reynolds, Froude, and Mach number and their applications in model testing Boundary layer thickness, Momentum integral equation, Drag and lift, Separation of the boundary layer, and Methods of preventing the boundary layer separation.

UNIT V

6 Hours

HYDRAULIC MACHINES

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

1

2 Hours

EXPERIMENT 1

Find the coefficient of discharge by suitable device that is most accurate to measure the fuel and air distribution in the carburetor of an IC engine in a two wheeler Also, in Pasteurization and Sterilization process. Discuss the effects of the Reynolds number and friction factor in relation to the rate of flow

2

4 Hours

EXPERIMENT 2

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

3

3 Hours

EXPERIMENT 3

Determine the coefficient of discharge by suitable device used to monitor and control the flow of water and chemicals in water treatment plants

4

3 Hours

EXPERIMENT 4

Analyze the Lift and drag force of an aerofoil design used in a windmill for power generation

5

3 Hours

EXPERIMENT 5

Conduct the performance test of a suitable turbine that is used to extract energy from waterfalls whose water drops down from a height of about 500 m to generate power in Hydropower station

6

3 Hours

EXPERIMENT 6

Conduct the test from which electricity is to be generated has its reservoir fully filled up during the rainy season and the level drops down during summer. A turbine has to be put up such that it can accommodate both cases in a hydropower station

7

3 Hours

EXPERIMENT 7

Determine the efficiency of a pump to pump water to a very high elevation, say >300 ft, and high viscous fluid used for an irrigation and Chocolate Industry

8 **3 Hours**
EXPERIMENT 8
Performance test on reaction (Kaplan) turbine

9 **3 Hours**
EXPERIMENT 9
Performance test on a centrifugal pump.

10 **3 Hours**
EXPERIMENT 10
Performance test on submersible pump/Gear pump.

Total: 60 Hours

Reference(s)

1. Yunus A. Cengel, and John M. Cimbala, Fluid Mechanics, Third edition, Mc Graw Hill Education (India) Pvt. Ltd, 2014.
2. Dr R.K. Bansal , A text book of Fluid Mechanics and Hydraulic Machines, Tenth Edition, Laxmi Publications, New Delhi, 2018.
3. Frank .M. White, Fluid Mechanics, McGraw Hill Publishing Company Ltd, New Delhi, 8th Edition. 2017
4. R.C. Hibbler, Fluid Mechanics, Pearson, First edition, 2017.
5. . S.K. Som and G. Biswas, Introduction to Fluid Machines, 3rd Edition, McGraw-Hill Education, 2017
6. . S.K. Som and G. Biswas, Introduction to Fluid Machines, 3rd Edition, McGraw-Hill Education, 2017

22MC305 ENGINEERING MECHANICS

3 1 0 4

Course Objectives

- To make the students to apply static equilibrium of rigid bodies both in two dimensions and also in three dimensions.
- To comprehend the effect of friction on equilibrium.
- To understand the geometrical properties of surfaces and solids
- To understand various terms involved in Projectiles.
- To apply dynamic equilibrium of particles in solving basic problems.

Course Outcomes (COs)

1. Explain the different principles of mechanics and to solve engineering problems dealing with forces.
2. Apply the concepts of friction to solve various problems dealing with friction.
3. Explain the different geometrical properties of various sections.
4. Solve problems in rigid body dynamics (kinematic systems).
5. Solve problems in rigid body dynamics (kinetic systems).

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	2	2	1	2	2	2	2	2
2	2	2	2	2	2	2	2		1		2	2		2
3	2	2	2	2	2	3	2		1		2	2		2
4	3	3	2	3	2	2	2	2	1	2	2	2	2	2
5	3	3	2	2	2	2	2		1		2	2		2

UNIT I

9 Hours

INTRODUCTION TO MECHANICS AND FORCE CONCEPTS

Principles and Concepts Laws of mechanics system of forces resultant of a force system Lamis theorem moment of a force Varignons theorem resolution of a force into force and couple force in space equilibrium of a particle in space.

UNIT II

9 Hours

BASIC STRUCTURAL ANALYSIS AND FRICTION

Beams and types of beams Simple Trusses Method of Joints Method of Sections. Friction resistance classification of friction laws of friction angle of repose cone of friction free body diagram equilibrium of a body on a rough inclined plane non concurrent force system ladder friction rope friction wedge friction virtual work method.

UNIT III

9 Hours

GEOMETRICAL PROPERTIES OF SECTION

Centroids determination by integration moment of inertia product of inertia principal moment of inertia of plane areas radius of gyration Mass moment inertia of simple solids.

UNIT IV

9 Hours

BASICS OF DYNAMICS KINEMATICS

Kinematics and kinetics displacements velocity and acceleration equations of motion rectilinear motion of a particle with uniform velocity uniform acceleration varying acceleration curvilinear motion of particles projectiles angle of projection range time of flight and maximum height kinematics of rigid bodies.

UNIT V

9 Hours

BASICS OF DYNAMICS KINETICS

Newtons second law of motion D Alemberts principle dynamics equilibrium work energy equation of particles law of conservation of energy principle of work and energy. Principles of impulse and momentum equations of momentum laws of conservation of momentum. impact time of compression restitution collision coefficient of restitution collision of elastic bodies by direct central impact and oblique impact collision of small body with a massive body kinetic energy of a particle kinetics of rigid body rotation.

Total: 60 Hours

Reference(s)

1. Beer F.P and Johnston Jr. E.R.Vector Mechanics for Engineers (In SI Units): Statics and Dynamics 11th Edition, Tata McGraw-Hill Publishing company, New Delhi (2015).
2. Bhavikatti S. S. and Rajashekarappa, K.G., Engineering Mechanics New Age International (P) Limited Publishers, 2017.
3. Hibbeler, R.C and Ashok Gupta, Engineering Mechanics Statics and Dynamics 11th Edition, Pearson Education 2010.
4. Irving H. Shames and Krishna MohanaRao. G. Engineering Mechanics Statics and Dynamics 4th Edition, Pearson Education 2006.
5. Meriam J. L. and Kraige L. G., Engineering Mechanics Statics - Volume 1, Dynamics Volume 2 4th Edition, John Wiley & Sons,1996.
6. www.nptel.iitm.ac.in/video.php?subjectId=122104015.

22HS004 HUMAN VALUES AND ETHICS

2 0 0 2

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

6 Hours

COURSE INTRODUCTION - NEED, BASIC GUIDELINES AND ANALYSIS

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

UNIT II

6 Hours

EMBRACING THE COMMON ETIQUETTE

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

UNIT III

6 Hours

CONTINUOUS HAPPINESS AND PROSPERITY

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

UNIT IV

6 Hours

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS

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

UNIT V

6 Hours

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

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

Total: 30 Hours

Reference(s)

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

22MC401 PROBABILITY, STATISTICS AND RANDOM PROCESS

3 1 0 4

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

9 Hours

PROBABILITY AND RANDOM VARIABLES

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

UNIT II

9 Hours

STANDARD DISTRIBUTIONS

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

UNIT III

9 Hours

TESTING OF HYPOTHESIS

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

UNIT IV **9 Hours**

DESIGN OF EXPERIMENTS AND CONTROL CHART

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

UNIT V **9 Hours**

RANDOM PROCESSES

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

Total: 60 Hours

Reference(s)

1. Peyton Z Peebles, Probability, Random Variables and Random Signal Principles, Tata McGraw Hill Publications, New Delhi, 4th Edition, 2010.
2. Richard A Johnson and John Freund, Miller and Friends Probability Statistics for Engineers, 8th Edition, Pearson Education, 2015
3. Henry Stark and John W. Woods, Probability and Random Processes with Applications to Signal Processing, Pearson Education, Delhi, 3rd Edition, 2002
4. Athanasios Papoulis, S. UnniKrishna Pillai, Probability , Random Variables and Stochastic Processes, Tata McGraw Hill Publications, New Delhi, 4th Edition , 2010

22MC402 SENSORS AND TRANSDUCER

3 0 2 4

Course Objectives

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

Course Outcomes (COs)

1. Predict the type of errors, characteristics and mathematical model of a transducer
2. Assess the characteristics of variable resistive transducer in a given application
3. Justify the principles of variable inductive transducer
4. Compare the different capacitive transducers for the measurement of physical quantities
5. Identify various transduction methods used for field applications

Articulation Matrix

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

UNIT I

9 Hours

CHARACTERISTICS OF INSTRUMENTS

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

UNIT II

9 Hours

VARIABLE RESISTANCE TRANSDUCERS

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

UNIT III

9 Hours

VARIABLE INDUCTANCE TRANSDUCERS

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

UNIT IV

9 Hours

VARIABLE CAPACITIVE TRANSDUCERS

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

UNIT V	9 Hours
OTHER TRANSDUCERS	
Piezoelectric transducer- Ultrasonic transducer, magnetostrictive transducer, fiber optic transducers, hall effect transducers, photoelectric transducers, and humidity sensor, Digital transducer. FOR FURTHER READING Seismic Sensor - IC temperature sensor- Pneumatic transducer- Flapper-Nozzle sensor - Sensors for environmental monitoring-Sensing environmental pollution-Aerospace sensor- Sensing direction of air flow- Measuring air speed on air craft	
1	4 Hours
EXPERIMENT 1	
Measurement of linear displacement and Pressure using inductive transducer	
2	3 Hours
EXPERIMENT 2	
Design of signal conditioning circuit for resistance thermometer	
3	3 Hours
EXPERIMENT 3	
Measurement of magnetic field using Hall Effect transducer	
4	2 Hours
EXPERIMENT 4	
Liquid level measurement using capacitive transducer.	
5	4 Hours
EXPERIMENT 5	
Measurement of light intensity using optical transducers	
6	3 Hours
EXPERIMENT 6	
Design of linearization circuit for thermistor	
7	2 Hours
EXPERIMENT 7	
Vibration measurement using Piezo electric accelerometer	
8	3 Hours
EXPERIMENT 8	
Measurement of force using strain gauge and load cell.	
9	3 Hours
EXPERIMENT 9	
Measurement of linear and angular displacement using resistive transducer.	
10	3 Hours
EXPERIMENT 10	
Measurement of speed using digital shaft angle encoder	
	Total: 75 Hours

Reference(s)

1. A. K. Sawhney, PuneetSawhney, A course in Electrical and Electronic Measurements and Instrumentation, Nineteenth edition Dhanpat Rai & Co (P) Ltd, 2012.
2. H.S.Kalsi, Electronic Instrumentation, Third Edition, Tata McGraw Hill Education Private Limited, 2012.
3. D. Patranabis, Sensors and Transducers, 2nd Edition, Prentice Hall India Pvt. Ltd, 2009
4. E.O.Doeblin, Measurement Systems: Applications and Design , 6th Edition, Tata McGraw-Hill Book Co., 2012.
5. D. V. S. Murthy, Transducers and Instrumentation, 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.
6. J. P. Bentley, Principles of Measurement Systems, 4th Edition, Addison Wesley Longman Ltd., UK, 2015.

22MC403 STRENGTH OF MATERIALS

2 1 2 4

Course Objectives

- To provide knowledge about stress structures subjected to axial and thermal loads
- To familiarize about two-dimensional stress systems and theories of failure.
- To construct shear force, bending moment diagrams and evaluate the bending stress in beams under transverse loading
- To impart knowledge on finding slope and deflection of beams and buckling of columns for different boundary conditions
- To provide awareness on stresses on shafts and helical springs based on theory of torsion

Course Outcomes (COs)

1. Find the stress distribution and strains in regular and composite structures subjected to axial loads.
2. Compare the compound stresses in two dimensional systems and thin cylinders
3. Assess the shear force, bending moment and bending stresses in beams under transverse loading
4. Compare the slope and deflection of beams and buckling loads of columns under different boundary conditions
5. Justify torsion equation in design of circular shafts and helical springs

Articulation Matrix

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

UNIT I

6 Hours

SIMPLE STRESS AND STRAIN

Mechanical properties of Materials. Stress-strain curve - Factor of safety. Strain Energy and Impact Loading. Stepped and Composite bars - Axial Stresses, Thermal Stress and Volumetric Stresses - Elastic constants and their relationship.

UNIT II

6 Hours

COMPOUND STRESSES AND THIN CYLINDER

State of stresses at a point, 2D Stress System, Plane Stress Condition, Mohr's circle. Thin Cylinders - Stresses, Strain, Maximum Shear stress, Changes in dimensions and volume. Theories of Failure - Significance and Graphical Representations.

UNIT III

9 Hours

COMPOUND STRESSES AND THIN CYLINDER

Beams - Types of supports, loads and beams, Shear force and Bending Moment in Cantilever, simply supported and overhanging beams, Point of contra flexure. Theory of Simple Bending, Section modulus, Bending stress and stress variation along the length and section of the beam.

UNIT IV **6 Hours**

DEFLECTION OF BEAMS AND COLUMNS

Slope and Deflection of cantilever and simply supported beams by Double integration method and Macaulays method. Theory of Columns - Slenderness ratio, End Conditions, Equivalent length, Euler and Rankine's formulae.

UNIT V **6 Hours**

TORSION IN SHAFT AND HELICAL SPRING

Theory of Torsion, Stresses and Deformations in Solid and Hollow Circular Shafts, Combined bending moment and torsion of shafts, Power transmitted to shaft, Shaft in series and parallel. Close coiled helical spring - Stresses, deflection, Maximum shear stress in spring section including Wahls Factor, springs in series and parallel.

1 **3 Hours**

EXPERIMENT 1

Prepare the specimen and find the hardness of the given material

2 **3 Hours**

EXPERIMENT 2

Plot stress-strain curve by observing the tensile behaviour of the given specimen

3 **3 Hours**

EXPERIMENT 3

Study the deflection phenomenon of the loaded beam and compare the experimental values of deflection with the theoretical values.

4 **3 Hours**

EXPERIMENT 4

Subject the material to compressive loading and find its strength.

5 **3 Hours**

EXPERIMENT 5

Calculate the strains in cylindrical vessels subjected to internal pressure through thin cylinder test setup

6 **3 Hours**

EXPERIMENT 6

Determine the strain energy of a material subjected to impact loading

7 **3 Hours**

EXPERIMENT 7

Determination of spring constant through load vs deflection curve

8 **3 Hours**

EXPERIMENT 8

Experimental analysis of a bar under torsion to obtain stiffness and angle of twist

Total: 72 Hours

Reference(s)

1. S.S.Rattan, Strength of Materials, McGraw Hill Education (India) Private Limited, Chennai, Third Edition, 2017
2. F. P. Beer and R. Johnston, McGraw Hill Education India Private Limited, Seventh edition, 2017
3. S.S.Bhavikatti, Strength of Materials, Vikas Publishing House, New Delhi, Fourth edition, 2013
4. Egor P. Popov, Engineering Mechanics of Solids, Pearson India Education Services Pvt Ltd, New Delhi, 2015
5. William Nash and Nilanjan Malik, Strength of Materials (Schaum"s Outline Series), McGraw Hill Education, Fourth Edition, 2017
6. https://onlinecourses.nptel.ac.in/noc18_ce17/preview

22MC404 THEORY OF MACHINES

3 0 2 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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

9 Hours

BASICS OF MECHANISMS

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

UNIT II

9 Hours

KINEMATICS OF MECHANISMS

Vector representation of Displacement, velocity and acceleration - Graphical method of velocity (relative velocity method) and acceleration diagrams for simple mechanisms - Coriolis component of acceleration

UNIT III

9 Hours

KINETICS OF MECHANISMS

Static force analysis: Applied and constraint forces, Free body diagrams, Static equilibrium conditions: Two, three and four members - Static force analysis of simple mechanisms - The principle of superposition Dynamic force analysis: Inertia force and Inertia torque, D Alemberts principle, Dynamic Analysis in Four bar mechanism

UNIT IV **9 Hours**

BALANCING AND VIBRATION

Balancing: Balancing of Single Rotating mass by a single mass rotating in the same plane and two masses rotating in different planes - Several masses rotating in the same plane and different planes
Vibration : Introduction - 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 Involute and cycloidal tooth profiles Spur gear terminology and definitions
Gear tooth action Interference and undercutting Problems Helical, bevel, worm, rack and pinion gears, Strain wave (harmonic) gear (Basics only)
Gear trains: Introduction to gear correction, gear trains Speed ratio, train value, - Types of gear trains: Parallel axis gear trains, Epicyclic gear trains - Determination of gear speeds and torque using tabular method

1 **6 Hours**

EXPERIMENT 1

Determine moment of inertia of engine components

2 **6 Hours**

EXPERIMENT 2

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

3 **6 Hours**

EXPERIMENT 3

Analyse vibration in unbalanced shaft

4 **6 Hours**

EXPERIMENT 4

Find torque and speed ratio of given epicyclic gear

5 **6 Hours**

EXPERIMENT 5

Analyse the given fourbar mechanism for its kinematic behaviours

Total: 75 Hours

Reference(s)

1. S. S. Rattan, Theory of Machines, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2019
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 Garry L. Kinzel, Kinematics, Dynamics and Design of Machinery, John Wiley and Sons (Asia) Pvt. Ltd., New Delhi, 2007

22MC405 EMBEDDED SYSTEMS

3 0 2 4

Course Objectives

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

Course Outcomes (COs)

1. Construct the 8086 architecture and write ALP for 8086 processor
2. Use hardware and software architectures of Embedded Systems
3. Outline the special features and architecture of TIVA C series microcontroller
4. Justify different communication protocols used for Embedded Networking
5. Integrate the embedded applications by interfacing the OFF-chip peripherals with the microcontroller

Articulation Matrix

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

UNIT I

9 Hours

8086 MICROPROCESSOR

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

UNIT II

9 Hours

INTRODUCTION TO EMBEDDED SYSTEM

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

UNIT III

9 Hours

TIVA-C MICROCONTROLLER

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

UNIT IV

9 Hours

COMMUNICATION PROTOCOLS

UART, ADC, PWM, Timer, I2C, SPI.

UNIT V

9 Hours

OFF-CHIP PERIPHERAL INTERFACING AND PROGRAMMING

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

1 EXPERIMENT 1 16-bit, 32-bit Arithmetic Operations (8086)	4 Hours
2 EXPERIMENT 2 String Operations (8086)	Hours
3 EXPERIMENT 3 EXPERIMENT 3 Sorting (8086)	5 Hours
4 EXPERIMENT 4 Flashing of LEDS using Shift Register	5 Hours
5 EXPERIMENT 5 Interfacing DC	6 Hours
6 EXPERIMENT 6 Interfacing temperature sensor	6 Hours

Total: 75 Hours

Reference(s)

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

22HS007 ENVIRONMENTAL SCIENCE

2 0 0 0

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

6 Hours

NATURAL RESOURCES

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

UNIT II

6 Hours

ECOSYSTEMS AND BIODIVERSITY

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

UNIT III

6 Hours

ENVIRONMENTAL POLLUTION

Pollution: Definition - causes - effects - control measures of air pollution - Water pollution - Sewage water treatment by activated sludge and trickling filter process - Noise pollution - Thermal pollution. Disaster management - causes - effects - control measures of floods - Earthquake

UNIT IV

7 Hours

SOCIAL ISSUES AND ENVIRONMENT

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

UNIT V

5 Hours

HUMAN POPULATION AND ENVIRONMENT

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

Total: 30 Hours

Reference(s)

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

22MC501 ROBOTICS AND MACHINE VISION

2 1 2 4

Course Objectives

- To acquire knowledge on the fundamentals of robotics and machine vision systems
- To develop the kinematic model of an industrial manipulator
- To understand the concept of robot work cell design and the applications of the robotic systems.

Course Outcomes (COs)

1. Select the robot systems and robotic manipulators based on their mobility and interpret the fundamental terminologies used in robotic
2. Demonstrate gripper mechanisms and select suitable gripper for a robotic application
3. Compute the kinematic model of the robotic systems using the fundamental transformation and homogeneous transformation matrices
4. Use an appropriate robot work cell layout for different applications in manufacturing and assembly sectors
5. Outline the applications of mobile robots and path planning techniques using machine vision 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	1	1	2	2	2	2	1	1
2	2	2	1	1	1	1	2	2	2	2	2	2	2	3
3	2	3	1	2	1	1	1		1	1			1	2
4	3	2	2	1	1	2	2	2	2				1	2
5	2	1	2	1	1	2	2	1	1	1		1	2	2

UNIT I

9 Hours

INTRODUCTION TO ROBOTICS

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

8 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

10 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**

MOBILE ROBOTICS AND MACHINE VISION

Introduction - types of mobile robot - kinematics of wheeled mobile robot -Path planning techniques in field robots- Machine Vision Systems- CCD/CMOS camera-Imaging techniques Non-conventional industrial robots- Mobile Manipulators- ROS and programming.

1 **3 Hours**

EXPERIMENT 1

Visualization of Denavit- Hartenberg parameters

2 **3 Hours**

EXPERIMENT 2

Simulation of forward kinematics of 3R robot

3 **3 Hours**

EXPERIMENT 3

Simulation of forward kinematics of 3P robot

4

4 **3 Hours**

EXPERIMENT 4

Simulation of Forward kinematics of PRP configured robot

5 **3 Hours**

EXPERIMENT 5

Simulation of Forward and inverse kinematics of SCARA robot.

6 **3 Hours**

EXPERIMENT 6

Generate a program in CpROG environment for pick and place operation

7 **3 Hours**

EXPERIMENT 7

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

8 **3 Hours**

EXPERIMENT 8

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

9 **3 Hours**

EXPERIMENT 9

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

10 **3 Hours**

EXPERIMENT 10

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

Total: 90 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. S.R. Deb, Robotics Technology and flexible automation, 2nd Edition, Tata McGraw-Hill Education, 2017
4. Roland Siegwart, Nourbaksh I. R., Scaramuzza D., 2nd Edition, The MIT press, 2011
5. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, Robotics Engineering an Integrated Approach, PHI Learning, 2009.
6. NPTEL - <https://nptel.ac.in/courses/112105249/>

22MC502 MANUFACTURING TECHNOLOGY

2 0 2 3

Course Objectives

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

Course Outcomes (COs)

1. Predict the basics and working principle of sand casting and special casting processes
2. Demonstrate the principles of different joining processes like welding, brazing, soldering and adhesive bonding
3. Select the suitable metal forming processes for various application
4. Demonstrate the process of conventional machining and explain the principles of non-conventional machining processes
5. Outline the suitable method to produce thermo and thermosetting plastics

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	2	2	2	2	1	1
2	2	2	1	1	1	1	2	2		2	2	2	2	3
3	3	3	1	2	1	1	1	2	1	1			1	2
4	2	2	2	1	1	2	2	2	2				1	2
5	2	1	2	1	1	2	2	1	1	1		1	2	2

UNIT I

6 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 -Flim blowing - -Thermoforming - Compression moulding -Transfer moulding

UNIT II

6 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

6 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

6Hours

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 machines

UNIT V	6 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 3D Printing - Technologies, Processes, STL File, Advantages and Disadvantages; Laser Beam Welding; Automated Molding system	
1 EXPERIMENT 1 Machining a cotter pin whose diameter is continuously varying throughout its length	3 Hours
2 EXPERIMENT 2 Making a model of screw used in vernier caliper	3 Hours
3 EXPERIMENT 3 Practicing to make models like table, chair, rack, teapoy, stool, etc using arc welding equipment	3 Hours
4 EXPERIMENT 4 Fabrication of a pin and hole with push fit assembly using centre lathe	3 Hours
5 EXPERIMENT 5 Preparing the shaft/key/coupling assembly by selecting suitable machining operations and to list the sequence of operations.	3 Hours
6 EXPERIMENT 6 Machining of flange with four holes placed \hat{A}, \hat{A}° and with internal thread at the centre to connect pipes	3 Hours
7 EXPERIMENT 7 Machining a spur gear with n number of teeth with 2 mm module by selecting suitable machine tool.	3 Hours
8 EXPERIMENT 8 Grinding of single point cutting tool in the 10 mm MS square rod with standard nomenclature using tool and cutter grinding machine	3 Hours
9 EXPERIMENT 9 Preparing the surface of the shaft within the tolerance limit of $\tilde{A}, \hat{A} \pm 0.002$ mm to assemble with a bearing of inside diameter 22 mm	3 Hours
10 EXPERIMENT 10 Producing a square bar from the given shaft with minimum material wastage by selecting suitable machining operations	3 Hours

Total: 60 Hours

Reference(s)

1. J. P. Kaushish, Manufacturing Processes, Prentice Hall of India Learning Private Limited, New Delhi, 2014
2. P. N. 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.

22MC503 THERMODYNAMICS AND HEAT TRANSFER

3 0 2 4

Course Objectives

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

Course Outcomes (COs)

- Use fundamental thermodynamic properties and laws for engineering problems
- Demonstrate various thermodynamic process and solve steady flow energy equation for engineering system
- Select the concept of entropy and evaluate efficiency for major thermodynamic gas power cycles
- Compare fundamentals of heat transfer and overall heat transfer coefficient of a system
- Outline 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	2	3	2	1	2		2	3	2
2	3	3	3	2		2	3	2	1	2	2	2	2	3
3	3	3	2	2	2	2	3		2	2	1	2	3	2
4	3	3	3	2	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 steam. 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 mechanism. Interior and exterior convection. Convection over flat surfaces. Convection over cylinders. Electromagnetic spectrum and radiation physics. Kirchoffs law. Black-body radiation. Numerical problems

1	3 Hours
EXPERIMENT 1 Experimental study on port timing and valve timing diagram of IC engines.	
2	3 Hours
EXPERIMENT 2 Experimental study on performance test of 4-Stroke diesel engine	
3	3 Hours
EXPERIMENT 3 Experimental study on heat balance test of 4-Stroke diesel engine	
4	3 Hours
EXPERIMENT 4 Experimental study on performance test of 4-Stroke Petrol engine	
5	3 Hours
EXPERIMENT 5 Experimental study on determination of Coefficient of Performance of refrigeration system	
6	3 Hours
EXPERIMENT 6 Experimental study on determination of Coefficient of Performance of Air-conditioning system	
7	3 Hours
EXPERIMENT 7 Determination of thermal conductivity for one dimensional steady state conduction	
8	3 Hours
EXPERIMENT 8 Determination of heat transfer co-efficient by unsteady heat transfer	
9	3 Hours
EXPERIMENT 9 Determination of heat transfer co-efficient by natural convection	
10	3 Hours
EXPERIMENT 10 Determination of Stefan-Boltzmann constant	
	Total: 75 Hours

Reference(s)

1. I. P. K. Nag, Engineering Thermodynamics, Edition 6, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017
2. Yunus A. Cengel and Michael A. Boles, Thermodynamics - An Engineering Approach in SI Units, Tata McGraw Hill Publishing Company, New Delhi, 2017
3. R. K. Rajput, Thermal Engineering, Laxmi Publications, 2020.
4. C. P. Kothandaraman and S. Subramanya, Fundamentals of Heat and Mass Transfer, New Age International Publishers, New Delhi, 2012
5. T. D. Eastop and McConkey, Applied Thermodynamics for Engineering Technologists, Pearson, New Delhi, 2004
6. NPTEL - <https://nptel.ac.in/courses/112105123/1>

22MC504 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

Course Outcomes (COs)

1. Demonstrate a mathematical model of a physical system and compute the transfer function using block diagram reduction technique and Signal flow graph
2. Assess the performance of first and second order system and compute the steady state error for different test signals
3. Find the frequency domain response and determine the phase margin and gain margin using bode plot, polar plot and Nyquist plot
4. Use the cascade compensation and design a lag, lead and lag-lead series compensator using bode plot
5. Outline 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		2	2				2	3
2	1	2	3	2					1	1	2			2
3	1	3	3	2		1		1	1		2			3
4	1	2	3	1	1		1			1	1			2
5	1	2	1	2										3

UNIT I

9 Hours

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.

Total: 60 Hours

Reference(s)

1. Develop a mathematical model of mechanical/ electrical/ thermal system and develop transfer function of system using Block diagram approach/signal flow graph/ transfer function approach.
2. Analyze the stability and time domain performance of a developed mechanical/ electrical/ thermal system using time domain analysis like Root locus, Bode plot.
3. Design a controller for a developed mechanical/ electrical/ thermal system based on required time domain specification in MATLAB

22MC601 DESIGN OF MECHATRONICS SYSTEM

3 0 2 4

Course Objectives

- To study about mechatronics design process
- To study the Electro pneumatics in Mechatronics system
- To Understand about the application of mechatronics system

Course Outcomes (COs)

1. Demonstrate the mechatronics design process, data acquisition and control through case studies
2. Compare the various System modelling parameters available in mechatronics system
3. Outline the aspects of real time interfacing in mechatronics system design
4. Justify the different design technology for various applications
5. Determine the concept of micro mechatronics system and implementing in real time systems

Articulation Matrix

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

UNIT I

9 Hours

ELEMENTS OF MECHATRONICS SYSTEM

Key elements Mechatronics Design process Design Parameters Traditional and Mechatronics designs - Advanced approaches in Mechatronics - Industrial design and ergonomics, safety

UNIT II

9 Hours

ELECTRO PNEUMATICS

Components and symbols of electro pneumatics Electrical Logical connection relay circuit Latching unlatching Solenoid operated valve Direct and indirect electrical actuation of Solenoid valve Memory circuit with solenoid valve open loop and closed loop control Proximity sensor Timer and counter Application pneumatic speed control multi cylinder control Diverting packages, sealing plastic can Palletising

UNIT III

9 Hours

PROGRAMMABLE LOGIC CONTROLLER

Introduction-selection of interfacing standards Elements of Data Acquisition & control Systems- Over view of I/O process, General purpose I/O card and its installation, Data conversion process, Application Software Lab view Environment and its applications, Vim-Sim Environment & its applications Man machine interface

UNIT IV **9 Hours**

PROGRAMMING PLC

Ladder logic I/O addressing, registers basics, basic relay instructions, timer-counter instructions, arithmetic functions, comparison functions, data handling, data move functions, input-output instructions, sequencer instructions, Functional block, Sequential Flow control Programming Application PLC control of pneumatic cylinder and multi cylinder control.

UNIT V **9 Hours**

MODULAR PRODUCTION SYSTEM

Introduction Components/ commissioning of Modular production system (MPS) Commissioning, Assembly interfacing and programming of Distribution station, Pick and place station, Handling station and Measuring station.

1 **6 Hours**

EXPERIMENT 1

Design a control panel with SMPS and interface Input output devices such as HMI, Relay, with programmable logic controller (PLC) according to industrial standard.

2 **6 Hours**

EXPERIMENT 2

Design / Develop a PLC program to interface minimum 8 DI/DO to a factory or process automation plant using ladder logic

3 **6 Hours**

EXPERIMENT 3

Design / Develop a PLC program to interface minimum 2 AI/AO to a factory or process automation plant using SFC/Functional Block

4 **6 Hours**

EXPERIMENT 4

Demonstrate / Interface the control of Factory automation plant with minimum 4DI/DO using Programmable logic controller.

5 **6 Hours**

EXPERIMENT 5

Demonstrate / Interface the control of process automation plant with minimum 4DI/DO using Programmable logic controller.

Total: 75 Hours

Reference(s)

1. Bishop, Robert H, Mechatronics Hand book, CRC Press, 2002.
2. Bradley, D.Dawson, N.C. Burd and A.J. Loader, Mechatronics: Electronics in Products and Processes, CRC Press 1991 , First Indian print 2010.
3. De Silva, Mechatronics: A Foundation Course, Taylor & Francis, Indian Reprint, 2013.
4. Devdas shetty, Richard A. Kolk, Mechatronics System Design, 2nd Edition ,Cengage Learning 2011
5. Georg pelz, Mechatronic Systems: Modeling and simulation with HDL's, John wiley and sons Ltd, 2003

22MC602 POWER ELECTRONICS AND DRIVES

3 0 2 4

Course Objectives

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

Course Outcomes (COs)

1. Predict the switching characteristic of different types of power semi-conductor devices
2. Assess the operation, characteristics and performance parameters of converters
3. Show various inverter techniques and harmonics elimination methods
4. Find the speed control of solid state DC drives
5. Outline the speed control methods of AC machines and power factor correction

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	2	2	2	2	1
2	2	2	2		2				3	2	2		2	2
3	3	2	2	3					3					3
4	3	3		2	2			2	2		2			2
5		2	2		2		2		2				2	2

UNIT I

8 Hours

POWER SEMICONDUCTOR DEVICES

Construction, Operation, Characteristics of Power Diode SCR TRIAC - Power transistor MOSFET and IGBT - di/dt and dv/dt protection, introduction to driver and snubber circuits.

UNIT II

10 Hours

CONVERTERS AND CHOPPERS

Phase Control Single Phase and Three phase uncontrolled and controlled rectifiers with R and RL load, performance parameters, Choppers, Time ratio control, Types, Buck-boost chopper-four quadrant operation cycloconverters Applications-Battery operated vehicles.

UNIT III

7 Hours

INVERTERS

Single phase and three phase voltage source inverters PWM techniques Sinusoidal PWM modified sinusoidal PWM and multiple PWM Current source inverters Harmonics elimination technique Applications Induction heating, UPS.

UNIT IV

10 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

10 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. vector control- Applications.

1	6 Hours
EXPERIMENT 1 Create a new simulation model for the rectifier, inverter to verify the efficiency	
2	6 Hours
EXPERIMENT 2 Create a new simulation model of chopper and cycloconverter to verify the efficiency	
3	6 Hours
EXPERIMENT 3 Construct closed loop Class A chopper drive circuit and to control the speed of the dc motor.	
4	6 Hours
EXPERIMENT 4 Control the speed of the DC motor with direct torque control using digital simulation	
5	6 Hours
EXPERIMENT 5 Control the speed of the Induction motor with direct torque control using digital simulation	

Total: 75 Hours

Reference(s)

1. Muhammad H. Rashid, Power Electronics - Circuits, Devices and Applications, Prentice Hall of India Learning. Ltd., New Delhi, 2017.
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. M. D. Singh and K. B. Khanchandani, Power Electronics, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2017. 5
5. Vedam Subrahmaniam, Electric Drives (concepts and applications), Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2013.
6. P. S. Bhimbra, Power Electronics, Khanna Publishers, New Delhi, 2018.

22MC603 FLUID POWER SYSTEM

2 1 2 4

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

Course Outcomes (COs)

1. Assess the components of fluid power system and compute losses in hydraulic system
2. Demonstrate hydraulic pumps and select suitable actuators used in hydraulic system
3. Select the hydraulic valves for the given applications.
4. Outline the fundamentals of pneumatic system
5. Integrate 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	2	1	1	1	1	2	1	1	2	1	2	1	1	1
2	2	1	1	1	1		2	2	2			1	2	2
3	2	1	1	1	1	2		2						2
4	2	1	1	1	1							1		2
5	2	2	1	1	2	2	1	1	1	2			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 Numerical Problems.

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 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 Numerical Problems.

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	
1	3 Hours
EXPERIMENT 1 Identification of fluid power system components.	
3	3 Hours
EXPERIMENT 3 Actuation of a single acting cylinder using limit switch and push button in a kit and simulation software.	
4	3 Hours
EXPERIMENT 4 Actuation of a double acting cylinder using limit switch in a kit and simulation software	
5	3 Hours
EXPERIMENT 5 Simulation of fluid power circuits with logic controls (AND valve and OR valve).	
6	3 Hours
EXPERIMENT 6 Design of PLC circuits using to actuate the double acting cylinder of Hydraulic lift	
7	3 Hours
EXPERIMENT 7 Actuation of meter in, meter out, synchronizing and quick exhaust circuit in a simulation software	
8	3 Hours
EXPERIMENT 8 Design of pneumatic circuit for a drilling operation and simulate the operation in a simulation software (use step counter method).	
9	3 Hours
EXPERIMENT 9 Design of hydraulic circuit for a pick and place operation using cascade method and simulate the operation	
10	3 Hours
EXPERIMENT 10 Design of fluid power circuit using Karnaugh Veitch method and simulate the operation in a simulation software.	
	Total: 72 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, 2015
3. James L. Johnson, Introduction to Fluid Power, Delmar Thomson Learning, 2016
4. S. R. Majumdar, Pneumatic systems - Principles and maintenance, Tata McGraw Hill Publishing Company Pvt Ltd. New Delhi, 2014.
5. Andrew Parr, Hydraulics and Pneumatics, Jaico Publishing House, 2015
6. <https://nptel.ac.in/courses/112105047>

22MC701 INDUSTRIAL AUTOMATION AND IOT

3 0 2 4

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

Course Outcomes (COs)

1. Outline the need of automation in industries
2. Demonstrate different instructions available in PLC for various applications
3. Justify supervisory control and data acquisition systems for particular applications
4. Integrate the distributed control system and to differentiate the DCS over other automation systems
5. Outline the proper communication buses and its protocol for industrial applications

Articulation Matrix

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

SUPERVISORY CONTROL 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 -Fieldbus, Modbus, Profibus - Device net - CAN network - System Operation and Troubleshooting.

1 **6 Hours**

EXPERIMENT 1

Design a control panel with SMPS and interface Input /output devices such as HMI, Relay, with programmable logic controller (PLC) according to industrial standard.

2 **6 Hours**

EXPERIMENT 2

Develop a PLC program to interface minimum 8 DI/DO and 2 AI/AO to a factory or process automation plant using ladder logic or SFC or Functional Block .

3 **6 Hours**

EXPERIMENT 3

Demonstrate the control of Factory automation or Process automation plant with minimum 4DI/DO using Programmable logic controller.

4 **6 Hours**

EXPERIMENT 4

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

5 **6 Hours**

EXPERIMENT 5

Design a SCADA screen for automatic level monitoring system

Total: 75 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

22MC702 MACHINE LEARNING TECHNIQUES

3 0 0 3

Course Objectives

- To understand the fundamentals of supervised learning algorithms
- To acquire knowledge on unsupervised learning algorithms
- To gain the knowledge on reinforcement algorithm
- To develop the neural networks and convolutional neural networks for object classifications.
- To perform object detection using CNN, RCNN, SSD and Yolo.

Course Outcomes (COs)

1. Predict the concepts of machine learning techniques
2. Assess the concepts of unsupervised learning techniques
3. Show the concept for reinforcement learning methods
4. Outline the neural network layer for object classification
5. Justify various neural network algorithms for object detection and its pose estimation

Articulation Matrix

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

UNIT I

9 Hours

SUPERVISED LEARNING METHODS

Introduction to learning & classifiers classification and regression naïve bayes linear regression logistic regression support vector mechanism Random forest Non Linear Regression Polynomial Regression.

UNIT II

9 Hours

UNSUPERVISED LEARNING METHODS

Clustering and association K means clustering K nearest neighbor Hierarchical clustering probabilistic clustering Autoencoders Apriori algorithm Principle component analysis independent component analysis Singular value decomposition.

UNIT III

9 Hours

REINFORCEMENT LEARNING METHODS

Terms in Reinforcement Learning Key features and Elements Bellman Equation Types of Reinforcement Learning Reinforcement Learning Algorithm Markov Decision Process Monte Carlo Methods QLearning Applications of Reinforcement Learning.

UNIT IV

9 Hours

DEEP LEARNING

Introduction Image fundamentals Layers Neuron Hyperparameter activation functions learning rate forward and back propagation gradient descent Neural network CNN Image classification.

UNIT V

9 Hours

OBJECT DETECTION METHODS

ImageNet VGG Net ResNet MobileNet R-CNN Faster R-CNN Single shot detector(SSD) You only look once (YOLO) Face recognition gesture recognition object recognition.

Total: 45 Hours

Reference(s)

1. Ethem Alpaydin, Introduction to Machine Learning, The MIT Press, Cambridge, London, 2014.
2. Vaibhav Verdhhan, Computer Vision Using Deep Learning: Neural Network Architectures with Python and Keras, 1st ed. Edition, Apress, 2021.
3. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, Second edition, The MIT Press, 2015.
4. S. Rajasekaran, GA Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms, Prentice Hall of India Private Limited, 2003.
5. Simon Haykin, Neural Networks, A comprehensive foundation, Prentice Hall, 3rd Edition, 2004.
6. https://onlinecourses.nptel.ac.in/noc18_cs26/course.

22MC707 PROJECT WORK I

0 0 4 2

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

Course Outcomes (COs)

1. Select a real world problem and develop the design solutions.
2. Compare technical ideas, strategies and methodologies
3. Integrate the new tools, algorithms, techniques that contribute to obtain the solution of the project
4. Check and validate through conformance of the developed prototype and analysis the cost effectiveness
5. Generate 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

22MC801 PROJECT WORK II

0 0 2010

Course Objectives

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

Course Outcomes (COs)

1. Select a real world problem, identify the requirement and develop the design solutions.
2. Compare technical ideas, strategies and methodologies
3. Integrate the new tools, algorithms, techniques that contribute to obtain the solution of the project
4. Check and validate through conformance of the developed prototype and analysis the cost effectiveness
5. Generate 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

22HSC01 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

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 language tasks

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 Sentence 3 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

22MC001 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.

Course Outcomes (COs)

1. Assess the robotic manipulator based on configuration and robot work cell
2. Compute the kinematic model of the robotic manipulator using DH convention
3. Show the workspace singularity of the robotic manipulator using differential kinematics
4. Justify the equation of motion of the manipulator using robot dynamic model
5. Show polynomial trajectories for a robotic manipulator motion

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	2	2	2	2	1	1
2	2	2	1	1	1	1	2			2			2	3
3	2	3	1	2	1	1	1		1	1			1	2
4	3	2	2	1	1	2	2	2	2				1	2
5	2	1	2	1	1	2	2		1	1	2	1	2	2

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 Jacobian. 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.

22MC002 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.

Course Outcomes (COs)

1. Select the concepts of ROS communication, nodes, topic and messages for data transfer applications
2. Demonstrate the model for the simulation and visualization of robots in the ROS platform
3. Use image processing concepts for robot perception using ROS
4. Outline the motion control algorithm to implement localization and navigation in autonomous mobile robots
5. Organize a low level control algorithm for robot arm motion in ROS

Articulation Matrix

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

22MC003 DRONE TECHNOLOGY

3 0 0 3

Course Objectives

- To understand the evolution and the basic structure of drone technology
- To analyze the characteristics of drone and its applications.
- To apply the method of operating drone in a desired trajectory.

Course Outcomes (COs)

1. Implement the fundamental ideology about exploring the potential of the drone technology
2. Use advanced ICT solutions for the programming of drones and establish the parameter for flying
3. Outline the precaution and pre-flight maintenance for the safety use of drones.
4. Integrate guidance and trajectory control algorithm to navigate the drone in projected path

Articulation Matrix

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

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 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.M. and Abdallah C.T., Robot Manipulator Control: Theory and Practice, Marcel Dekker Inc., NY, USA, 2004.

22MC005 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

Course Outcomes (COs)

1. Understand the different types of medical robots and the concepts of navigation and motion replication.
2. Outline the need for Minimally Invasive Surgery using medical robots
3. Compare the applications of image-guided interventions in surgical robotics
4. Integrate the concepts of exoskeleton and rehabilitation robotics
5. Compare the concept of biomedical robots.
6. Differentiate the design characteristics, methodology and technological choices for medical robots.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	2	3	2	3	3	2	2	3	1	3	2	2
2	2	2	3	2	2	3	3	2	2	2	3	3	2	2
3	3	3	3	2	3	3	3	2	2	3	3	2	3	2
4	3	1	2	3	2	3	3	3	2	2	3	1	2	3
5	3	1	3	2	2	3	3	1	2	2	2	3	3	3
6	3	1	2	2	2	3	3	2	2	2	2	3	2	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 resolution. EMG, EEG and ECG Machines.

UNIT V

9 Hours

BIO-MEDICAL ROBOTICS

Haptic Augmentation in Exoskeletons, Robotic Catheters for percutaneous interventions, Unsupervised learning 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 M. 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. JocelyneTroccaz, 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.

22MC006 MOBILE ROBOTICS

3 0 0 3

Course Objectives

- To recall the introduction to of Mobile Robotics with case studies.
- To study the forward and inverse kinematics of wheeled robot with Manoeuvrability.
- To illustrate gaussian filters , Particle filter with Velocity, odometry model of mobile robot.
- To study the localization and Mapping behaviour of Mobile Robot.
- To plan and control the path of mobile robot using path planning algorithm.

Course Outcomes (COs)

1. To understand locomotion and types of wheeled robot used in Mobile robotics field.
2. To apply forward and inverse kinematics of mobile robot to develop kinematics of mobile robot.
3. To Apply gaussian filters on Robotics model for identifying the behaviour of robot.
4. To analyse the position of robot by localization and mapping.
5. To develop mobile robot for path planning and control.

Articulation Matrix

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

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. Karsten Berns, Ewald Von Puttkamer , "Autonomous Land Vehicles Steps towards Service Robots", Vieweg Teubner Springer, 2009.
2. 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.
3. Bruno Siciliano, Oussama Khatib , "Springer Hand Book of Robotics", Springer, 2008.

22MC007 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

Course Outcomes (COs)

1. Predict the evolution and working principle of CNC machine tools with its relevant applications
2. Demonstrate the basic structure, construction, working and control of CNC machines over conventional units.
3. Compute a real time program for producing desired products using CNC machines.
4. Compare the different tooling and work holding device for tools and work pieces
5. Outline the maintenance and troubleshooting techniques in CNC Machines

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. N. Rao and N. 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. M. Adithan & B. S. Pabla, CNC Machines, New Age International Publishers , N Delhi, 2018

22MC008 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.

Course Outcomes (COs)

1. Assess CAD/CAM integration for changing manufacturing and management scene.
2. Construct a machine cell using the concepts of Group Technology and Computer Aided Process Planning
3. Select the suitable material handling and storage system for Flexible Manufacturing Systems.
4. Justify the suitable CIM implementation and data communication techniques.
5. Outline various protocols and database terminology in CIM.

Articulation Matrix

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

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 appaches.

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 system. 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

22MC009 ADDITIVE MANUFACTURING**3 0 0 3****Course Objectives**

- To provide knowledge on generic steps of Additive Manufacturing (AM) technique.
- To learn the concept and applications of liquid and solid based AM processes
- To impart knowledge on powder based AM processes.
- To introduce the concept of open source 3D printers and rapid tooling
- To expose the emerging trends and applications of Additive Manufacturing technology

Course Outcomes (COs)

1. Implement the generic steps and classification of Additive Manufacturing processes.
2. Select the suitable material and AM process based on applications.
3. Find the suitable AM process to fabricate metallic components.
4. Design their own open source 3D printer based on application.
5. Outline the reverse engineering techniques for developing prototype

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**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 Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, <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 2015

22MC010 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

Course Outcomes (COs)

1. Use surface NDT techniques to carry out various testing & inspection in accordance with the established procedures
2. Demonstrate eddy current testing procedures for non-destructive testing
3. Find principles of magnetism to investigate the service and processing defects
4. Outline right radiographic techniques and X-Rays for testing
5. Compare 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, advantages and 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
2. Baldev Raj, M. 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/>

22MC011 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

Course Outcomes (COs)

1. Find 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. Outline and design the parts for easy assembly using DFA guidelines
5. Organize 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. Geometric 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 amalgamation. 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. M. 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.

22MC012 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

Course Outcomes (COs)

1. Predict the ways of improving productivity by job design, work study, ergonomics, forecasting techniques and following safety
2. Assess inventory control techniques and the need for material requirement planning
3. Find sequencing of jobs with two and more machines and also compute the characteristics of single server queuing models
4. Compare linear programming problems and find the optimum solution.
5. Outline 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	1	1	3	3	3	2	3		2	2	-	1
2	1	2	1	1	2	3	3	2	2		2	3	-	2
3	1	2	3	2	3	3	2	3	3		3	2		1
4	2	3	1	1	2	2	2	2	2	-	2	3		1
5	2	3	1	2	3	2	2	3	3		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, N. 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

22MC013 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

Course Outcomes (COs)

1. Predict the current scenario of demand for fossil fuels, effects of automobile pollution and strategy of next generation vehicles.
2. Find the requirements of Electric Drive train for hybrid and electric vehicles.
3. Select appropriate electric motor and drive controls for EVs and HEVs.
4. Outline the performance of energy storage systems in electric and hybrid vehicles.
5. Compare appropriate Fuel Cell Technology for EVs and HEVs.

Articulation Matrix

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

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

Usage Pattern of Automobiles in cities and highways, Air Pollution: NO_x, 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 M. 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/>

22MC014 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

Course Outcomes (COs)

1. Find the importance of emission standards in automobiles and understand the need for starting and charging systems in automobiles
2. Demonstrate the electronic fuel injection/ignition components and their function
3. Use a sensors/ transducer for measuring mechanical quantities, temperature and appropriate actuators
4. Find the electronic engine control systems problems with appropriate diagnostic tools
5. Outline the need for vehicle chassis and safety system

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****VEHICLE NORMS, 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 system. 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

22MC015 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 variety of vehicle systems

Course Outcomes (COs)

1. Use laws of mechanics to calculate dynamic, road loads and equation motion.
2. Demonstrate knowledge on intelligent sensors, vehicle control, navigation, and communications systems
3. Find the recent trends in Vehicle Comfort System
4. Design the various security systems associated with vehicle system
5. Outline 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.N. 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, Tankut Acarman, 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.

22MC016 AUTOMOTIVE COMMUNICATION SYSTEMS**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

Course Outcomes (COs)

1. Assess the evolution of automotive electronic and connected vehicle concepts
2. Find sensors for automotive application
3. Use knowledge of Computer Vision and Deep learning in autonomous vehicle
4. Carryout fundamentals of Localization and Path planning in autonomous vehicle
5. Outline 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 Overview Connected 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
5. G. Mullett, Wireless Telecommunications Systems and Networks, Thomson- Delmar Learning, ISBN 1-4018-8659-0, 2006
6. G. Mullett, Basic Telecommunications : The Physical Layer, Thomson-Delmar Learning, ISBN 1-4018-4339-5, 2003

22MC017 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

Course Outcomes (COs)

1. Predict the importance of modern trends in vehicle System
2. Use the knowledge for selection of sensor and communication protocols for interfacing sensors
3. Show 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	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	3	-	3	3	3	2	3		3	3		3
5	2	2	2	-	3	2	2	2	3			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.

22MC018 MACHINE LEARNING FORAUTONOMOUS 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.

Course Outcomes (COs)

1. Select the mathematical models for components in a system.
2. Use the component models together to model a larger more complex system.
3. Design and run Model-in-the-Loop Simulations (MIL).
4. Outline and run real-time simulations for a physical system.
5. Integrate and run Hardware-in-the-Loop Simulations (HIL).

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 control methods Tune the system. 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 M. 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/>.

22MC019 APPLIED IMAGE PROCESSING**3 0 0 3****Course Objectives**

- To become familiar with digital image fundamentals
- To get exposed to simple image enhancement techniques in Spatial and Frequency domain.
- To learn concepts of degradation function and restoration techniques.
- To study the image segmentation and representation techniques.
- To become familiar with image compression and recognition methods

Course Outcomes (COs)

1. Find the basics and fundamentals of digital image processing
2. Assess the different techniques of smoothing, sharpening and enhancement in images processing.
3. Use the restoration concepts and filtering techniques.
4. Justify the basics of segmentation, features extraction of images.
5. Compare the basics compression and recognition methods for color models.

Articulation Matrix

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

UNIT II**9 Hours****IMAGE ENHANCEMENT**

Spatial Domain Gray level 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

IMAGE COMPRESSION AND RECOGNITION

Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors Topological feature, Texture Patterns and Pattern classes Recognition based on matching.

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 RM. 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.

22MC020 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

Course Outcomes (COs)

1. Find the concept of fuzzy set theory and its architectures
2. Use 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. Integrate machine learning through neural networks
5. Outline 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 of neural 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 M. 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. B. Yagnanarayanan, Artificial Neural Networks, PrenticeHall of India Ltd .,New Delhi.2012.

22MC021 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

Course Outcomes (COs)

1. Predict a problem using first order and predicate logic
2. Select appropriate search algorithms for any AI problem
3. Use the apt agent strategy to solve a given problem
4. Design software agents to solve a problem
5. Integrate 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. M. Tim Jones, Artificial Intelligence: A Systems Approach(Computer Science), Jones and Bartlett Publishers, Inc.; First Edition, 2009
6. <https://nptel.ac.in/courses/106105079>

22MC022 DEEPLARNING 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

Course Outcomes (COs)

1. Select the concepts of vision system and its operations
2. Find the concepts of image capturing and processing techniques.
3. Predict the concept for characterizing and analyzing the features in image
4. Outline a suitable vision algorithm to recognize the object.
5. Integrate 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.

Total: 45 Hours

Reference(s)

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 APi Robot Production, 2012

22MC023 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.

Course Outcomes (COs)

1. Assess the various types of neural networks.
2. Compute the pattern association algorithm in soft computing
3. Use the ART and neural networks.
4. Demonstrate the use of fuzzy logic concepts in soft computing
5. Justify genetic algorithm in real time problems

Articulation Matrix

O 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	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	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 Algorithm.

UNIT III**9 Hours****ADAPTIVE RESONANCE AND BACKPROPAGATION NEURAL NETWORKS**

ART1 and ART2 - Basic Operation and Algorithm, derivation of Learning 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

GENETICALGORITHM

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

22MC024 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 , Minimumspanning tree and shortest path problems.
- To learn about Decision making under uncertainty and certainty conditions.
- To learn various Queuing models.

Course Outcomes (COs)

1. Find how to translate a real-world problem, given in words, into a mathematical Formulation
2. Use simplex algorithm for LPP.
3. Design Transportation Models and Assignment Models, maximal flow problem, minimum spanning tree and shortest path problem.
4. Find issues in Decision making under various conditions.
5. Justify acquire capability in applying and using of queuing models for day today 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.

22MC025 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

Course Outcomes (COs)

1. Assess the biological behavior of human cell and to relate the resting and action potential associated with the principle of ECG, EEG, EMG and EOG Machines
2. Predict the principle, working and application of different types of biomedical sensors and transducers
3. Find the various monitoring systems and signal conditioning systems associated with biomedical devices.
4. Justify the construction and working of different biomedical patient measurement and monitoring systems
5. Outline 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

Oscillagrophic - galvanometric - thermal array recorder, photographic recorder, storage oscilloscopes, electron microscope. Biotelemetry, Diathermy, Audiometers, Dialyzers, Lithotripsy.

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

22MC026 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

Course Outcomes (COs)

1. Find the fundamentals of virtual Instrumentation and compare conventional with traditional methods
2. Predict the concept of graphical programming and LabVIEW with their functions
3. Assess the types of interfacing devices and protocol used in VI
4. Select the functions and the interface requirements in Data acquisition system
5. Outline the types of VI tools with its application

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	1	1	2		1			1	-				2
3	2	1	3	1	1	1	1	1	1	2		1	-	2
4	2	2	1	2	2	1	-	1		2		1		2
5	3	3	2	1	1	1	-	1	1	1		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>

2MC027 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

Course Outcomes (COs)

1. Predict the various types of drive system with gear arrangement
2. Assess the construction and working principle of asynchronous and asynchronous machine
3. Use the operation and characteristics of invertors and its related techniques
4. Compare on various types of frequency pattern and control modes
5. Justify the integrate positioning programming for various types of application

Articulation Matrix

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

UNIT I**8 Hours****BASICS OF DRIVESYSTEM 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 Brakerectifiers, Encoder theory of operation, various types.

UNIT III**10 Hours****TERNS BASICS OF FREQUENCYINVERTERS**

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 M. Gopal, Control System Engineering, New Age International Publisher, New Delhi, 2017
5. SEW Study materials, practical workbooks

**22MC028 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

Course Outcomes (COs)

1. Assess working of Electric Vehicles and recent trends
2. Predict the properties of batteries and its types
3. Find electric drives unit's control for application of electric vehicles.
4. Outline the control of the electric vehicle design system.
5. Compare different power converter topology used for electric vehicle application
6. Articulation Matrix

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				1	1		1	2		2
3	1	3	3			1			1			2		3
4	1	2	3	1	1		1			1		1		2
5	1	2	1	2		-					-			3
6					-					-				

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 basic principle 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. M. 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, 2016.
4. Chris Mi, M. AbulMasrur, David WenzhongGao, Hybrid Electric Vehicles Principles And Applications With Practical Perspectives, Wiley Publication, 2018

22MC029 PROCESS CONTROL**3 0 0 3****Course Objectives**

- To obtain the mathematical models for first order and higher order real-time systems and also understand the concept of self-regulation
- To get adequate knowledge about the characteristics of various controller modes and controller tuning methods
- To understand how to apply the control schemes for various applications

Course Outcomes (COs)

1. Predict the mathematical models for first order real time systems.
2. Select the characteristics of various control modes and the concept of various control schemes.
3. Find the various controller tuning methods to tune the controller
4. Outline the construction, characteristics and applications of different type of actuators.
5. Justify the process control knowledge on Industrial environment

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**

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

22MC030 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

Course Outcomes (COs)

1. Predict suitable automation transfer line for the given application
2. Assess potential areas of automation.
3. Compare various control aspects of automation.
4. Outline the self learning capability of Industrial Automation.
5. Justify suitable automation hardware for the given application

Articulation Matrix

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

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: Cases 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.

22MC031 IOT PROTOCOLS AND INDUSTRIAL SENSORS**3 0 0 3****Course Objectives**

- Understand the basic principles, architectures, physical and logical designs of IOT
- Explain the IoT communication principles and their protocols.
- Explain the transport and application layer principles and their protocols.
- Understand the working principles of motion, proximity and ranging sensors
- Explain the principles of force, magnetic and heading sensors and its case studies with real time applications.

Course Outcomes (COs)

1. Apply the concepts of IoT Architecture, physical design, logical design and their technologies.
2. Analyze the working principles & concepts of IoT Communication Protocols.
3. Analyze the working principles & concepts of Transport and Application layer Protocols.
4. Apply the various sensors in the Automotive and Mechatronics applications
5. Analyze the working principles and characteristics of force, magnetic and heading sensors.

Articulation Matrix

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

UNIT I**9 Hours****INTRODUCTION TO IOT**

Architectural Overview- IoT applications- Sensing - Actuators - Basics of Networking - M2M and IoT Technology fundamentals - Devices and gateways - Design of Internet of Things: Physical Design of IoT, Logical Design of IoT - IoT Enabling Technologies.

UNIT II**9 Hours****IOT COMMUNICATION PROTOCOLS**

IoT Data Link Layer & Network Layer Protocols, PHY/MAC Layer -3GPP MTC, IEEE 802.11, IEEE 802.15 - Wireless HART, ZWave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN.

UNIT III **9 Hours**

TRANSPORT

Transport Layer Protocols-Application Protocols for IoT: UPnP, CoAP, MQTT, XMPP, SCADA, Authentication Protocols; IEEE 802.15.4, REST and Websocket.

UNIT IV **9 Hours**

MOTION, PROXIMITY AND RANGING SENSORS

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

UNIT V **9 Hours**

CASE STUDIES/INDUSTRIAL APPLICATIONS

IoT applications in home appliances, infrastructures, buildings, security, Industries 4.0

Total: 45 Hours

Reference(s)

1. Vijay Madisetti, Arshdeep Bahga, Internet of Things, A Hands on Approach, University Press.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.
3. Peter Waher, Learning Internet of Things, Packt Publishing, UK, 2015.
4. Adrian McEwen, Hakim Classically, Designing the Internet of Things, Wiley Publishing, 2015.
5. Dieter Uckelmann, Mark Harrison and Florian Michahelles, Architecting the Internet of Things, Springer, New York, 2011.

22MC032 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

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****CORTEX M3/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****CORTEX M3/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

22MC033 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

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 time of IoT in real 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 Madiseti, 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.

22MC034 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.

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, State- centric 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. Walteneus Dargie , Christian Poellabauer, Fundamentals of Wireless Sensor Networks Theory and Practice, John Wiley and Sons Publications, 2011
4. K. Akkaya and M. Younis, A survey of routing protocols in wireless sensor networks, Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325--349
5. Philip Levis, TinyOS Programming
6. Anna Hac, Wireless Sensor Network Designs, John Wiley & Sons Ltd,

22MC035 INDUSTRIAL IOT AND INDUSTRY 4.0**3 0 0 3****Course Objectives**

- To provide the overview about evolution and importance of Industrial IoT in the era of Industry4.0
- To introduce the Industrial IoT reference architectures and Business models in industrial automation systems
- To understand the on-site key technologies for the requirement of a smart factory
- To get the knowledge of Industrial IoT data Analytics
- To apply the technologies of Industrial IoT in various Industries as case studies.

Course Outcomes (COs)

1. Understand about the evolution of Industry 4.0 in smart factories and cyber physical systems
2. Identify the process of industrial automation system network and control
3. Illustrating the reference architectural models and business models with key enabling technologies
4. Analyse the data of the industrial IoT systems with security
5. Apply the technologies to various sectors and case study the application of Industrial IoT in smart industries.

Articulation Matrix

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

UNIT I**9 Hours****INTRODUCTION AND KEY TECHNOLOGIES**

Industrial revolutions. Cyber physical systems and Next generation sensors. On-site key technologies in Industry 4.0, AR-VR, Big data Analytics, Smart factories and Lean Manufacturing system.

UNIT II**9 Hours****INDUSTRIAL AUTOMATION AND IOT**

Evolution of IT and OT convergence. Industrial sensing, Industrial Processes and Industrial Network. Business models and IIRA Reference architecture of IIOT, Industrial internet Consortium (IIC).

UNIT III**9 Hours****INDUSTRIAL DATA TRANSMISSION AND COMPUTING**

Foundation Fieldbus, Profibus, CC-link, MODBUS, DigitalSTROM, CAN, DeviceNet, ISA 100.11a, Wireless HART, NB-IoT. Edge and Fog Computing solutions. Cloud services.

UNIT IV**9 Hours****DATA ANALYTICS AND SECURITY**

Necessity of Analytics and IIOT Data Analytics. Machine Learning and Data Science applications in Industries. Artificial Intelligence for IIOT, IoT Security- Vulnerabilities, Threat Analysis, Security model for IoT.

UNIT V**9 Hours****APPLICATIONS OF IIOT**

Healthcare Applications, Inventory Management and Quality Control. Case studies in Manufacturing Industry, Automotive Industry, Mining Industry, Textile Industry.

Total: 45 Hours**Reference(s)**

1. Industry 4.0: The Industrial Internet of Things, by Alasdair Gilchrist (Apress), 2017.
2. Industrial Internet of Things: Cybermanufacturing Systems, by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), 2017
3. Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018.
4. Misra, Sudip, Chandana Roy, and Anandarup Mukherjee. Introduction to industrial Internet of Things and industry 4.0. CRC Press, 2021.
5. Ortiz, JesÃfÃs Hamilton. "Industry 4.0: Current status and future trends." (2020).
6. Ustundag, Alp, and Emre Cevikcan. Industry 4.0: managing the digital transformation.Springer, 2017.

22MC036 PYTHON FOR IOT DATAANALYTICS**3 0 0 3****Course Objectives**

- To understand the basics of nature of data
- To understand basic operation in data analysis using python
- To understand data manipulation using pandas library
- Data visualization using different types of charts
- To understand basic python program for IoT application

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
DATA ANALYSIS

9Hours

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

UNITIV
DATA MANUPULATION

9Hours

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
DATA VISUALIZATION

9 Hours

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

22OCE01 ENERGY CONSERVATION AND MANAGEMENT**3 0 0 3****Course Objectives**

- To develop an understanding and analyze the energy data of industries
- To carryout energy accounting and balancing
- To conduct energy audit and suggest methodologies for energy savings and
- To utilize the available resources in optimal ways

Course Outcomes (COs)

1. Classify and characterize the various energy utilization techniques.
2. Identify suitable technique to provide an energy efficient system.
3. Identify the need for thermal systems with latest technologies.
4. Choose suitable techniques doe conserving energy with respect to emerging trends.
5. Assess the impact economics on the conservation of energy.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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.energymanagertraining.com, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.
2. Witte. L.C., P.S. Schmidt, D.R. Brown, “Industrial Energy Management and Utilisation” Hemisphere Publ, Washington, 1988.
3. Callaghn, P.W. “Design and Management for Energy Conservation”, Pergamon Press, Oxford, 1981.
4. Dryden. I.G.C., “The Efficient Use of Energy” Butterworths, London, 1982
5. Turner. W.C., “Energy Management Hand book”, Wiley, New York, 1982.
6. Murphy. W.R. and G. Mc KAY, “Energy Management”, Butterworths, London 1987.

22OCS01 OBJECT ORIENTED PROGRAMMING**3 0 0 3****Course Objectives**

- Understand the concepts of Object Oriented Programming
- Study the concepts of objects and classes.
- Familiarize in the types of constructors.

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 conversion. 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**9 Hours****OPERATOR OVERLOADING AND INHERITANCE**

Operator Overloading and Inheritance Need of operator overloading- Overloading Unary Operators-Overloading binary Operators - Overloading Special Operators - Data Conversion Inheritance: Derived Class and Base Class - Derived Class Constructors-Overriding Member Functions-Class Hierarchies- Public and Private Inheritance-Levels of Inheritance-Multiple Inheritance.

UNIT IV

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.

22OCS02 JAVA FUNDAMENTALS**3 0 0 3****Course Objectives**

- Implement applications based on core Java Concepts with examples
- Construct application using inheritance, packages and exception handling for real time problems.
- Integrate the Java I/O concepts to handle input and output operations.
- Develop programs to perform string manipulation in java.
- Design GUI with Java for event handling and database applications.

Course Outcomes (COs)

1. Demonstrate applications based on core Java Concepts with examples
2. Construct application using inheritance, packages and exception handling for real time problem
3. Explain the Java I/O concepts to handle input and output operations.
4. Develop programs to perform string manipulation in Java.
5. Design GUI with Java for event handling and database applications.

Articulation Matrix

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

UNIT I**9 Hours****BASICS OF JAVA**

The Genesis of Java - Overview of Java - Data Types, Variables, and Arrays - Operators – Control Statements - Introducing Classes - Methods and Classes.

UNIT II**9 Hours****INHERITANCE, PACKAGES AND EXCEPTIONS**

Inheritance: Basics - Using Super - Creating a Multilevel Hierarchy - Method overriding - Using Abstract Classes - Packages and Interfaces: Packages - Access Protection - Importing Packages- Interfaces Definitions and Implementations - Exception Handling: Types - Try and Catch - Throw.

UNIT III**9 Hours****EXPLORING JAVA I/O**

I/O Basics - Reading Console Input -Writing Console output - Native Methods - I/ O Classes and Interfaces - File - The Byte Streams - The Character Streams - Using Stream I/ O - Serialization.

UNIT IV**9 Hours****JAVA STRINGS**

String Handling: Special String operations and Methods - String Buffer - Exploring java.lang: Simple type Wrappers - System - Math - Collections Framework: Collections Interfaces and Classes – Utility Classes: String Tokenizer - Date and Time.

UNIT V

9 Hours

GUI WITH JAVA

Applet Basics - Applet Architecture - Applet Display Methods - Parameter Passing - Event Handling Mechanisms - Event Classes - Event Listener - Working with Windows, Graphics, Colors and Fonts - AWT Controls - Layout Managers and Menus – JDBC

Total: 45 Hours

Reference(s)

1. Herbert Schildt, Java 2-Complete Reference, Tata Mc Graw Hill, 2015.
2. Deitel & Deitel, Java How to Program, Prentice Hall of India, 2010.
3. Gary Cornell and Cay S.Horstmann, Core Java Vol.1 and Vol.2, Sun Microsystems Press, 2008.

22OCS03 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

Articulation Matrix

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										

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.

22OCS04 E-LEARNING TECHNIQUES**3 0 0 3****Course Objectives**

- Understand the technologies involved in e-learning.
- Gain the fundamentals of e-learning techniques
- Determine the characteristics of Teaching-Learning Process

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.M. Nafay Kumail, Tata McGraw-Hill Publication, 2002.
2. E-Learning: New Trends and Innovations, P.P. Singh, Sandhir Sharma, Deep & Deep Publications, 2005. 4. 4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002
3. E-Learning: Concepts, Trends and Applications, Epignosis LLC, LLC publications, 2014.
4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002.

**22OCS05 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

10 Hours

SOCIAL NETWORK ANALYTICS

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 Shneiderman, Marc Smith. Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Morgan Kaufmann, 2011.
3. Avinash Kaushik. Web Analytics 2.0: The Art of Online Accountability, 2009.
4. Hanneman, Robert and Mark Riddle. Introduction to Social Network Method, 2005.
5. Wasserman, S. & Faust, K. Social network analysis: Methods and applications. New York: Cambridge University Press, 1994.
6. Monge, P. R. & Contractor, N. S. Theories of communication networks. New York: Oxford University, 2003

22OEC01 BASICS OF ANALOG AND DIGITAL ELECTRONICS**3 0 0 3****Course Objectives**

- Understand the working of diodes and transistors in electronic circuits.
- Understand the analog operational amplifier and its applications.
- Understand the implementation of combinational and sequential circuits in digital systems.

Course Outcomes (COs)

1. Apply the diodes and transistors in regulators and amplifiers and analyze their characteristics.
2. Illustrate the working of analog IC with different configurations and its applications.
3. Simplification of Boolean expressions using K-map and implementation of combinational circuits.
4. Analyze the Flip flops and memory configurations in digital circuits.
5. Classify and analyze A/D and D/A converters with its parameters.

Articulation Matrix

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

UNIT I**9 Hours****SEMICONDUCTORS DEVICES**

Conductor, Semiconductors & Insulators, Semiconductors: intrinsic & extrinsic, energy band diagram - Mobility - Electrons and holes - The P-N junction diode - Zener diode - Avalanche effect- Rectifier Circuits Half wave, Full wave circuits, Efficiency, PIV, Ripple factor and AC and DC current and voltage in rectifier. PNP and NPN Bipolar junction Transistors - H parameters equivalent circuit - Common emitter amplifier - DC behavior: the load slope and the Q point - AC behavior - Emitter follower amplifier - Field effect transistors: JFET and MOSFET.

UNIT II**9 Hours****OPERATIONAL AMPLIFIERS: DC PERFORMANCE**

The operational amplifier - Input resistance, Output resistance, Open loop gain - Bias currents - Offset currents - Offset voltage - Differential mode gain - Common mode gain - Common mode rejection ratio - Negative feedback - Open loop gain and closed loop gain - Inverter amplifier - Non-inverter amplifier - The voltage follower - Transimpedance amplifier (Current to voltage converter) - Differential amplifier. Adders, Subtractors, Comparator, Integrator and Differentiator.

UNIT III**9 Hours****DIGITAL TECHNIQUES: COMBINATIONAL CIRCUITS**

Numbering systems - Binary, octal and hexadecimal numbers - Boole algebra - Conversion and operations - AND gate- OR gate - Inverter - NAND gate - NOR gate - Exclusive OR gate. Morgans laws. Combinational Circuits: Truth tables, logic expressions, Logic simplification using K- map, half and full adder/subtractor, multiplexers, demultiplexers, Logic families :TTL and CMOS.

UNIT IV**9 Hours****DIGITAL TECHNIQUES: SEQUENTIAL CIRCUITS**

Gated Latches & Flip Flops- Level triggered and Edge triggered Flip-Flops, Flop (FF) types: RS type. JK FF. JK FF Master slave. D FF. T FF. Flip Flop Conversion. Shift registers, Counters. Memories Structure: address and data bus. ROM, PROM, EPROM and flash RAM. Volatiles Memories: RAM, SRAM, DRAM. Addressing modes.

UNIT V**9 Hours****DIGITAL TO ANALOG CONVERTERS AND ANALOG TO DIGITAL CONVERTERS**

DIGITAL TO ANALOG CONVERTERS : Input latch. Binary Weighted Resistor Network. R-2R Ladder Resistor Network. Pulse Width Modulation . Resolution. Accuracy. Linearity. Zero Offset. Settling Time. Glitches. ANALOG TO DIGITAL CONVERTERS: Sampling. Real time sampling and equivalent time sampling. Sampling frequency. Sampling theorem (Nyquist). Anti-aliasing filtering. Sampling and holding. Conversion.

Total: 45 Hours**Reference(s)**

1. L Robert Boylestead, Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education,2012.
2. J Millman, C. Halkias & Satyabrata Jit, Electronic Devices and Circuits, Tata McGraw- Hill,2010.
3. Ramakant A.Gayakwad, OP-AMP and Linear IC"s , Prentice Hall of India, 2002.
4. D.RoyChoudhry, Shail Jain, Linear Integrated Circuits, New Age International Pvt. Ltd., 2000.
5. Thomas L.Floyd, Digital Fundamentals, Prentice Hall, 11th Edition, 2015.
6. M.Morris Mano, Michael D Ciletti Digital Design 4th edition Pearson, 2011.

22OEC02 MICROCONTROLLER PROGRAMMING**3 0 0 3****Course Objectives**

- Understand Series of Microcontrollers in terms of architecture, Programming and Interfacing.
- Learn Programming of PIC series of microcontrollers and learn building of hardware circuits using PIC 16F series of Microcontrollers
- Learn the emerging trends in the design of advanced Microcontrollers.

Course Outcomes (COs)

1. Interpret the components and functionalities of 8051 Microcontrollers.
2. Develop microprocessor applications using the Assembly Language Program
3. Illustrate the working nature of PIC microcontroller on various versions
4. Illustrate the interfacing of different peripherals using PIC Microcontroller
5. Analyze the architecture and instruction set of ARM Microcontroller

Articulation Matrix

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

UNIT I**9 Hours****8-BIT MICROCONTROLLER**

Introduction-Intel 8051 architecture-Counters and Timers-Serial Interface- Interrupts- Interfacing to external memory and 8255- Instruction set- Address modes.

UNIT II**9 Hours****8051 ALP AND APPLICATIONS**

Assembly language program- Timers and Counters programming- DAC- ADC- Sensor- Keyboard and LCD.

UNIT III**9 Hours****PIC MICROCONTROLLER**

PIC Microcontroller features- PIC Architecture, Program Memory, Addressing Modes, Instruction Set, Instruction Format- Byte-oriented Instructions- Bit-oriented Instructions- Literal Instructions- Control Instructions (CALL & GOTO)- Destination Designator. MPLAB overview: Using MPLAB, Toolbars, Select Development Mode and Device type, Project, Text Editor, Assembler, MPLAB operations.

UNIT IV**9 Hours****PIC HARDWARE**

Reset, Clock, Control registers, Register banks, Program Memory Paging, Ports, Interrupts, Timer and Counter, Watchdog Timer, Power up timer, Sleep mode, I2C bus- A/D converter.

UNIT V

9 Hours

HIGH PERFORMANCE RISC ARCHITECTURE

ARM: The ARM architecture- ARM organization and implementation- The ARM instruction set- The THUMB instruction set- Basic ARM Assembly Language Program- ARM CPU Cores.

FOR FURTHER READING

Introduction- Architecture- Registers- Memory- Instruction set- Addressing Modes- I/O Pins- Timers- Counters- Interrupts.

Total: 45 Hours

Reference(s)

1. Ayala, Kenneth, "The 8051 Microcontroller", Thomson, 3rd Edition, 2004.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, " The 8051 Microcontroller and Embedded Systems", Person Education, 2nd Edition, 2004.
3. John B.Peatman, "Design with Microcontrollers", Person Education", 1st Edition, 2004.
4. Steave Furber, "ARM system-on-chip architecture" Addison Wesley, 2nd Edition, 2000.
5. A.V.Deshmukh, "Microcontrollers: Theory and Applications", Tata Mc Graw Hill, 12th reprint, 2005.

22OEC03 PRINCIPLES OF COMMUNICATION SYSTEMS**3 0 0 3****Course Objectives**

- To study the various analog and digital modulation techniques
- To study the various digital communication techniques
- To enumerate the idea of spread spectrum modulation
- To study the design concepts of satellite and optical communication

Course Outcomes (COs)

1. Illustrate the process involved in Amplitude, Frequency and phase modulation systems.
2. Analyze the performance of different digital modulation /demodulation techniques.
3. Analyze Pulse Code Modulation scheme for the transmission of analog data in digital format.
4. Apply the concepts of spread spectrum modulation techniques to eradicate interference in wireless communication.
5. Analyze the system design of satellite and optical communication.

Articulation Matrix

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

UNIT I**9 Hours****FUNDAMENTALS OF ANALOG COMMUNICATION**

Principles of amplitude modulation, AM envelope, frequency spectrum and bandwidth, modulation index and percent modulation, AM Voltage distribution, AM power distribution, Angle modulation. FM and PM waveforms, phase deviation and modulation index, frequency deviation and percent modulation, Frequency analysis of angle modulated waves. Bandwidth requirements for Angle modulated waves

UNIT II**9 Hours****DIGITAL COMMUNICATION**

Introduction, Shannon limit for information capacity, Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK) Minimum Shift Keying (MSK), Phase Shift Keying (PSK), BPSK, QPSK, 8 PSK Quadrature Amplitude Modulation (QAM), Bandwidth Efficiency, Comparison of various Digital Communication System (ASK - FSK - PSK - QAM).

UNIT III**9 Hours****DIGITAL TRANSMISSION**

Introduction, Pulse modulation, PCM, PCM sampling, sampling rate, signal to quantization noise rate, companding, delta modulation, adaptive delta modulation, differential pulse code modulation, pulse transmission, Intersymbol interference, eye patterns.

UNIT IV

9 Hours

SPREAD SPECTRUM AND MULTIPLE ACCESS TECHNIQUES

Introduction, Pseudo-noise sequence, DS spread spectrum with coherent binary PSK, processing gain, FH spread spectrum, multiple access techniques, wireless communication, TDMA and CDMA in wireless communication systems, source coding of speech for wireless communications.

UNIT V

9 Hours

SATELLITE AND OPTICAL COMMUNICATION

Satellite Communication Systems-Keplers Law, LEO and GEO Orbits, footprint, Link model- Optical Communication Systems-Elements of Optical Fiber Transmission link, Types, Losses, Sources and Detectors.

Total: 45 Hours

Reference(s)

1. Wayne Tomasi, Advanced Electronic Communication Systems, 6/e, Pearson Education, 2007.
2. Simon Haykin, Communication Systems, 4th Edition, John Wiley & Sons., 2001.
3. H.Taub, D L Schilling, G Saha, Principles of Communication, 3/e, 2007.
4. B.P.Lathi, Modern Analog And Digital Communication systems, 3/e, Oxford University Press, 2007
5. Dennis Roddy, "Satellite Communications", Third Edition, Mc Graw Hill International Editions, 2001.
6. Gerd Keiser, Optical Fiber Communication, McGraw-Hill International, Singapore, 4th edition., 2011.

21OEC04 PRINCIPLES OF COMPUTER COMMUNICATION AND NETWORKS 3 0 0 3**Course Objectives**

- To understand the concept of data communication and networking models.
- To study the various networking Components and Networks.
- To explore the routing, addressing and security and management aspects of computer networks.

Course Outcomes (COs)

1. Classify the types of computer networks and analyze the seven layers of OSI model.
2. Analyze the basic operations of Routing Algorithms and Routing devices
3. Analyze the local and wide area networking technologies.
4. Apply the ISDN and ATM interface connections in broadband networks.
5. Analyze the security and management techniques related with networks.

Articulation Matrix

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

UNIT I**9 Hours****NETWORK FUNDAMENTALS**

Types of Computer Networks: by Area, by Topology ; Communication Services: Serial and Parallel, Synchronous and Asynchronous, Simplex and Duplex, Analog and Digital; Speed and Capacity; Multiplexing and Switching; Network Architecture: OSI Seven-Layer Network model.

UNIT II**9 Hours****INTERNETWORKING AND COMPONENTS**

Routing Concepts: Routing Algorithms, RIP, RIP-2, OSPF and other routing Protocols; Switches and Hubs: Store and Forward Switch, Cut-Through Switch,Hybrid Switch, Performance of Switches ; Repeaters; Repeater Vs Hubs; Bridges: Standards, Bridges Vs Repeaters; Routers and Gateways.

UNIT III**9 Hours****LOCAL AND WIDE AREA NETWORKING TECHNOLOGIES**

LAN Components and Topologies; Access Techniques; Transmission Protocols and Media; Ethernet and IEEE 802.3 Networks: History, 10-MBPS Ethernet, Switched Ethernet, 100-MBPS Ethernet, Gigabit Ethernet.

UNIT IV

9 Hours

BROADBAND NETWORKS

ISDN: Evolution, ISDN Channel and Interface Structures; Broadband ISDN: Basics, Principles and General Architecture; Asynchronous Transfer Mode(ATM): Introduction, Concepts, Components, Connection Supported by ATM network and Concept of Virtual Channel and Virtual Path, Traffic control and Congestion Control, Operation and Maintenance aspects.

UNIT V

9 Hours

NETWORK SECURITY AND MANAGEMENT

Security: Need of Security, Security Threats, Vulnerabilities, Methods, tools and Techniques for Attacks; Network Security: Levels of Security, Cryptosystems; Data Encryption Standard (DES), Public Key Cryptography, Firewalls; Network Management: Functions and Elements, Distribution of Management; Simple Network Management Protocol (SNMP), Remote Network Management Services.

Total: 45 Hours

Reference(s)

1. Michael A.Gallo, William M. Hancock, Computer Communications and Networking Technologies, 1 Ed, Thomson Learning, 2002.
2. Kenneth C. Mansfield, Jr.James L. Antonakos, An Introduction to Computer Networking, 1Ed, Prentice Hall of India, 2002
3. A Shanmugam, S Rajeev, Computer Communication Networks, 1Ed, ISTE Learning Materials Centre, 2001
4. Discrete-Time Signal Processing by Alan V. Oppenheim and Ronald W. Schaffer, 3rd edition, 2010, Prentice Hall
5. Digital Signal Processing by Sanjit Mitra, 4th edition, 2011, McGraw-Hill, New York, NY

22OEI01 PROGRAMMABLE LOGIC CONTROLLERS**3 0 0 3****Course Objectives**

- To impart knowledge about automation and architecture of PLC
- To understand the PLC programming using timers, counters and advanced PLC functions
- To familiarize the student with PLC based applications

Course Outcomes (COs)

1. Outline the fundamental Concepts of Automation
2. Conclude the architecture, interfacing and communication techniques of PLC
3. Execute the suitable PLC Programming languages
4. Attribute the various functions and instruction sets of PLC
5. Generate a suitable logical programming for given applications

Articulation Matrix

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

UNIT I**10 Hours****INTRODUCTION TO AUTOMATION**

Evolution of automation -Types of automation - Fixed, flexible and programmable automation - Batch process and continuous process - open loop system and closed loop system - Function of sensors - Proximity sensors: Capacitive and Inductive - Infrared and Laser Push-buttons and toggle switches - Actuators: Solenoid valve - servo motor - electromagnetic relays.

UNIT II**9 Hours****ARCHITECTURE OF PLC**

Components of PLC - sink and source I/O cards - Processor - Memory: Types of memory, Input and Output modules: Discrete, Analog -Scan time of PLC -Interfacing computer and PLC: RS232, RS485, Ethernet - Selection criteria for PLC.

UNIT III**8 Hours****PLC PROGRAMMING**

Programming languages - Ladder logic components: User and bit Instructions, branch instructions, internal relay instruction Boolean logic using ladder logic programming, Latching -Timers: On Delay timer, OFF Delay timer and Retentive timer - Counters: Up Counter and Down Counter.

UNIT IV**10 Hours****ADVANCED PLC FUNCTIONS**

Instructions in PLC: Program Control Instructions, Math Instructions, Data Manipulation Instructions: Data compare operations, Data transfer operations - Sequencer and Shift register instructions- Analog Instructions: PID Controller - Scaling Instructions.

UNIT V

8 Hours

APPLICATIONS OF PLC

Case Studies: Bottle filling system - Pick and place robot - Car Parking - Traffic light control (4 ways with pedestrian signal) -Elevators - Pneumatic stamping system - alarm annunciator system.

Total: 45 Hours

Reference(s)

1. F.D. Petruzella, Programmable Logic Controllers, Tata Mc-Graw Hill, Third edition, 2015.
2. Benjamin C Kuo, Automatic Control Systems, Prentice Hall of India, New Delhi, 2014.
3. John Park, Steve Mackay, Edwin Wright, Practical data communications for instrumentation and control, Newnes, Elsevier, 2015.
4. K. L.S. Sharma, Overview of Industrial Process Automation, Elsevier, 2014.
5. John W Webb and Ronald A Resis, Programmable Logic Controller, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.

22OEI02 SENSOR TECHNOLOGY**3 0 0 3****Course Objectives**

- To impart knowledge about various sensors in multidisciplinary engineering domain
- To familiarize students with different applications and its material handling technology
- To understand the concept of sensing circuits and its static and dynamic characteristics

Course Outcomes (COs)

1. Conclude the static and dynamic characteristics of measuring instruments
2. Compare the characteristics and working principles of Resistance, Inductance and Capacitance type sensors
3. Construct the interfacing and signal conditioning circuit for measurement system using different types of sensor
4. Analyze and select the suitable sensor for different industrial applications
5. Combine the modern technologies and smart materials to design various sensors

Articulation Matrix

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

UNIT I**8 Hours****SENSORS FUNDAMENTALS AND CHARACTERISTICS**

Sensors: Principles of Sensing - Sensor Classification and terminology- Units of Measurements - Measurands- Sensor Characteristics: Static and Dynamic.

UNIT II**8 Hours****PHYSICAL PRINCIPLES OF SENSING**

Electric Charges, Fields, and Potentials; Capacitance; Magnetism; Induction; Resistance; Piezoelectric Effect; Hall Effect; Temperature and Thermal Properties of Material; Heat Transfer; Light; Dynamic Models of Sensor Elements.

UNIT III**9 Hours****INTERFACE ELECTRONIC CIRCUITS**

Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits, Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries for Low Power Sensors.

UNIT IV**10 Hours****SENSORS IN DIFFERENT APPLICATION AREA**

Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity and Acceleration; Force, Strain, and Tactile Sensors; Pressure Sensors, Temperature Sensors.

UNIT V

10 Hours

SENSOR MATERIALS AND TECHNOLOGIES

Materials, Surface Processing- MEMS microsystem components- Microfluidics microsystem components - Nano Technology- Smart Materials.

Total: 45 Hours

Reference(s)

1. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer, 2016.
2. D. Patranabis, Sensors and Transducers, 2nd Edition, Prentice Hall India Pvt. Ltd, New Delhi, 2009.
3. Guozhen Shen, Zhiyong Fan, “Flexible Electronics: From Materials to Devices”, 1st Edition, World Scientific Publishing Co, Singapore, 2015.
4. Horowitz, P., and W. Hill. The Art of Electronics. 2nd ed. Cambridge University Press, 1989.

22OEI03 FUNDAMENTALS OF VIRTUAL INSTRUMENTATION**3 0 0 3****Course Objectives**

- Understand the basic components of Virtual Instrumentation system.
- Learn the developing VIs based on Lab VIEW software.
- To learn to develop applications based on Virtual Instrumentation system.

Course Outcomes (COs)

1. Outline the concepts of traditional instruments and virtual instruments
2. Conclude the overview of modular programming and the structuring concepts in VI programming
3. Attribute the procedure to install DAQ in various OS and its interfacing methods
4. Implement the VI toolsets for specific applications
5. Generate the applications using Virtual Instrumentation software

Articulation Matrix

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

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

Virtual Instrumentation: Historical perspective - advantages - block diagram and architecture of a virtual instrument - Conventional Instruments versus Traditional Instruments - data-flow techniques, graphical programming in data flow, comparison with conventional programming.

UNIT II**9 Hours****VI PROGRAMMING TECHNIQUES**

VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, State machine, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

UNIT III**9 Hours****DATA ACQUISITION**

Introduction to data acquisition on PC, Sampling fundamentals, Input/output techniques and buses. Latest ADCs, DACs, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements - Issues involved in selection of Data acquisition cards - Data acquisition cards with serial communication - VI Chassis requirements. SCSI, PCI, PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

UNIT IV

9 Hours

VI TOOLSETS

Use of Analysis tools, Fourier transforms, power spectrum, correlation methods, windowing and filtering. Application of VI in process control designing of equipments like oscilloscope, Digital multimeter, Design of digital Voltmeters with transducer input Virtual Laboratory, Web based Laboratory.

UNIT V

9 Hours

APPLICATIONS

Distributed I/O modules- Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming.

Total: 45 Hours

Reference(s)

5. Lisa K. wells & Jeffrey Travis, LabVIEW for everyone, Prentice Hall, New Jersey,1997.
6. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGraw Hill, Newyork, 1997.
7. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newness, 2000.

22OEI04 OPTOELECTRONICS AND LASER INSTRUMENTATION**3 0 0 3****Course Objectives**

- To enhance the student knowledge in fiber optics fundamentals and fabrication
- To be recognized with industrial applications of fibers
- To understand the fundamental concepts about lasers
- To identify and describe various fiber optic imaging and optoelectronic sensor applications

Course Outcomes (COs)

1. Attribute the properties of optical fibers, their light sources and detectors.
2. Implement the fiber-optic sensor for the measurement of various physical quantities.
3. Conclude the fundamentals of laser, types of laser and its working.
4. Outline the applications of laser for industrial applications.
5. Differentiate the use of laser instruments for various medical applications.

Articulation Matrix

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

UNIT I**9 Hours****OPTICAL FIBERS AND THEIR PROPERTIES**

Introduction to optical fibers - Light guidance - Numerical aperture - Dispersion - Different types of fibers and their properties - Light Sources for fiber optics, Photo detectors, source coupling, splicing and connectors.

UNIT II**9 Hours****INDUSTRIAL APPLICATION OF OPTICAL FIBERS**

Fiber optics instrumentation system - optical fiber sensors, Measurement of pressure, temperature, current, voltage and liquid level - fiber optic communication set up - different types of modulators - detectors.

UNIT III**9 Hours****LASER FUNDAMENTALS**

Fundamental characteristics of lasers: laser rate equation - three level system - four level system - properties of laser beams - laser modes - resonator configuration - Q- switching and mode locking - cavity dumping - types of lasers: gas lasers, solid state lasers, liquid lasers and semiconductor lasers.

UNIT IV**9 Hours****INDUSTRIAL APPLICATION OF LASERS**

Lasers for measurement of distance and length, velocity, acceleration, atmospheric effects, sonic boom, pollutants - material processing: laser heating, melting, welding and trimming of materials - removal and vaporization - calculation of power requirements of laser for material processing.

UNIT V

9 Hours

HOLOGRAM AND MEDICAL APPLICATIONS

Holography: basic principle, methods - holographic interferometry and application, holography for non-destructive - medical applications of lasers, laser and tissue interactive - laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynaecology and oncology.

Total: 45 Hours

Reference(s)

5. John M. Senior, Optical Fiber Communications - Principles and Practice, Prentice Hall of India, 2010.
6. John F. Ready, Industrial Applications of Lasers, Academic Press, 2012.
7. Gerd Keiser, Optical Fiber Communication, Mc Graw Hill, New York, 2013.
8. S.C. Gupta, Textbook on Fiber Optics Communications and its application, Prentice Hall of India, 2012.
9. John Wilson and J.F.B. Hawkes, Introduction to Opto Electronics, Prentice Hall of India, 2011.
10. R. P. Khare, Fiber Optics and Optoelectronics, Oxford University Press, 2011.

22OBT01 BIOFUELS**3 0 0 3****Course Objectives**

- To understand and explore the scope of biofuels the most efficient renewable source of energy.
- To develop the expertise in the technology pertaining to their generation and employment in order to surrogate the existing conventional fuels and hence strives towards sustainable development
- To give way to the bolster green technology and incline towards more ecofriendly options.

Course Outcomes (COs)

1. Apply the bio resources that can be used for the production of biofuels.
2. Analyze the physical and chemical properties of the biodiesel.
3. Analyze the mechanisms of improvising the quality and performance of engines using biofuels
4. Analyze the bio-fuel conversion technologies and their environmental attributes
5. Evaluate the designing aspects of major unit processes/operations of an integrated bio-refinery

Articulation Matrix

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

UNIT I**9 Hours****CLASSIFICATION AND RESOURCES**

Introduction, biofuel as a renewable energy, classification of biofuels - First, second, third and fourth generation biofuels, different plant sources as biofuel feed stocks, Biogases, physical and chemical characteristics of vegetable oils - iodine number, hydroxyl, acid values, rancidity, hydrogenolysis and hydrolysis, Food vs energy.

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

Definition, basics and chemistry of biodiesel, vegetable oils in biodiesel production, Trans esterification: Chemical methods, enzymatic methods and types of catalysts, separation and purification, physical properties and characterization of biodiesel - Cloud point, pour point, cold filter plugging point, flash point, viscosity and cetane number.

UNIT III**9 Hours****QUALITY BIODIESEL AND ENVIRONMENT**

Producing Quality Biodiesel, quality control, test methods, ASTM specifications. Oxidative and thermal stability, estimation of mono, di, triglycerides and free glycerol, engine performance test, blending of ethanol with biodiesel, blending of biodiesel with high speed diesel (HSD) and their combustion properties.

UNIT IV

9 Hours

BIOETHANOL AND BIOGASES

Ethanol as a fuel, microbial and enzymatic production of ethanol from biomass - lignocellulose, sugarcane, sugar beet, corn, wheat starch, purification - wet and dry milling processes, saccharification-chemical and enzymatic. Production of bio methane and bio hydrogen.

UNIT V

9 Hours

BIOREFINERIES

Definition and types of biorefineries, co-products of biorefineries-oil cake and glycerol, purification of glycerol obtained in biodiesel plant; anaerobic and thermal gasification of biomass, economics of biorefineries.

Total: 45 Hours

Reference(s)

1. Caye Drapcho, John Nghiem and Terry Walker, Biofuels Engineering process technology, McGraw Hill Professional, 2008.
2. Mousdale, Biofuels, CRC Press, 2008
3. Ahindra Nag, Biofuels Refining and Performance, McGraw-Hill Professional, 2007.
4. Lisbeth Olsson, Biofuels (Advances in Biochemical Engineering/ Biotechnology), Springer, 2007

22OFD01 TRADITIONAL FOODS**3 0 0 3****Course Objectives**

- Understand the importance of traditional foods and food habits
- Know the traditional processing of snack, sweet and dairy food products
- Infer the wide diversity and common features of traditional Indian foods and meal patterns.

Course Outcomes (COs)

1. Justify the processing methods of traditional foods in terms of its health benefits
2. Assess the production methods of traditional sweets, snacks and dairy products
3. Differentiate Traditional fermented foods products based on its raw material
4. Implement a large scale production of tradition foods for its increased consumption
5. Compare the health aspects of traditional foods with modern foods

Articulation Matrix

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

UNIT I**9 Hours****TRADITIONAL METHODS OF FOOD PROCESSING**

Introduction - food culture -geographical features and food. Traditional methods of milling grains - rice, wheat and corn - equipment and processes as compared to modern methods. Equipment and processes for edible oil extraction- comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation - sun-drying, osmotic drying, brining, pickling and smoking.

UNIT II**9 Hours****TRADITIONAL SWEETS, SNACKS AND DAIRY PRODUCTS**

Production, formulation, preparation and processing of Indian traditional sweet and snack food products:- Rasgolla, Gulab jamun; formulation and preparation of namkeen, potato chips, banana chips. Acid coagulated and fermented dairy products- paneer, dahi, shrikhand, lassi - processing conditions, defects etc. Fat rich products- Butter, ghee and its processing.

UNIT III**9 Hours****TRADITIONAL FERMENTED FOOD PRODUCTS**

Idli, Soya sauce, fish pickle, dry fish, meat and vegetable fermented products. Various alcohol based products. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation. Best cooking and processing methods to retain nutrients

UNIT IV

10 Hours

COMMERCIAL PRODUCTION OF TRADITIONAL FOODS

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods - types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods - ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters

UNIT V

8 Hours

HEALTH ASPECTS OF TRADITIONAL FOODS

Comparison of traditional foods with typical fast foods / junk foods - cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

Total: 45 Hours

Reference(s)

1. Sen and Colleen Taylor, Food Culture in India, Greenwood Press, 2005.
2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes:" East West Books, 2001.
3. Steinkrus.K.H. Handbook of Indigenous Fermented Foods, CRC press, 1995.
4. Aneja. R.P, Mathur.BN, R.C. Chandan,and Banerjee.A.K. Technology of Indian Milk Products. Dairy India Year Book, 2009.

22OFD02 FOOD LAWS AND REGULATIONS**3 0 0 3****Course Objectives**

- Introduce the concept of food hygiene, importance of safe food and laws governing it
- Learn common causes of food borne illness - viz. physical, chemical and biological and identification through food analysis
- Understand food inspection procedures employed in maintaining food quality

Course Outcomes (COs)

1. Analyse the food safety strategies and nutritional quality of the food
2. Check the food regulatory mechanism and mandatory laws for food products
3. Determine the national and international regulatory agencies
4. Understand and apply the voluntary regulatory standards
5. Assess the implementation of food safety for a food processing industry

Articulation Matrix

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

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

Introduction, concept of food safety and standards, food safety strategies. Food hazards and contaminations - biological (bacteria, viruses and parasites), chemical (toxic constituents / hazardous materials) pesticides residues / environmental pollution / chemicals) and physical hazards. Preventive food safety systems - monitoring of safety, wholesomeness and nutritional quality of food. Prevention and control of physical, chemical and microbiological hazards. Principles of food safety - Establishment: design and facilities - emergency preparedness - Maintenance cleaning and sanitation - personal hygiene - packaging and labelling - transportation - traceability - recall procedure - visitor policy. Adulteration: Intentional and unintentional - Preservatives - antioxidants, sweeteners, flavours, colours, vitamins, stabilizers - indirect additives - organic residues - inorganic residues and contaminants.

UNIT II**10 Hours****FOOD LAWS**

Indian and Food Regulatory Regime (Existing and new), PFA Act and Rules, Food Safety and Quality Requirements, Additives, Contaminants and Pesticide Residue. Food Safety and Standards Act, 2006, FSSAI roles and responsibilities, Essential Commodities Act, 1955, Global Scenario, Codex Alimentarius, WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR) WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR). Food safety inspection services (FSIS) and their utilization.

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

Introduction to OIE & IPPC, Other International Food Standards (e.g. European Commission, USFDA etc). WTO: Introduction to WTO Agreements: SPS and TBT Agreement, Export & Import Laws and Regulations, Export (Quality Control and Inspection) Act, 1963. Role of Agricultural and Processed Food Products Export Development Authority (APEDA), Customs Act and Import Control Regulations, Other Voluntary and mandatory product specific regulations, Other Voluntary National Food Standards: BIS Other product specific standards; AGMARK. Nutritional Labelling, Health claims.

UNIT IV

10 Hours

STANDARDS

Voluntary Quality Standards and Certification GMP, GHP, HACCP, GAP, Good Animal Husbandry Practices, Good Aquaculture Practices ISO 9000, ISO 22000, ISO 14000, ISO 17025, PAS 22000, FSSC 22000, BRC, BRCIOP, IFS, SQF 1000, SQF 2000. Role of NABL, CFLS.

UNIT V

5 Hours

IMPLEMENTATION AND RISK ASSESSMENT

Implementation of food safety for a desired food processing industry. Risk assessment studies: Risk management, risk characterization and communication.

Total: 45 Hours

Reference(s)

1. Singal RS (1997). Handbook of indices of food quality and authenticity. Woodhead Publ. Cambridge, UK.
2. Shapton DA (1994). Principles and practices of safe processing of foods. Butterworth Publication, London. Winton AL (1999) Techniques of food analysis, Allied Science Publications New Delhi.
3. Pomeranze Y (2004). Food analysis - Theory and Practice CBS Publications, New Delhi.
4. Jacob MB (1999). The chemical analysis of foods and food products. CBS Publ. New Delhi

22OFD03 POST HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES 3 0 0 3**Course Objectives**

- To understand the importance and different methods of post harvest handling and storage of fruits and vegetables.
- To gain knowledge on different preservation methods of fruits and vegetables
- To familiarize with the value added products from fruits and vegetables

Course Outcomes (COs)

1. Implement the different post harvest handling practices for the storage of fruits and vegetables
2. Analyze the suitable preservation method (sugar, salt or dehydration) to produce value added products from fruits and vegetables
3. Evaluate the requirement of low temperature and irradiation methods to preserve specific fruits and vegetables
4. Apply the concentration and fermentation methods to preserve fruits and vegetables
5. Implement the canning method to preserve fruits and vegetables

Articulation Matrix

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

UNIT I**9 Hours****POST-HARVEST PRACTICES AND PROCESSING**

Maturity indices for harvesting; pathological spoilage's during storage, ripening and control measures, Post-harvest handling, sorting & grading, packaging, storage, transportation, Methods of pre-cooling, post-harvest treatments to hasten and delay ripening; Methods of storage at farm level - cold storage, controlled/modified atmosphere storage, Quality management, export requirements, Nutritive value, nutraceutical properties

UNIT II**9 Hours****PRESERVATION AND VALUE ADDITION**

General principles and methods of fruit and vegetable preservation. Preservation using sugar: Principle and Preparation of jam, jelly, marmalade, squash, RTS, carbonated beverages, crush, nectar, cordial, fruit bar, preserves, candies and carbonated fruit beverages. Processing using salt: Principle - Brining - Preparation of pickles, chutney and sauces, ketchup.

UNIT III

9 Hours

PRESERVATION BY LOW TEMPERATURE AND IRRADIATION

Preservation by low temperature: definition, principle, methods - Refrigeration, freezing. Methods of freezing- changes during freezing. Preparation of frozen foods. Minimal Processing of Fruits and Vegetables - techniques involved - Preservation by irradiation: definition- principle, application, irradiation unit.

UNIT IV

9 Hours

PRESERVATION BY DRYING

Machineries involved in processing of fruits and vegetables products. Drying and dehydration: definition, principle, Types of driers: Solar, cabinet, spray drier, drum drier, fluidized bed drier. Preparation of product for dehydration. Dehydration principles and equipment. Preparation of fruits - powder production. Problems related to storage of dehydrated products.

UNIT V

9 Hours

PRESERVATION BY CANNING

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

Total: 45 Hours

Reference(s)

1. S.Ranganna, HandBook of Analysis and Quality Control for Fruit and Vegetable Products, McGraw Hill Education (India) Private Limited, Chennai, 2017
2. N.W. Desrosier, the Technology of Food Preservation, CBS Publisher & Distributions, New Delhi, 1987.
3. R.P. Srivastava and S. Kumar, Fruit and Vegetable Preservation: Principles and Practices, Second Edition, International Book Distribution Co., Lucknow, 1998.
4. G. Lal, G. Siddappa and G.L. Tondon, Preservation of Fruits and Vegetables, Indian Council of Agricultural Research, New Delhi, 1986.
5. Chakraverty, A.S. Mujumdar, G.S.V. Raghavan and H.S. Ramaswamy, Handbook of Post-harvest Technology, Marcel Dekker Press, USA, 2001.
6. D.K. Salunkhe, and S.S. Kadam, Handbook of Fruit Science and Technology: Production, Composition and Processing, Marcel Dekker, New York, 1995.

22OFD04 CEREAL, PULSES AND OILSEED TECHNOLOGY**3 0 0 3****Course Objectives**

- Understand the application of scientific principles in the processing technologies specific to the materials
- Understand the storage methods and handling techniques followed for cereals, pulses and oil seeds
- Develop the knowledge in the area of Cereals, pulses and oil seed processing and technology

Course Outcomes (COs)

1. Identify the specific processing technologies employed for cereals
2. Analyse the composition of millets and their nutritional importance
3. Relate the compositional changes and processing methods of pulses and legumes
4. Create the competence in processing of oilseeds technology
5. Relate the storage processing of food grains with quality aspects

Articulation Matrix

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	2		1		2								
4	2	3		2		2								2
5	2	2		2		3								

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

Cereal Grains- Basic agricultural aspects, structure and composition; Storage, Insect control; Processing: Wheat- milling, (Atta and maida), quality aspects of flour, wheat proteins and their function, rheology of flour; wheat based baked products - Bread, Biscuit, Cakes, Extruded products, Pizza, Chapatis, malting and malt products; Rice-Milling, Parboiling, Quick cooking rice, Traditional Indian Products- Puffed Rice, flaked rice, Idli/Dosa/vada mixes and other savouries; Corn- Wet and dry milling, Corn Products - Corn flakes, Corn starch, canned corn products, puffed product; Oats-Milling, Oat Products - Steel cut, rolled oats, quick cooking; Traditional and Fermented cereal products.

UNIT II**9 Hours****OTHER CEREALS AND MILLETS**

Sorghum, Pearl Millet, Finger millet, Foxtail Kodo Millet - Basic agricultural millet, aspects, structure and composition; storage, insect control; processing - pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet.

UNIT III**9 Hours****PULSES AND LEGUMES**

Basic agricultural aspects, structure, composition, storage, insect control, processing Milling/splitting, dhal milling, products - puffed, flakes, flour, legume-based traditional products, flour based Indian sweets and savouries, soya milk, soy protein Isolate, soya paneer

UNIT IV

9 Hours

OIL SEEDS AND NUTS

Basic agricultural aspects structure, composition, Storage, Insect control; processing: traditional and modern methods of oil extraction, refining, bleaching, deodorizing, hydrogenation; oil blends; applications of different oils and fats in food processing & products.

UNIT V

9 Hours

STORAGE AND HANDLING

Bag Storage - Advantages and Disadvantages, Cover Plinth Storage Structures, CAP storage (Cover and Plinth Storage). Protection against Rodents, Fungi, Pests and Mites. Fumigation Processes for bag storage piles. Bulk Storage in silos and large Bins. Conveyors and Elevators for feeding and discharging.

Total: 45 Hours

Reference(s)

1. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 1995.
2. Delcour, Jan A. and R. Carl Hoseney., Principles of Cereal Science and Technology, 3rd Edition, American Association of Cereal Chemists, 2010.
3. Karl Kulp, Handbook of Cereal Science and Technology, 2nd Rev. Edition, CRC Press, 2000.
4. N.L.Kent and A.D.Evans, Technology of Cereals (4th Edition) Elsevier Science (Pergaman),Oxford, UK, 1994.
5. Matz, Samuel A., The Chemistry and Technology of Cereals as Food and Feed, 2nd Edition,CBS, 1996.
6. Morris, Peter C. and J.H. Bryce., Cereal Biotechnology, CRC/Wood head publishing, 2004.

22OFT01 FASHION CRAFTSMANSHIP**3 0 0 3****Course Objectives**

- To impart theoretical and practical knowledge about various handi-craft techniques
- To enhance innovative skills on hand crafts.
- To build confidence on doing handicrafts.

Course Outcomes (COs)

1. Outline the classification, techniques and criteria for selecting raw materials for making various handicraft materials and produce textile based handicrafts. Produce various decorative and appealing products
2. Design and construct various wall hangings and fashion accessories.
3. Design and construct toys and accessories
4. Design and construct head accessories, home furnishings and paintings
5. Design and construct various decorative and appealing products for interiors

Articulation Matrix

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

UNIT I**9 Hours****TECHNIQUES OF HANDICRAFT MATERIALS**

Definition of Handicraft, Classification: Reusable, Non reusable, Raw materials used in various craft materials: printed, embroidered, stitched and handmade, Criteria for selection of raw materials: material types and end uses.

UNIT II**9 Hours****DECORATIVE AND APPEALING PRODUCTS - INTERIORS**

Designing and Construction procedures for following various decorative and appealing products: Wall hangings - String Art on plywood, Pressed Flower Art frames.

UNIT III**9 Hours****DECORATIVE AND APPEALING PRODUCTS - ACCESSORIES**

Designing and Construction procedures for following various decorative and appealing products: Handbags, Hats, footwear.

UNIT IV**9 Hours****DECORATIVE AND APPEALING PRODUCTS - ORNAMENTS**

Designing and Construction procedures for following various decorative and appealing products: Stone necklace using Macrame Technique, Tribal Jewellery using woollen threads, Floral Jewellery using Resin Technique, Fabric Jewellery using Tie and Dye Technique.

UNIT V

9 Hours

DECORATIVE AND APPEALING PRODUCTS - FANCY ITEMS

Designing and Construction procedures for following various decorative and appealing products: Jewellery Box, Utility Holder, Gift items. Lampshade decors from cardboard, Driftwood Frames for pictures and Mirrors.

Total: 45 Hours

Reference(s)

1. Handmade in India: A Geographic Encyclopaedia of India Handicrafts. Abbeville press; 1 edition (October 20,2009)
2. Encyclopaedia of Card making Techniques (Crafts), Search Press Ltd, illustrated edition, 2007
3. All about Techniques in Illustration, Barron Educational Series, 2001
4. Printing by Hand: A Modern Guide to printing with Handmade stamps, Stencils and Silk Screens, STC Craft/A Melanie Falick Book, 2008
5. Materials & Techniques in the Decorative Arts: An Illustrated Dictionary, University of Chicago Press, 2000
6. <https://www.marthastewart.com/274411/fashion-crafts>

22OFT02 INTERIOR DESIGN IN FASHION**3 0 0 3****Course Objectives**

- To impart knowledge on interior design.
- To improve the design skills, sustainable with socially-conscious designs

Course Outcomes (COs)

1. Interpret the elements of interior design concepts and resolve the personality requirements
2. Develop graphical representations of interior design concepts
3. Resolve the space planning requirements of residential home as per CPWD guidelines
4. Determine the aesthetic requirements of interior design components.
5. Appraise the roles and responsibilities of interior designer.

Articulation Matrix

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

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

Interior designing - definition, importance, requirements and types - Structural design, Decorative Design - Designing interiors, Good taste; Design themes, types and application. Personality of the Home - Art elements - Line: types, characteristics and importance; form: size and shape, characteristics; Colour - sources, qualities, emotional effects, colour wheel and schemes.

UNIT II**9 Hours****GRAPHICAL PRESENTATIONS**

3D composition; Isometric and Axonometric- Still life- Furniture Sketching- Object Drawing with color rendering - Interior elements, Lighting, plants. Perspective, Axonometric Isometric drawing. Orthographic Projection - Lifts and escalators.

UNIT III**9 Hours****SPACE PLANNING**

Space planning concepts- interiors, circulation. Definition, application of ergonomic principals in interiors. Residential house space planning case study- CPWD guidelines. Lighting for different locations and activities, measurement, ventilation and indoor air quality, noise control methods.

UNIT IV**9 Hours****INTERIOR COMPONENTS**

Application of colour in interiors; Texture - types and significance; Pattern: types and effects; Light - importance. Importance of Furniture Design for Interiors- Ancient Age / Middle Age / Contemporary. Doors, Windows, Staircase designs, False Ceiling, Partitions, Wall Panelling, Comics, Mosaic, Cladding- Flooring and Wall Cladding

UNIT V

9 Hours

ROLES AND RESPONSIBILITIES OF INTERIOR DESIGNER

Role of an Interior Designer- Responsibility towards society and need of an Interior Designer to better the environment- Ethics and Code of Conduct- Responsibility towards client, contractor and supplier, Estimation. Professional Fees- Work of an Interior Designer- Making of portfolio, JD Annual Design Awards.

Total: 45 Hours

Reference(s)

1. Joanna Gaines, *Homebody: A guide to creating spaces you never want to leave*, Harper design, 2018.
2. Erin gates, *Elements of Style: Designing a Home and a life*, Simon and Schuster, 2014.
3. Simon Dodsworth, *The Fundamentals of Interior Design*, AVA publishing, 2009.
4. V. Mary. Knackstedt, *The Interior Design Business Handbook: A Complete Guide to Profitability*, Wiley, New Jersey; 2006.
5. M. G. Shah, C. M. Kale, and S.Y. Patki, *Building Drawing with an Integrated Approach to Build Environment*, Tata McGraw Hill, 2002.
6. <https://eclectictrends.com>

22OFT03 SURFACE ORNAMENTATION**3 0 0 3****Course Objectives**

- To familiarize the students about the various techniques of surface embellishment with relevance to garment embellishments.
- To aware of various types of embroidery and methods of producing it.
- To make the students confident about doing surface embellishment work

Course Outcomes (COs)

1. Analyze the raw material requirements for surface ornamentation and its application
2. Implement hand embroidery stitches on fabric and show the stitch development procedure in diagrammatic representations
3. Apply the machine and computerized embroidery stitches
4. Analyze the surface embellishment techniques and its application
5. Assess the quality maintenance parameters of all embroidered products and analyze the 6 traditional embroidery techniques

Articulation Matrix

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

UNIT I**9 Hours****INTRODUCTION TO SURFACE ORNAMENTATION**

Introduction, Definition, Need, Types, Raw materials, Importance of surface ornamentation, Selection of needle, thread and fabric for hand embroidery and machine embroidery. various methods of surface embellishment- embroidery and surface ornamentation.

UNIT II**9 Hours****HAND EMBROIDERY**

General rules for hand embroidery. Types of hand embroidery stitches-Running, Couching, Button hole, Satin, Long & Short, Wheat, Chain, Stem, Herringbone, Cross stitch, Knotted stitches, Fish bone, Fly stitch, Braids, Back, Hem, Seed, Needle weaving, Whip stitches.

UNIT III**9 Hours****MACHINE EMBROIDERY**

General rules for machine embroidery. Types of frames and methods of transferring the designs. Attachments to sewing machines for embroidery, Types of machine embroidery stitches- Eyelet work, Cut work, patch work, Mirror work, Applique, Shaded embroidery, Shadow work, Bead and Sequins work, Vermicelli, Zigzag, Granite stitch. Computerized embroidery machine- Concept of design and development, software used in embroidery machines, process of designing, method and types of stitch application, punching and digitizing.

UNIT IV

9 Hours

EMBELLISHMENT TECHNIQUES

Materials used and Applications. Types of embellishment techniques- fabric painting-hand, Stencil-dabbing and Spraying. Dyeing and printing-advanced tie and dye techniques, batik and block printing. Trimmings and decorations-Laces, Pompons, Fringes, Tassels, Tucks, Show buttons, Crocheting.

UNIT V

9 Hours

TRADITIONAL EMBROIDERIES OF INDIA AND CARE

Care and maintenance of embroidered articles-care and maintenance methods for embroidered apparel, pressing. Traditional Embroideries of India-Phulkari, Kasuti, Kashmiri embroidery, Kutch work, Chikkankari, Kantha.

Total: 45 Hours

Reference(s)

1. Ruth Chandler, Modern Hand Stitching-Dozens of stitches with creative free-form variations,2014
2. Sophie Long, Mastering the Art of Embroidery: Traditional Techniques and Contemporary Applications for Hand and Machine Embroidery, Heritage Publishers, London, 2013
3. Christen Brown ,Embroidered & Embellished, C&T Publishing, 2013
4. Sheila Paine, Embroidered Textiles, Thames and Hudson Publisher, UK, 1990.
5. Gail Lawther, Inspirational Ideas for Embroidery on Clothes & Accessories, Search Press Ltd, UK, 1993.
6. <http://www.needlenthread.com/tag/hand-embroidery-stitches>

22OPH01 NANOMATERIALS SCIENCE**3 0 0 3****Course Objectives**

- Impart knowledge on Nanoscience
- Explore different techniques of producing nanomaterials
- Create expertise on the applications of nanomaterials in various fields

Course Outcomes (COs)

1. Summarize the origin and advance of nanomaterials and its classification
2. Compare the different types of methods adopted for synthesizing nanomaterials
3. Analyze the characterization techniques for analyzing nanomaterials
4. Explain the physical properties exhibited by nanomaterials
5. Organize the nanomaterials developed for advanced technological applications

Articulation Matrix

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

UNIT II**9 Hours****NANO SCALE MATERIALS**

Introduction-Feynman's vision-national nanotechnology initiative (NNI) - past, present, future - classification of nanostructures, nanoscale architecture - effects of the nanometer length scale - changes to the system total energy, and the system structures- effect of nanoscale dimensions on various properties - differences between bulk and nanomaterials and their physical properties.

UNIT II**9 Hours****NANOMATERIALS SYNTHESIS METHODS**

Top down processes - mechanical milling, nanolithography and types based on radiations - Bottom up process physical method: physical vapour deposition, RF sputtering, CVD- chemical method: colloidal and sol-gel methods - template based growth of nanomaterials - ordering of nanosystems, self-assembly and self-organization.

UNIT III**9 Hours****CHARACTERIZATION TECHNIQUES**

General classification of characterization methods - analytical and imaging techniques - microscopy techniques - electron microscopy, scanning electron microscopy, transmission electron microscopy, atomic force microscopy - diffraction techniques - X-ray spectroscopy - thermogravimetric analysis of nanomaterials.

UNIT IV**9 Hours****SEMICONDUCTOR NANOSTRUCTURES**

Quantum confinement in semiconductor nanostructures - quantum wells, quantum wires, quantum dots, super lattices-epitaxial growth of nanostructures-MBE, metal organic VPE, LPE - carbon nano tubes-structure, synthesis and electrical properties -applications- quantum well laser- quantum efficiency of semiconductor nanomaterials

UNIT V**9 Hours****NANOMACHINES AND NANODEVICES**

Microelectromechanical systems (MEMS) and Nanoelectromechanical systems (NEMS)-fabrication, actuators-organic FET- principle, description, requirements, integrated circuits- single electron transistor - - organic photovoltaic cells- spintronics

Total: 45 Hours**Reference(s)**

1. Willam A. Goddard, Donald W.Brenner, "Handbook of Nanoscience, Engineering, and Technology", CRC Press, 2012
2. Charles P. Poole Jr and. Frank J. Owens, "Introduction to Nanotechnology", Wiley Interscience, 2007
3. Guozhong Cao, Y. Wang, "Nanostructures and Nanomaterials-Synthesis, Properties & Applications", Imperials College Press, 2011.
4. T. Pradeep, "NANO: The Essentials Understanding Nanoscience and Nanotechnology", McGraw - Hill Education (India) Ltd, 2012
5. Robert W. Kelsall, Ian W. Hamley, Mark Geoghegan, "Nanoscale Science and Technology", John Wiley and Sons Ltd, 2006
6. Viswanathan B, AuliceScibioh M, "Fuel cells: Principles and Applications", University Press, 2009.

22OPH02 SEMICONDUCTOR PHYSICS AND DEVICES**3 0 0 3****Course Objectives**

- Impart knowledge in physical properties of semiconducting materials
- Analyze the factors affecting the operation of semiconductor devices
- Apply the physics of semiconductors to develop semiconductor devices

Course Outcomes (COs)

1. Exemplify the band gap, drift and diffusion current densities due to carrier transport in semiconductors
2. Analyze the energy band diagram in thermal equilibrium and space charge width of PN junction
3. Illustrate the operation of Bipolar Junction transistor at different modes and different configurations
4. Illustrate the operation of metal oxide field effect transistor and their memory devices
5. Represent the working mechanism of opto-electronic devices

Articulation Matrix

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

UNIT I**9 Hours****ENERGY BANDS AND CARRIER TRANSPORT PROPERTIES**

Energy Bands: Formation of energy bands - doping effects - energy levels - electron and hole concept in semiconductor. Carrier transport: Carrier drift-drift current density - conductivity- diffusion current density - total current density

UNIT II**9 Hours****P-N JUNCTION**

Basic structure and fabrication process of p-n junction - current - voltage characteristics - energy band diagram - equilibrium Fermi levels - depletion region - junction breakdown phenomena - zener - avalanche breakdown.

UNIT III**9 Hours****BIPOLAR JUNCTION TRANSISTOR**

The basic transistor action - operation in the active mode - current gain - static characteristics - carrier distribution in emitter, base and collector region - modes of operation - current - voltage characteristics of common base and emitter configuration - frequency response and switching of bipolar transistor

UNIT IV

9 Hours

MOSFET

The ideal MOS diode - basic fundamentals and characteristics - types - CMOS and BiCMOS - CMOS inverter - MOSFET on insulator - thin film transistor (TFT) - silicon on insulators (SOI) devices - MOS Memory structures - DRAM and SRAM

UNIT V

9 Hours

PHOTONIC DEVICES

Radiative transitions and optical absorption-light emitting diodes-organic LED - infrared LED - semiconductor laser - temperature effect - photo detector - photo diode - silicon and compound semiconductor solar cells - efficiency

Total: 45 Hours

Reference(s)

1. Donald A Neamen, "Semiconductor Physics and Devices", Tata McGraw Hill, 2012
2. S. M. Sze and M. K. Lee, "Semiconductor Devices, Physics and Technology", John-Wiley & Sons, 2015
3. Ben. G. Streetman and S. K. Banerjee , "Solid State Electronic Devices", Pearson Education Ltd, 2015
4. C. Kittel, "Introduction to Solid State Physics", John-Wiley & Sons, 2012
5. J. Millman and C. Halkias, "Electronic Devices and Circuits", Tata McGraw Hill, 2010
6. Hagen Klauk, "Organic Electronics: Materials, Manufacturing and Applications", Wiley-VCH, 2006

22OPH03 APPLIED LASER SCIENCE**3 0 0 3****Course Objectives**

- Impart knowledge on laser science
- Explore different strategies for producing lasers
- Create expertise on the applications of lasers in various fields

Course Outcomes (COs)

1. Illustrate the transition mechanisms and the components of a laser system
2. Compare the different types of lasers based on pumping method, active medium and energy levels
3. Compute the rotation of earth, velocity and distance using lasers and apply the same for day today applications
4. Analyze the role of lasers in surgical and endoscopy applications
5. Apply the laser techniques in industrial applications

Articulation Matrix

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

UNIT I**9 Hours****LASER FUNDAMENTALS**

Introduction - principle - absorption and emission of light - thermal equilibrium - Einstein's prediction - Einstein's relations - A and B coefficients - condition for large stimulated emission - spontaneous and stimulated emission in optical region - light amplification - condition for light amplification - population inversion- Components of lasers - pumping methods - pumping mechanisms - optical resonator

UNIT II**9 Hours****LASER BEAM CHARACTERISTICS AND TYPES**

Characteristics of laser - Classification of lasers - principle, construction, working, energy level diagram and applications of molecular gas laser (CO₂ laser) - liquid laser (dye laser) - excimer laser - Solid state laser (Nd:YAG laser) - semiconductor laser (homojunction laser).

UNIT III

9 Hours

LASERS IN SCIENCE

Introduction - Harmonic generation (SHG) - Stimulated Raman emission - lasers in chemistry - laser in nuclear energy - lasers and gravitational waves - rotation of the earth - measurement of distance - Light detection And Ranging (LIDER) - velocity measurement - holography

UNIT IV

9 Hours

LASERS IN MEDICINE AND SURGERY

Light induced biological hazards: Eye and skin - Eye laser surgery - photocoagulations - homeostasis - dentistry - laser angioplasty - different laser therapies - advantages & disadvantages - laser endoscopy.

UNIT V

9 Hours

LASERS IN INDUSTRY

Applications in material processing: laser welding - hole drilling - laser cutting - Lasers in electronics industry: information storage - bar code scanner- Lasers in defence: laser based military weapons - laser walls.

Total: 45 Hours

Reference(s)

1. K. Thiyagarajan and A. K. Ghatak, "LASERS: Fundamentals and Applications", Springer, USA, 2015
2. M. N. Avadhanulu, "An Introduction to Lasers Theory and Applications", S. Chand Publisher, 2013
3. W. Koechner, M. Bass, "Solid State Lasers: a graduate text", Springer Verlag, New York, 2006
4. K. P. R. Nair, "Atoms, Molecules and Lasers", Narosa Publishing House, 2009
5. K. R. Nambiar, "Lasers: Principles Types and Applications", New Age International Publications, 2006
6. A. Sennaroglu, "Solid-State Lasers and Applications", CRC Press, 2006

22OPH04 BIO-PHOTONICS**3 0 0 3****Course Objective:**

- To understand the light-matter interaction in biological cells or tissues by using the principles of optics and lasers.
- To apply the properties of biological cells or tissues in biomedical applications by various optical imaging, sensing and activation techniques.
- To analyze the concepts of Modern optical measurement techniques and devices in early detection of disease and cure them.

Course Outcomes (COs)

1. Infer the laws of optics and lasers to interpret the biological cells and tissues.
2. Identify the properties of different optical instruments in biological systems to represent their behavior in structure and design of detection engineering instruments.
3. Use laser tweezers techniques to infer the activities of cells (tissues) and explain the single molecule detection processes in medical diagnosis.
4. Outline the properties of ultra short laser pulses and tissue engineering to rectify the affecting factors in biological cells.
5. Compare the various types of bio-imaging methods to detect the infected cells and molecules in biological science.

Articulation Matrix

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

UNIT I**9 Hours****INTRODUCTION TO BIOPHOTONICS**

Light as Photon Particles – Coherence of light - lasers – classification of lasers – Mechanisms of Non-linear Optics (NLO) processes associated with Biophotonics - Light scattering mechanisms: Rayleigh scattering, Miescattering, Brillouin Scattering, Raman Scattering -Different light sources – Quantitative description of light: Radiometry

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

Interaction of light with cells and tissues – Light – Tissue Interaction Variables – Light –Tissue Interaction Theory: Radiative Transport Theory – Photo process in biopolymers – In Vivo Photoexcitation – photo-induced physical, chemical, thermal and mechanical effects in biological systems – Optical biopsy – Single molecule detection

UNIT III**9 Hours****BIO-NANO-PHOTONICS**

Laser Microtools, Semiconductor quantum dots for bioimaging, Metallic nanoparticles and nanorods for biosensing – Optical biosensors: Fibre-Optic, evanescent wave, surface Plasmon resonance (SPR) based biosensors – biomaterials for photonics – Principle and design of laser tweezers – laser trapping and dissection for biological manipulation.

UNIT IV**9 Hours****TISSUE ENGINEERING WITH LIGHT**

Basics of tissue optics: Light absorption and scattering in tissues, Wavelength effects and spectra– the therapeutic window, Light penetration in tissues – Absorbing agents in tissues and blood –Skinoptics, response to the UV radiation, Optical parameters of tissues – tissue welding – tissue contouring – tissue regeneration – Femto laser surgery – low level light therapy and photo dynamic therapy

UNIT V**9 Hours****BIO-IMAGING TECHNIQUES AND ITS APPLICATIONS**

An overview of optical imaging – Fluorescence Microscopy – Scanning Microscopy – In vivo Confocal Microscopy – Multi photon Microscopy – Optical Coherence Tomography (OCT) – Fluorescence Resonance Energy Transfer (FRET) imaging – fluorescence lifetime imaging Microscopy (FLIM) – Nonlinear optical imaging – Coherent Anti-stokes Raman Scattering –Bioimaging Applications.

Total: 45 Hours**Reference(s)**

1. Introduction to Biophotonics, ParasN.Prasad, WileyInter-science, AJohnWiley & Sons, Inc., Publication (Class notes are developed mainly based on this book.)
2. Introduction to Biomedical Imaging, Andrew G.Webb, 2002, IEEE Press.
3. Biomedical Optics: Principles and Imaging, Lihong.V.Wang, Hsin.-I.Wu, 2007, Wiley Interscience 2007. & "An Introduction to Biomedical Optics", R.Splinterand B.A.Hooper, Taylor & Francis
4. Bioimaging Current Concepts in Light and Electron Microscopy, DouglasE.Chandler & Robert W.Roberson, Jones and Bartlett publishers.
5. Optical Imaging and Microscopy : Techniques and Advanced Systems, Peter Török and Fu-JenKao, 2004, Springer.

22OPH05 PHYSICS OF SOFT MATTER**3 0 0 3****Course Objectives**

- To recognize the properties of soft matter and hard matter
- To understand the fundamental interactions of colloids and gels
- To explain the structure and phase behavior of liquid crystals and supramolecules
- To summarize the soft matter properties of structures and components of life

Course Outcomes (COs)

1. Identify the salient features of soft matter and hard matter
2. Exemplify the fundamental interactions and stability of colloids and gels
3. Illustrate the structure and properties of liquid crystals
4. Outline the aggregation and phase behavior of surfactants, polymers, copolymers and block copolymers
5. Analyze the soft matter behavior of nucleic acids, proteins, polysaccharides and membranes

Articulation Matrix

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

UNIT I**9 Hours****CONDENSED MATTER**

Intermolecular forces-Condensation and freezing-mechanical response: Hookean solid-Newtonian liquid-viscoelasticity. Glasses: relaxation time-viscosity- glass forming liquids. Soft matter: length scales-fluctuations and Brownian motion

UNIT II**9 Hours****COLLOIDAL DISPERSIONS & GELS**

Forces between colloidal particles: vander Waals forces-electrostatic double layer forces-steric hindrance-depletion interactions. Stability and phase behaviour: Crystallisation-strong colloids-weak colloids.Physical and chemical gels-classical theory of gelation-elasticity of gels

UNIT III**9 Hours****LIQUID CRYSTALS**

Liquid crystal phases-distortions and topological defects-electrical and magnetic properties-polymer liquid crystals-Fredricks transition and liquid crystal displays

9 Hours

UNIT IV

SUPRAMOLECULAR SELF ASSEMBLY

Aggregation and phase separation-types of micelles- bilayers and vesicles. Phase behaviour of concentrated surfactant solutions-phase separation in polymers, copolymers and block copolymers

9 Hours

UNIT V

SOFT MATTER IN NATURE

Components and structures of life-Nucleic acids-proteins-interaction between proteins-polysaccharides-membranes

Total: 45 Hours

REFERENCES

1. Richard A L Jones, *Soft Condensd Matter*, Oxford University Press, UK, 2002
2. Masao Doi, *Soft Matter Physics*, Oxford University Press, UK, 2013.
3. Ian W. Hamley, *Introduction to Soft Matter*, John Wiley & Sons, 2007
4. A. Fernandez-Nieves, A M Puertas, *Fluids, Colloids and Soft materials: An Introduction to Soft Matter Physics*, John Wiley & Sons, 2016
5. Maurice Kleman, Oleg D. Lavrentovich, *Soft Matter Physics: An Introduction*, Springer-Verlag, New York, 2003.

22OCH01 CORROSION SCIENCE AND ENGINEERING**3 0 0 3****Course Objectives**

- Analyse the loss incurred due to corrosion in different sectors and terminologies related to corrosion
- Identify forms and types of corrosion with suitable mechanism
- Apply various methods of corrosion control, corrosion testing and monitoring

Course Outcomes (COs)

1. Explain if corrosion can occur under specific operating conditions in a given equipment or construction and indicate regions of immunity, corrosion and passivity of a metal
2. Compare different corrosion types on metals when exposed to air, water and at high temperatures (> 100 C)
3. Identify the corrosion mechanism on steel, iron, zinc and copper metal surfaces
4. Calculate the rate of corrosion on metals using electrochemical methods of testing
5. Propose the correct materials, design and operation conditions to reduce the likelihood of corrosion in new equipment and constructions

Articulation Matrix

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

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

Importance of corrosion - spontaneity of corrosion - units of corrosion rate (mdd and mpy) - direct and indirect damage by corrosion - importance of corrosion prevention in industries - Pilling Bedworth ratio and its significance - passivation - area relationship in both active and passive states of metals - Pourbaix diagrams of Mg, Al and Fe and their advantages and disadvantages

UNIT II**7 Hours****TYPES OF CORROSION**

Eight forms of corrosion: uniform, galvanic, crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion-Catastrophic oxidation corrosion

UNIT III**9 Hours****MECHANISM OF CORROSION**

Hydrogen embrittlement - corrosion fatigue - filiform corrosion - fretting damage and microbes induced corrosion. Corrosion mechanism on steel, iron, zinc and copper metal surfaces

UNIT IV**10 Hours****CORROSION RATE AND ITS ESTIMATION**

Rate of corrosion: Factors affecting corrosion. Electrochemical methods of polarization: Tafel extrapolation polarization and linear polarization. Weight loss method - testing for intergranular susceptibility and stress corrosion. Non destructive testing methods: Visual testing - liquid penetrant testing - magnetic particle testing - Ultrasonic monitoring, and eddy current testing

UNIT V**10 Hours****CORROSION CONTROL METHODS**

Fundamentals of cathodic protection - types of cathodic protection(sacrificial anodic and impressed current cathodic protection). Stray current corrosion, problems and its prevention. Protective coatings: Metal coatings: Hot dipping (galvanizing, tinning and metal cladding) - natural inhibitors. Selection of suitable design for corrosion control

Total: 45 Hours**Reference(s)**

1. Mouafak A. Zaher, "Introduction to Corrosion Engineering", CreateSpace Independent Publishing Platform, 2016.
2. E.McCafferty, "Introduction to Corrosion Science", Springer; 2010 Edition, January 2010.
3. R. Winstone Revie and Herbert H. Uhlig, "Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering", 4th Edition, John Wiley & Science, 2008.
4. Mars G. Fontana, "Corrosion Engineering", Tata McGraw Hill, Singapore, 2008
5. David E.J. Talbot (Author), James D.R. Talbot, "Corrosion Science and Technology", Second Edition (Materials Science & Technology), CRC Press; 2nd Edition, 2007.
6. <http://corrosion-doctors.org/Corrosion-History/Eight.html>

22OCH02 POLYMER SCIENCE**3 0 0 3****Course Objectives**

- Explain the properties of different polymers with its mechanism
- Select the appropriate polymerization techniques to synthesize the polymers
- Identify suitable polymers for various industrial applications

Course Outcomes (COs)

1. Illustrate the types of mechanism of polymerization reactions and analyze the natural and synthetic polymers
2. Identify the suitable polymerization techniques to synthesize the high quality polymers
3. Identify the structure, thermal, and mechanical properties of polymers for different applications
4. Apply the polymer processing methods to design polymer products
5. Analyze the polymers used in electronic and biomedical applications.

Articulation Matrix

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

UNIT I**10 Hours****POLYMERS AND ELASTOMERS**

Classification of polymers - Mechanism: Addition polymerization - free radical, cationic, anionic and coordination (Ziegler-Natta) polymerization - copolymerization - condensation polymerization (nylon-6,6) - ring opening polymerization (nylon-6). Elastomers: Natural rubber and synthetic rubber: styrene-butadiene rubber (SBR), butyl, neoprene, thiocol rubbers. High performance polymers: polyethers, polyether ether ketone (PEEK), polysulphones and polyimides

UNIT II**8 Hours****POLYMERIZATION TECHNIQUES**

Homogeneous and heterogeneous polymerization - bulk polymerization (PMMA, PVC) - solution polymerization - polyacrylic acid, suspension polymerization (ion-exchange resins) - emulsion polymerization (SBR) - advantages and disadvantages of bulk and emulsion polymerization. Melt solution and interfacial poly-condensation

UNIT III**8 Hours****CHARACTERIZATION AND TESTING**

Characterization of polymers by Infrared Spectroscopy (IR) and Nuclear Magnetic Spectroscopy (NMR) - Thermal properties: TGA and DSC - Testing tensile strength - Izod impact - Compressive strength - Rockwell hardness - Vicot softening point - water absorption

UNIT IV

9 Hours

POLYMER PROCESSING

Moulding: Compression - injection - extrusion and blow mouldings. Film casting - calendering. Thermoforming and vacuum formed polystyrene - foamed polyurethanes. Fibre spinning: melt, dry and wet spinning. Fibre reinforced plastics fabrication: hand-layup - filament winding and pultrusion

UNIT V

10 Hours

SPECIALITY POLYMERS

Preparation and properties of heat resistant and flame retardant polymers. Polymers for electronic applications: liquid crystalline, conducting and photosensitive polymers – E waste management. Polymer for biomedical applications: artificial organs, controlled drug delivery, Scaffolds in tissue Engineering – waste management.

Total: 45 Hours

Reference(s)

1. V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, "Polymer Science", New Age International (P) Ltd., New Delhi, 2021
2. Joel R. Fried, "Polymer Science and Technology", Prentice Hall of India (P). Ltd., 2014
3. F. W. Billmeyer, "Text Book of Polymer Science", John Wiley & Sons, New York, 2008
4. Barbara H. Stuart, "Polymer Analysis", John Wiley & Sons, New York, 2008
5. George Odian , "Principles of Polymerization", John Wiley & Sons, New York, 2004
6. R. J. Young and P. A. Lovell, "Introduction to Polymers", CRC Press, New York, 2011
7. Common Biocompatible Polymeric Materials for Tissue Engineering and Regenerative Medicine (2019), Materials Chemistry and Physics <https://doi.org/10.1016/j>.

22OCH03 ENERGY STORING DEVICES**3 0 0 3****Course Objectives**

- Compare the energy density of commercialized primary and secondary batteries.
- Classify the fuel cells and compare their efficiency in different environmental conditions.
- Demonstrate the various energy storage devices and fuel cells.

Course Outcomes (COs)

1. Find the parameters required for operation of a cell to evaluate the capacity of energy storage devices.
2. Identify the electrodes, electrolyte and cell reactions of different types of primary, secondary batteries and infer the selection criteria for commercial battery systems with respect to commercial applications.
3. Differentiate fuel cells based on its construction, production of current and applications.
4. Compare different methods of storing hydrogen fuel and its environmental applications.
5. Classify the solar cell based on the materials used in it.

Articulation Matrix

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

UNIT I**6 Hours****BASICS OF CELLS AND BATTERIES**

Components - classification - operation of a cell - theoretical cell voltage - capacity - specific energy - energy density of lithium and lead acid battery - charge efficiency- charge rate - charge retention - closed circuit voltage - open circuit voltage current density - cycle life - discharge rate-over charge-over discharge

UNIT II**10 Hours****BATTERIES FOR PORTABLE DEVICES AND ELECTRIC VEHICLES**

Primary batteries: zinc-carbon - magnesium, and mercuric oxide - recycling/safe disposal of used cells. Secondary batteries: lead acid - nickel-cadmium - lithium ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide - lithium anode cell - photogalvanic cells. Battery specifications for cars and automobiles. Extraction of metals from battery materials.

UNIT III

10 Hours

TYPES OF FUEL CELLS

Importance and classification of fuel cells: Description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells - phosphoric acid - solid oxide - molten carbonate and direct methanol fuel cells

UNIT IV

10 Hours

HYDROGEN AS A FUEL

Sources and production of hydrogen: Electrolysis and photocatalytic water splitting. Methods of hydrogen storage: High pressurized gas - liquid hydrogen type - metal hydride. Hydrogen as engine fuel - features, application of hydrogen technologies in the future – limitations.

UNIT V

9 Hours

ENERGY AND ENVIRONMENT

Future prospects of renewable energy and efficiency of renewable fuels - economy of hydrogen energy. Solar Cells: First, second, third and fourth generation solar cell - photobiochemical conversion cell.

Reference(s)

1. N. Eliaz, E. Gileadi, Physical Electrochemistry, Fundamentals, Techniques and Applications, Wiley, 2019.
2. J. Garche, K. Brandt, Electrochemical Power sources: Fundamentals Systems and Applications, Elsevier, 2018
3. S.P. Jiang, Q. Li, Introduction to Fuel Cells, Springer, 2021.
4. A. Iulianelli, A. Basile, Advances in Hydrogen Production, Storage and Distribution, Elsevier, 2016.
5. M.M. Eboch, The Future of Energy, From Solar Cells to Flying Wind Farms, Capstone, 2020.

22OMA01 GRAPH THEORY AND COMBINATORICS**3 0 0 3****Course Objectives**

- This course comprehends the graphs as a modeling and analysis tool in computer science & Engineering
- It introduces the structures such as graphs & trees and techniques of counting and combinations, which are needed in number theory based computing and network security studies in Computer Science.

Course Outcomes (COs)

1. Recognize the basic ideas of Graph and its characteristics.
2. Assess the characteristics of trees and its properties.
3. Predict the coloring of graphs and its applications in the respective areas of engineering.
4. Compute the permutations and combinations in the engineering field.
5. Demonstrate the types of generating functions and their applications in engineering.

Articulation Matrix

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

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

Graphs - Introduction - Isomorphism - Sub graphs - Walks, Paths, Circuits - Connectedness - Components - Euler graphs - Hamiltonian paths and circuits - Trees - Properties of trees - Distance and centers in tree - Rooted and binary trees.

UNIT II**9 Hours****TREES, CONNECTIVITY**

Spanning trees - Fundamental circuits - Spanning trees in a weighted graph - cut sets - Properties of cut set - All cut sets - Fundamental circuits and cut sets - Connectivity and separability - Network flows - 1- Isomorphism - 2-Isomorphism - Combinational and geometric graphs - Planer graphs - Different representation of a planer graph.

UNIT III**9 Hours****MATRICES, COLOURING AND DIRECTED GRAPH**

Chromatic number - Chromatic partitioning - Chromatic polynomial - Matching - Covering - Four color problem - Directed graphs - Types of directed graphs - Digraphs and binary relations - Directed paths and connectedness - Euler graphs.

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

Fundamental principles of counting - Permutations and combinations - Binomial theorem - combinations with repetition - Combinatorial numbers - Principle of inclusion and exclusion - Derangements - Arrangements with forbidden positions.

UNIT V

9 Hours

GENERATING FUNCTIONS

Generating functions - Partitions of integers - Exponential generating function - Summation operator - Recurrence relations - First order and second order - Non-homogeneous recurrence relations - Method of generating functions.

Total: 45 Hours

Reference(s)

1. Narsingh Deo, Graph Theory: With Application to Engineering and Computer Science, Prentice Hall of India, 2003
2. Grimaldi R.P., Discrete and Combinatorial Mathematics: An Applied Introduction, Addison Wesley, 1994.
3. Rosen K.H., Discrete Mathematics And Its Applications, McGraw Hil, 2007
4. Clark J. & Holton D.A., A First Look at Graph Theory, Allied Publishers, 1995.
5. Mott J.L., Kandel A. & Baker T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 1996.
6. Liu C.L., Elements of Discrete Mathematics, McGraw Hill, 1985.

22OGE01 PRINCIPLES OF MANAGEMENT**3 0 0 3****Course Objectives**

- To develop cognizance about importance of management principles.
- Extract the functions and responsibilities of managers.
- To Study and understand the various HR related activities.
- Learn the application of the theories in an organization.
- Analyze the position of self and company goals towards business.

Course Outcomes (COs)

1. Students will be able to understand the basic concepts of Management.
2. Have some basic knowledge on planning process and its Tools & Techniques.
3. Ability to understand management concept of organizing and staffing.
4. Ability to understand management concept of directing.
5. Ability to understand management concept of controlling.

Articulation Matrix

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

UNIT I**9 Hours****BASICS OF ENTREPRENEURSHIP**

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

UNIT II**9 Hours****GENERATION OF IDEAS**

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractional, Reversal Method, Brain Storming, Analogies

UNIT III**9 Hours****LEGAL ASPECTS OF BUSINESS**

Contract act-Indian contract act, Essential elements of valid contract, classification of contracts, sale of goods act- Formation of contract of sale, negotiable instruments- promissory note, bills and cheques, partnership, limited liability partnership (LLP), companies act-kinds, formation, memorandum of association, articles of association.

UNIT IV

9 Hours

BUSINESS FINANCE

Project evaluation and investment criteria (cases), sources of finance, financial statements, break even analysis, cash flow analysis.

UNIT V

9 Hours

OPERATIONS MANAGEMENT

Importance- functions-deciding on the production system- facility decisions: plant location, plant layout (cases), capacity requirement planning- inventory management (cases)-lean manufacturing, Six sigma.

FURTHER READING

Retrofitting, objectives, classification of retrofitting, cost effectiveness through retrofitting (economical aspects), circumstances leading to retrofitting, features and selection for retrofitting.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005.
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, TataMcGraw-Hill Publishing Company Limited, New Delhi: 2000.
3. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.

22OGE02 ENTREPRENEURSHIP DEVELOPMENT I**3 0 0 3****Course Objectives**

- Learn the basics and scope of the Entrepreneurship
- Understand the generation of ideas of the Entrepreneurship
- Evolve the legal aspects of the business
- Learn to analyze the various business finance
- Learn the basics of the Operations Management

Course Outcomes (COs)

1. Analyze the role of entrepreneurship in economic development.
2. Explain the types of ideas that to be used for entrepreneurship development.
3. Examine the legal aspects of business and its association.
4. Examine the sources of business and its analysis.
5. Analyse the different modes of operation management.

Articulation Matrix

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

UNIT I**9 Hours****BASICS OF ENTREPRENEURSHIP**

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

UNIT II**9 Hours****GENERATION OF IDEAS**

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractional, Reversal Method, Brain Storming, Analogies

UNIT III**9 Hours****LEGAL ASPECTS OF BUSINESS**

Contract act-Indian contract act, Essential elements of valid contract, classification of contracts, sale of goods act- Formation of contract of sale, negotiable instruments- promissory note, bills and cheques, partnership, limited liability partnership (LLP), companies act-kinds, formation, memorandum of association, articles of association.

UNIT IV**9 Hours****BUSINESS FINANCE**

Project evaluation and investment criteria (cases), sources of finance, financial statements, break even analysis, cash flow analysis.

UNIT V

9 Hours

OPERATIONS MANAGEMENT

Importance- functions-deciding on the production system- facility decisions: plant location, plant layout (cases), capacity requirement planning- inventory management (cases)-lean manufacturing, Six sigma.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, TataMcGraw-Hill Publishing Company Limited, New Delhi: 2000.
3. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006

22OGE03 ENTREPRENEURSHIP DEVELOPMENT II**3 0 0 3****Course Objectives**

- Evolve the marketing mix for promotion the product / services
- Handle the human resources and taxation
- Learn to analyze the taxation
- Understand the Government industrial policies and supports
- Preparation of a business plan

Course Outcomes (COs)

1. Examine the strategies and plans in marketing management.
2. Analyse the cases involved in human resource management.
3. Classify the direct and indirect taxes in business.
4. Analyze the supports given by government for improving the business.
5. Examine the various steps involved in preparing the business plan.

Articulation Matrix

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

UNIT I**9 Hours****MARKETING MANAGEMENT**

Marketing environment, Segmentation, Targeting and positioning, Formulating marketing strategies
Marketing research, marketing plan, marketing mix (cases)

UNIT II**9 Hours****HUMAN RESOURCE MANAGEMENT**

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view)

UNIT III**9 Hours****BUSINESS TAXATION**

Direct taxation, Income tax, Corporate tax, MAT, Tax holidays, Wealth tax, Professional tax (Cases). Indirect taxation, Excise duty, Customs, Sales and Service tax, VAT, Octroi, GST (Cases)

UNIT IV**9 Hours****GOVERNMENT SUPPORT**

Industrial policy of Central and State Government, National Institute-NIESBUD, IIE, EDI. State Level Institutions-TIIC, CED, MSME, Financial Institutions

UNIT V

9 Hours

BUSINESS PLAN PREPARATION

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Philip Kotler., Marketing Management, Prentice Hall of India, New Delhi: 2003
3. Aswathappa K, Human Resource and Personnel Management - Text and Cases, Tata McGraw Hill:2007.
4. Jain P C., Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi: 2002.
5. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.
6. <http://niesbud.nic.in/agencies.html>

**22OGE04 NATION BUILDING, LEADERSHIP AND
SOCIAL RESPONSIBILITY**

3 0 0 3

Course Objectives

- To understand the importance of National Integration, Patriotism and Communal Harmony
- To outline the basic awareness about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality
- To analyze the different types of responsibility role of play for the improvement of society

Course Outcomes (COs)

1. Understand religo-cultural diversity of the country and its impact on the lives of the people and their beliefs
2. Acquire a sense of responsibility, smartness in appearance and improve self confidence
3. Develop the sense of self-less social service for better social & community life
4. Apply the importance of Physical and Mental health and structure of communication organization and various mode of communication
5. Acquire awareness about the various types of weapon systems in the Armed Forces.

Articulation Matrix

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

UNIT I**9 Hours****NATIONAL INTEGRATION**

Importance & Necessity, Factors Affecting National Integration, Unity in Diversity. Threats to National Security. Water Conservation and Rain Harvesting, Waste Management and Energy Conservation. Leadership Capsule-Traits-Indicators-Motivation-Moral Values-Honor Code-Case Studies: Shivaji, Jhansiki Rani, Case Studies-APJ Abdul kalam, Deepa Malik, Maharana Pratap, N Narayan Murthy Ratan Tata Rabindra Nath Tagore, role of NCC cadets in 1965 war.

UNIT II**9 Hours****PERSONALITY DEVELOPMENT AND LEADERSHIP**

Intra & Interpersonal skills - Self-Awareness- & Analysis, Empathy, Critical & creative thinking, Decision making and problem solving, Communication skills, Group Discussion – coping with stress and emotions, changing mindset, Public Speaking, Time Management, Social skills, Career counseling, SSB procedure and Interview skills.

UNIT III**9 Hours****SOCIAL SERVICE, COMMUNITY DEVELOPMENT AND ENVIRONMENTAL AWARENESS**

Basics of social service and its need, Types of social service activities, Objectives of rural development programs and its importance, NGO's and their contribution in social welfare, contribution of youth and NCC in Social welfare. Protection of children & women safety, Road/ Rail Travel Safety, New initiatives, Cyber and mobile security awareness.

Disaster management Capsule-Organization-Types of Disasters-Essential Services-Assistance-Civil Defence Organization

UNIT IV**9 Hours****HEALTH, HYGIENE AND COMMUNICATION**

Sanitation, First Aid in Common Medical Emergencies. Health, Treatment and Care of Wounds. Yoga-Introduction, Definition, Purpose, Benefits. Asanas-Padamsana, Siddhasana, Gyan Mudra, Surya Namaskar, Shavasana, Vajrasana, Dhanurasana, Chakrasana, Sarvaangasana, Halasanaetc.

Obstacle Training Contact: Obstacle training - Intro, Safety measures, Benefits, Straight balance, Clear Jump, Gate Vault, ZigZagBalance, High Wall etc.

COMMUNICATION: Basic Radio Telephony (RT) Procedure-Introduction, Advantages, Disadvantages, Need for standard- Procedures-Types of Radio Telephony Communication-Radio telephony procedure, Documentation.

UNIT V**9 Hours****ARMED FORCES AND NCC GENERAL**

Introduction to Digital Signal Processors- Basic Classification-Features TMS320C6713 Architecture-Functional Unit-Pipelining- Addressing Modes -Instruction set Simple Assembly Language Program.

Total: 45 Hours**Reference(s)**

1. Director General NCC Website: <https://indiancc.nic.in/ncc-general-elective-subject-course-design/>
2. Grooming Tomorrow's Leaders, published by DG, NCC. <https://indiancc.nic.in/>
3. Youth in Action, published by DG, NCC. <https://indiancc.nic.in/>
4. The Cadet, Annual Journal of the NCC. <https://indiancc.nic.in/>
5. Précis Issued by respective Service Headquarters on specialized subject available to PI Staff as reference material. <https://indiancc.nic.in/>

22HS001 FOUNDATIONAL ENGLISH

L	T	P	C
1	0	2	2

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

15 Hours

SELF-EXPRESSION

Self-Introduction-Recreating Interview Scenarios (with a focus on verbal communication)-Subject Verb Concord - Tenses - Common Errors in verbal communication Be-verbs Self-Introduction- Recreating interview scenarios-Haptics-Gestures-Proxemics-Facial expressions- Paralinguistic / Vocalic- Body Language- Appearance-Eye Contact-Artifacts Self-Introduction-Powerful openings and closings at the interview-Effective stock phrases - Modified for spontaneity and individuality-Question tags, framing questions including WH- questions- Prepositions-Listening to Ted talks-Listening for specific information

UNIT II

15 Hours

CREATIVE EXPRESSION

Descriptive Expression-Picture Description and Blog Writing -Vocabulary-One-word substitution-Adjectives-Similes, Metaphors, Imagery & Idioms -Link words - Inclusive language Narrative Expression- Travelogue and Minutes of Meeting -Verbal Analogy-Sequence & Time order words -

Jumbled paragraph, sentences, Sequencing-Text & Paragraph Completion-Past tense -Using quotation marks

UNIT III

15 Hours

FORMAL EXPRESSION

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

Total: 45 Hours

Reference(s)

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

22HS005 SOFT SKILLS AND EFFECTIVE COMMUNICATION

L	T	P	C
0	0	2	1

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT – I - SELF-EXPRESSION

10 Hours

Group discussion/ Peer discussion - Communicating decisions and opinions - Tone, Pitch, Stress - Agreeing, Disagreeing, Suggesting, Speculating - Comparing and Contrasting - Comparatives and Superlatives - Discourse markers – Interjections - Decision making - Synthesis - Higher order thinking
 Group discussion/Peer discussion - Effective Communication Types of communication - Written vs Spoken - Contractions Intonation Stress Active voice - Question tags - Confidence and body language Guided writing- Outlining Main Points - Group discussion/Peer discussion - Avoiding common errors Reduction of MTI - Common errors - Barriers to communication Accent

UNIT – II - CREATIVE EXPRESSION

10 Hours

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

UNIT – III - FORMAL EXPRESSION

10 Hours

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

Total: 30 Hours

Reference(s)

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

22HS008 ADVANCED ENGLISH AND TECHNICAL EXPRESSION

L	T	P	C
0	0	2	1

Course Objectives

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT – 1 - CREATIVE EXPRESSION

15 Hours

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

UNIT 2 - FORMAL EXPRESSION

15 Hours

Writing: Action plans, Cover letters, Mind-Mapping, Paragraph writing Logical reasoning - SVA - Advanced level - Style: Clarity, Concision, Coherence, Evocativeness, Efficacious Vocabulary - Conditional Clause - Be verbs- Tenses- advanced - Opening and closing sentences - Action plans, Anecdotal references, order of communication/ narration, complete communication- Wh-questions -

Effective beginning and closing - Rhetorical questions - Appraising target audience - Pronunciation, Enunciation, Tone, Pace and Volume. - Writing: SOPs, Research Objectives, Thesis Statement, Indexing, Scholarly Articles, Academic Writing, Executive Summary, Survey Questionnaires, Citations and Bibliography - Reading: Quantitative & qualitative analysis, Analysis and paraphrasing of reference materials Speaking: Commentate live events, give instructions to operate machines/ conduct experiments Listening: Informational listening, Reflective listening, - Discriminative listening - Connective words - Prefixes and Suffixes - Quoting and paraphrasing Proofreading - Directed writing and writing formats - Note taking - Active verbs

Total: 30 Hours

Reference(s)

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

22HS201 COMMUNICATIVE ENGLISH II

L	T	P	C
1	0	2	2

Course Objectives

- Command over the English language for day-to-day transactions.
- Improve listening and reading skills
- Increase ability to comprehend complex content
- Enhance confidence in expressing with clarity and elegance
- Enthusiastic and reflective use of the language through sufficient and focused practice
- Articulate fluently and confidently in challenging situations

Course Outcomes (COs)

1. Engage with the English language in functional contexts
2. Express in both descriptive and narrative formats
3. Understand and make effective use of the English Language in Business contexts
4. Actively read and comprehend authentic text
5. Express opinions and communicate experiences.

Articulation Matrix

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

UNIT I

15 Hours

SELF-EXPRESSION

Personal Goals and Values - Being a Team Player-Expressing strengths and Weaknesses-Abstract nouns -Adjectives-Active Listening Skills-Note Making-Pronunciation and Accent Personal goals and values - Reading for Gist and Details-Professional Ethics-Reported Speech- Conjunctions Reading skills - phonemics, word/phrase recognition, sight words Personal Goals and Values-Conditional clauses-Hypothetical questions and Answers-Sentence Structure-Simple Present Tense-Perfect tense

UNIT II

15 Hours

CREATIVE EXPRESSION

Instructive and Expository Expression - Creating brochures, catalogues, and manuals for products/ services, Giving directions, Process writing, Sequencing experiments, Concept Explanation-Reported Speech-Voice Sentence Equivalence-Proofreading

UNIT III

15 Hours

FORMAL EXPRESSION

Notices and Announcements-Writing: Creating notices and circulars for events, announcing college tours

and lost and Found-Varied Vocabulary - Gender Sensitive Vocabulary, Non-discriminatory Vocabulary, Concise Vocabulary-Paragraph writing - Effective titles, topics and supporting sentences, calling in registrations and queries. Effective communication- Understanding purpose, reach and target audience, achieving complete communication Punctuation - Capitalization, Numeration, Use of proper nouns and Articles-Spelling-Reading: Analyzing and interpreting notices and Circulars-Understanding the gist of short real-world notices, and messages. Culling out keywords Information words vs Supporting words- Interpreting Abbreviations, Acronyms and Short-forms-Listening: Analyzing and interpreting announcements Decoding - Screening for salient points-Note making-Raising queries for clarification-Speaking: Announcements-Giving complete information-Pronunciation and Enunciation Pace, Intonation, and Pitch-Conducting Events-Speaking: Master of ceremonies, Short speeches - welcome speech, the vote of thanks/ valedictory speech, award-acceptance speech Writing: Invitations, Preparation of script/draft after interviewing someone. Adjectives-Pronunciation/ Punctuation Precision and Concision-Politeness markers

Total: 45 Hours

Reference(s)

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

22HSH01 HINDI

L	T	P	C
1	0	2	2

Course Objectives

- To help students acquire the basics of Hindi
- To teach them how to converse in Hindi on simple day- to -day situations
- To help students understand a simple technical text in Hindi

Course Outcomes (COs)

1. Construct simple sentences and use vocabulary required for day- to -day conversation.
2. Distinguish and understand the basic sounds of Hindi language.
3. Apply appropriate grammar to write and speak in Hindi language
4. Comprehend the conversation and give correct meaning
5. Take up Hindi examinations conducted by Dakshin Bharat Hindi Prachar Sabha

Articulation Matrix

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

UNIT I

9 Hours

VOWELS AND CONSONANTS

Hindi Alphabet: Introduction (Self introduction) - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu & Visarg -Table of Alphabet -Vocabulary.

UNIT II

9 Hours

NOUNS

Nouns: Genders -Masculine & Feminine -Reading Exercises

UNIT III

9 Hours

PRONOUNS AND TENSES

Pronouns and Tenses - Categories of Pronouns - Personal Pronouns - Second person (you & honorific) - Definite & Indefinite pronouns - Relative pronouns - Present tense - Past tense - Future tense - Assertive & Negative Sentences - Interrogative Sentences.

UNIT IV

9 Hours

CLASSIFIED VOCABULARY

Classified Vocabulary: Parts of body -Relatives Spices Eatables -Fruit & Vegetables -Clothes - Directions -Seasons Professions.

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

Speaking - Telling the times -Saying the Numbers from 1 to 50 Speaking practice for various occasions.

Total: 45 Hours**Reference(s)**

1. B.R. Kishore, Self Hindi Teacher for Non-Hindi Speaking People, Vee Kumar Publications (P) Ltd., New Delhi, 2009.
2. Hindi Prachar Vahini - 1
3. Videos, Stories, Rhymes and Songs.

22HSG01 GERMAN

L	T	P	C
1	0	2	2

Course Objectives

- To help students appear for the A1 level Examination
- To teach them how to converse fluently in German in day-to-day scenarios

Course Outcomes (COs)

1. Listen and identify individual sounds of German
2. Use basic phonemes and words while speaking
3. Read and understand short passages on familiar topics
4. Use basic sentence structures while writing
5. Understand basic grammar and appropriate vocabulary in completing language tasks

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Introduction to the German language-Alphabets-Numbers Greetings -Days and Seasons-Working with Dictionary.

UNIT II **9 Hours**

LANGUAGE AND ITS COMMON USE

Nouns -articles-Speaking about oneself-Listening to CD supplied with books-paying special attention to pronunciation

UNIT III **9 Hours**

TECHNICAL DEUTSCHE

Regular & Irregular verbs -Personal pronouns-family-Introduction to types of sentences

UNIT IV **9 Hours**

INTERROGATION

Question words -Types of Questions -Nominative case-Verb Conjugation -country -nationalities

UNIT V **9 Hours**

IMPLEMENTATION

Verbs to be & to have -conjugation -Hobbies -Framing basic Questions and answers

Total: 45 Hours

Reference(s)

1. Kursbuch and Arbeitsbuch, NETZWERK A1 DEUTSCH ALS FREMDSPRACHE, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2015.
2. Langenscheidt Eurodictionary, German English / English German, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2009.
3. Grundkurs, DEUTSCH Lehrbuch Hueber München, 2007.

22HSJ01 JAPANESE

L	T	P	C
1	0	2	2

Course Objectives

- To train students for N5 Level Examination
- To teach them use basic Japanese sentences in day-to-day conversation
- To make students familiar with the Japanese cultural facets and social etiquette

Course Outcomes (COs)

1. Recognize and write Japanese alphabet
2. Speak using basic sounds of the Japanese language
3. Apply appropriate vocabulary needed for simple conversation in Japanese language
4. Apply appropriate grammar to write and speak in Japanese language
5. Comprehend the conversation and give correct meaning

Articulation Matrix

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

UNIT I

9 Hours

SELF INTRODUCTION / DEMONSTRATIVES / NOUN MODIFIERS

Introduction to Japanese Japanese script - Pronunciation of Japanese(Hiragana (Katakana) Long vowels - Pronunciation of in,tsu,ga -Letters combined with ya,yu,yo - Daily Greetings and Expressions - Numerals. Speaking: Self Introduction - Listening: Listening to Greetings, Listening to specific information: Numbers, Time

UNIT II

9 Hours

TIME EXPRESSION / VERBS - PAST

Introduction to time -Introduction of verbs -Listening to specific information

UNIT III

9 Hours

ADJECTIVES

Word Sentence -Introduction to Adjectives -Technical Japanese Vocabulary -Pair Activity Day to day situational conversation
Listening to Japanese Alphabet Pronunciation -Simple Conversation

UNIT IV

9 Hours

CONJUGATION OF II ADJECTIVE

Past tense of Noun sentences and Na adjective sentences -Past tense of ii adjective sentences -houga adjective desu -Technical Japanese Vocabulary -Individual Activity - Listening to conversation with related particles

UNIT V**9 Hours****CONJUGATION OF VERBS - TE FORM / TA FORM / NAI FORM / PLAIN FORM**

N gahoshidesu - V masu form tai desu - Verb te form - Technical Japanese Vocabulary -Listening to different Counters, simple conversations with verbs and adjectives

Total: 45 Hours**Reference(s)**

1. Minna no Nihongo Japanese for Everyone Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.
2. Minna no Nihongo Japanese for Everyone Elementary Main Textbook 1-2 Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

22HSF01 FRENCH

L	T	P	C
1	0	2	2

Course Objectives

- To prepare the students for DELF A1 Examination
- To teach them to converse fluently in French in day-to-day scenarios

Course Outcomes (COs)

1. Help students acquire familiarity in the French alphabet & basic vocabulary
2. Listen and identify individual sounds of French
3. Use basic sounds and words while speaking
4. Read and understand short passages on familiar topics
5. Understand and use basic grammar and appropriate vocabulary in completing language tasks

Articulation Matrix

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

UNIT I

9 Hours

ENTRER EN CONTACT

La langue française, alphabets, les numéros, les jours, les mois. Grammaire Les verbes s'appeler, être, avoir, les articles définis, indéfinis Communication Saluer, s'informer sur quelqu'un, demander de se présenter Lexique L alphabet, les nationalités, l'âge, les pays, les couleurs, les jours de la semaine, les mois de l'année, les professions

UNIT II

9 Hours

PARTAGER SON LIEU DE VIE

Les français et leur habitat, des habitations insolites -Grammaire Verbes Conjugaison Present (Avoir / Être / ER, IR, RE Régulier et Irrégulier) Adjectifs les propositions de lieu Communication Chercher un logement, décrire son voisin, s'informer sur un logement - Lexique L habitat, les pièces, l'équipement, la description physique

UNIT III

9 Hours

VIVRE AU QUOTIDIEN LES LOISIRS DES FRANÇAIS, LES GOUTS DES AUTRES, LES ACTIVITÉS QUOTIDIENNES

Grammaire Articles contractés, verbes vouloir, pouvoir, devoir, adjectifs interrogatifs, future proche Communication Exprimer ses goûts, parler de ses loisirs, justifier un choix, exprimer une envie - Lexique le temps libre et les loisirs, les saisons, les activités quotidiennes, le temps (le matin, le soir, la nuit)

UNIT IV**9 Hours****COMPRENDRE SON ENVIRONNEMENT SOUVRIR A LA CULTURE**

Grammaire Verbes Finir, Sortir, les adjectifs demonstratifs, le passe compose, l imparfait
Communication Propose a quelqu un de faire quelque chose, raconter une sortie au passe,
parler d un film Lexique Les sorties, la famille, l art, les vetements et les accessoires

UNIT V**9 Hours****GOUTER A LA CAMPAGNE**

Grammaire La forme negative, les verbes acheter, manger, payer, articles partitifs, le
pronom en de quantite
Communication Accepter et refuser une invitation, donner des instructions, commander au
restaurant Lexique Les services et les commerces, les aliments, les ustensiles, l argent

Total: 45 Hours**Reference(s)**

1. Grammaire Progressive du Francais, CLE International, 2010
2. Saison1, Marie Noelle Cocton et al, Didier, 2014.
3. Preparation a l examen du DELF A1 Hachette
4. Reussir le DELF A1 Bruno Girardeau
5. Website: Francais Linguaphone Linguaphone Institute Ltd., London, 2000.
6. Francais Harrisonburg : The Rosetta Stone : Fairfield Language Technologies, 2001