FACULTY OF ENGINEERING

Scheme of Instruction & Examination

(AICTE Model Curriculum for the Academic Year 2020-2024)

and

Syllabi

B.E. I to VIII Semesters

of

Four Year Degree Programme

in

B.E. (Mechanical Engineering)

(With effect from the Academic Year 2020– 2021)
(As approved in the Faculty Meeting held on 04 Jan, 2021)

Issued by
Dean, Faculty of Engineering
Osmania University, Hyderabad
30.01.2021

Osmania University, Hyderabad

Vision

The Vision of the University is to generate and disseminate knowledge through a harmonious blend of ancient and modern wisdom, and to serve the society by developing in students heightened intellectual, cultural, ethical, and humane sensitivities; to foster a scientific temper, and to promote professional and technological expertise. Central to this vision is a commitment to regional and national development in consonance with our culture, heritage, and environment.

Mission

- To achieve excellence in teaching and research.
- To generate, disseminate and preserve knowledge.
- To meet the challenges of a complex, and modern society through informed social outreach.
- To empower through knowledge and information.
- To develop a responsible and productive citizenry.
- To develop, enhance, and improve the quality of human resources.
- To cultivate resolute moral and ethical values.
- To meet contemporary regional and national needs and anticipate future social and economic development.
- To preserve and promote cultural heritage, humanistic and spiritual values.

Program Educational Objectives (BE Mechanical Engineering)

- **Objective 1**

  To provide the requisite fundamentals of varied subjects related to Mechanical Engineering to conceive, plan, model, design, construct, maintain and improve systems to enhance human comfort.

- **Objective 2**

  To provide knowledge of experimental, computational, analytical, simulation tools and techniques require to address the challenges in Mechanical Engineering and other allied fields.

- **Objective 3**

  To provide knowledge for applying Mechanical Engineering Fundamentals to design and implement cost effective systems in manufacturing.

- **Objective 4**

  To provide effective communication skills, creative methods, ethics and continuous learning techniques to fulfill their professional requirements and societal needs.

POs	Engineering Graduates will be able to:
PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an mechanical engineering to the solution of complex engineering problems.
PO2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems related to mechanical engineering and allied fields reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Mechanical engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the Mechanical engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the mechanical engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the mechanical engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.
PS01	Apply the principles of collaborative and multi disciplinary approach for solving problems
PS02	Able to interact with industry and R&D institutions leading to start-ups/ budding entrepreneurs.

For the academic years 2020-2024

SCHEME OF INSTRUCTION & EXAMINATION
AICTE Model Curriculum
B. E. I – Semester (MECHANICAL ENGINEERING)
(Proposed for the Academic year 2020-2021)

S. No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in Hours	
Three Week Induction Programme										
Theory Course										
1	MC801PO	Indian Constitution	2	-	-	2	30	70	3	-
2	BS201MT	Mathematics-I	3	1	-	4	30	70	3	4
3	BS202PH	Engineering Physics	3	1	-	4	30	70	3	4
4	ES301EE	Basic Electrical Engineering	3	1	-	4	30	70	3	4
Practical / Laboratory Course										
5	BS251PH	Physics Lab	-	-	3	3	25	50	3	1.5
6	ES354EE	Basic Electrical Engineering Lab	-	-	2	2	25	50	3	1
7	ES353CE	Engineering Graphics	-	-	6	6	50	50	3	3
Total										**17.5**

MC: Mandatory Course **BS**: Basic Science **ES:** Engineering Science
L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:

1. Each contact hour is a clock hour
2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

For the academic years 2020-2024

SCHEME OF INSTRUCTION & EXAMINATION
AICTE Model Curriculum
B. E. II – Semester (MECHANICAL ENGINEERING)
(Proposed for the Academic year 2020-2021)

S. No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in Hours	
Theory Course										
1	MC802CE	Environmental Science	2	-	-	2	30	70	3	-
2	MC803PY	Essence of Indian Traditional Knowledge	2	-	-	2	30	70	3	-
3	HS101EG	English	2	-	-	2	30	70	3	2
4	BS203MT	Mathematics-II	3	1	-	4	30	70	3	4
5	BS204CH	Engineering Chemistry	3	1	-	4	30	70	3	4
6	ES302CS	Programming for Problem Solving	3	-	-	3	30	70	3	3
Practical / Laboratory Course										
7	HS151EG	English Lab			2	2	25	50	3	1
8	BS252CH	Chemistry Lab			3	3	25	50	3	1.5
9	ES351CS	Programming for Problem Solving Lab			2	2	25	50	3	1
10	ES352ME	Workshop Practice	-	-	6	6	50	50	3	3
Total										**19.5**

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For the academic years 2020-2024

SCHEME OF INSTRUCTION & EXAMINATION
AICTE Model Curriculum
B. E. III – Semester (MECHANICAL ENGINEERING)
(Proposed for the Academic year 2020-2021)

S. No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in Hours	
Theory Course										
1	HS102EG	Effective Technical Communication in English	2	-	-	2	30	70	3	2
2	HS103CM	Finance and Accounting	3	-	-	3	30	70	3	3
3	BS205MT	Mathematics-III	3	-	-	3	30	70	3	3
4	ES303ME	Engineering Mechanic-I	3	-	-	3	30	70	3	3
5	ES304EC	Basic Electronics	3	-	-	3	30	70	3	3
6	PC401ME	Metallurgy and Material Science	3	-	-	3	30	70	3	3
7	PC402ME	Thermodynamics	3	-	-	3	30	70	3	3
Practical / Laboratory Course										
8	PC451ME	Metallurgy and Material Testing Lab	-	-	2	2	25	50	3	1
9	PC452ME	Machine Drawing and Modeling Lab	-	-	2	2	25	50	3	1
Total										**22**

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Note:

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For the academic years 2020-2024

SCHEME OF INSTRUCTION & EXAMINATION
AICTE Model Curriculum
B. E. IV – Semester (MECHANICAL ENGINEERING)
(Proposed for the Academic year 2020-2021)

S. No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in Hours	
Theory Course										
1	ES304ME	Engineering Mechanic-II	3	-	-	3	30	70	3	3
2	PC403ME	Fluid Mechanics	3	-	-	3	30	70	3	3
3	ES305ME	Energy Sciences and Engineering	2	-	-	2	30	70	3	2
4	PC404ME	Mechanics of Materials	3	-	-	3	30	70	3	3
5	PC405ME	Applied Thermodynamics	3	-	-	3	30	70	3	3
6	PC406ME	Kinematics of Machinery	3	-	-	3	30	70	3	3
7	PC407ME	Manufacturing Processes	3	-	-	3	30	70	3	3
Practical / Laboratory Course										
7	PC453ME	Thermal Engineering Lab -I	-	-	2	2	25	50	3	1
8	PC454ME	Manufacturing Processes Lab	-	-	2	2	25	50	3	1
Total										**22**

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CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:

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SCHEME OF INSTRUCTION & EXAMINATION
AICTE Model Curriculum
B. E. V – Semester (MECHANICAL ENGINEERING)
(Proposed for the Academic year 2020-2021)

S. No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in Hours	
Theory Course										
1	PC408ME	Hydraulic Machines	3	-	-	3	30	70	3	3
2	PC409ME	Design of Machine Elements	3	-	-	3	30	70	3	3
3	PC410ME	Dynamics of Machines	3	-	-	3	30	70	3	3
4	PC411ME	Metrology and Instrumentation	3	-	-	3	30	70	3	3
5	PC412ME	Heat Transfer	3	-	-	3	30	70	3	3
6	PE51ME	Professional Elective-I	3	-	-	3	30	70	3	3
Practical / Laboratory Course										
7	PC455ME	Thermal Engineering Lab-2	-	-	2	2	25	50	3	1
8	PC456ME	Dynamics of Machines Lab	-	-	2	2	25	50	3	1
9	PC457ME	Fluid Mechanics and Hydraulics Machinery Lab	-	-	2	2	25	50	3	1
Total										**21**

Professional Elective-I		
S. No.	**Course Code**	**Course Title**
1	PE511ME	CAD/CAM
2	PE512ME	Automobile Engineering
3	PE513ME	Industrial Engineering

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SCHEME OF INSTRUCTION & EXAMINATION
AICTE Model Curriculum
B. E. VI – Semester (MECHANICAL ENGINEERING)
(Proposed for the Academic year 2020-2021)

S. No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in Hours	
Theory Course										
1	PC413ME	Machine Design	3	-	-	3	30	70	3	3
2	PC414ME	Metal Cutting and Machine Tools	3	-	-	3	30	70	3	3
3	PC415ME	Finite Element Analysis	3	-	-	3	30	70	3	3
4	PE52ME	Professional Elective-II	3	-	-	3	30	70	3	3
5	PE53ME	Professional Elective-III	3	-	-	3	30	70	3	3
6	OE61	Open Elective-I	3	-	-	3	30	70	3	3
Practical / Laboratory Course										
7	PC458ME	Metrology and Machine Tools Lab	-	-	2	2	25	50	3	1
8	PC459ME	Computer Aided Engineering Lab	-	-	2	2	25	50	3	1
9	PW701ME	Summer Internship*						50		2
Total										**22**

Professional Elective-II			**Professional Elective-III**		
S. No.	**Course Code**	**Course Title**	**S. No.**	**Course Code**	**Course Title**
1.	PE521ME	Thermal Turbo Machines	1.	PE531ME	Composite Materials
2.	PE522ME	Production and Operations management	2.	PE532ME	Product Design And Process Planning
3.	PE523ME	Design For Manufacture	3.	PE533ME	Power Plant Engineering

Open Elective-I		
S. No.	**Course Code**	**Course Title**
1	OE611ME	Industrial Robotics (Not for Mech. Engg. students)

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Note: 1. Each contact hour is a clock hour

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* ***At the end of VI semester students should undergo Summer Internship. Credits for Summer Internship will be awarded in VII semester.***

SCHEME OF INSTRUCTION & EXAMINATION
AICTE Model Curriculum
B. E. VII – Semester (MECHANICAL ENGINEERING)
(Proposed for the Academic year 2020-2021)

S. No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in Hours	
Theory Course										
1	HS104ME	Operations Research	3	-	-	3	30	70	3	3
2	PC416ME	Automation in Manufacturing	3	-	-	3	30	70	3	3
3	PE54ME	Professional Elective-IV	3	-	-	3	30	70	3	3
4	PE55ME	Professional Elective-V	3	-	-	3	30	70	3	3
5	OE62	Open Elective-II	3	-	-	3	30	70	3	3
Practical / Laboratory Course										
6	PW702ME	Project -I	-	-	6	6	50			3
Total										**18**

Professional Elective-IV			**Professional Elective-V**		
S. No.	**Course Code**	**Course Title**	**S. No.**	**Course Code**	**Course Title**
1	PE541ME	3D Printing Technology	1	PE551ME	Non- Destructive Testing
2	PE542ME	Robotics Engineering	2	PE552ME	Mechanical Vibrations
3	PE543ME	Refrigeration & Air Conditioning	3	PE553ME	Total Quality Management
4	PE544ME	Tool Design			

Open Elective-II		
S. No.	**Course Code**	**Course Title**
1	OE621ME	Entrepreneurship (Not for Mech. Engg. students)

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Note:

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2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

For the academic years 2020-2024

SCHEME OF INSTRUCTION & EXAMINATION
AICTE Model Curriculum
B. E. VIII – Semester (MECHANICAL ENGINEERING)
(Proposed for the Academic year 2020-2021)

S. No	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in Hours	
Theory Course										
1	PE56ME	Professional Elective-VI	3	-	-	3	30	70	3	3
2	OE63	Open Elective-III	3	-	-	3	30	70	3	3
Practical / Laboratory Course										
3	PW703ME	Project-II	-	-	16	16	50	150		8
Total										**14**

Professional Elective-VI		
S. No.	**Course Code**	**Course Title**
1	PE561ME	Energy Conversation & Management
2	PE562ME	Entrepreneurship Development
3	PE563ME	Control Systems Theory
4	PE564ME	Cryogenics

Open Elective-III		
S. No.	**Course Code**	**Course Title**
1.	OE631ME	Mechatronics (Not for Mech Engg students)

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Note:
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2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

For the academic years 2020-2024

SCHEME OF INSTRUCTION & EXAMINATION
AICTE Model Curriculum
B. E. I – Semester (MECHANICAL ENGINEERING)
(Proposed for the Academic year 2020-2021)

S. No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in Hours	
Three Week Induction Programme										
Theory Course										
1	MC801PO	Indian Constitution	2	-	-	2	30	70	3	-
2	BS201MT	Mathematics-I	3	1	-	4	30	70	3	4
3	BS202PH	Engineering Physics	3	1	-	4	30	70	3	4
4	ES301EE	Basic Electrical Engineering	3	1	-	4	30	70	3	4
Practical / Laboratory Course										
5	BS251PH	Physics Lab	-	-	3	3	25	50	3	1.5
6	ES354EE	Basic Electrical Engineering Lab	-	-	2	2	25	50	3	1
7	ES353CE	Engineering Graphics	-	-	6	5	50	50	3	3
Total										**17.5**

MC: Mandatory Course **BS**: Basic Science **ES:** Engineering Science
L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

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INDIAN CONSTITUTION

MC801PO

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: Nil

Objectives:

1. To create awareness among students about the Indian Constitution.
2. To acquaint the working conditions of union, state, local levels, their powers and functions.
3. To create consciousness in the students on democratic values and principles articulated in the constitution.
4. To expose the students on the relations between federal and provincial units.
5. To divulge the students about the statutory institutions

Outcomes:

After completing this course, the student will
1. Know the background of the present constitution of India.
2. Understand the working of the union, state and local levels.
3. Gain consciousness on the fundamental rights and duties.
4. Be able to understand the functioning and distribution of financial resources between the centre and states.
5. Be exposed to the reality of hierarchical Indian social structure and the ways the grievances of the deprived sections can be addressed to raise human dignity in a democratic way.

UNIT – I
Evolution of the Indian Constitution: 1909 Act, 1919 Act and 1935 Act. Constituent Assembly: Composition and Functions; Fundamental features of the Indian Constitution.
UNIT – II
Union Government: Executive-President, Prime Minister, Council of Minister ***State Government:*** Executive: Governor, Chief Minister, Council of Minister ***Local Government*****:** Panchayat Raj Institutions, Urban Government
UNIT – III
Rights and Duties: Fundamental Rights, Directive principles, Fundamental Duties
UNIT – IV
Relation between Federal and Provincial units**:** Union-State relations, Administrative, legislative and Financial, Inter State council, NITI Ayog, Finance Commission of India
UNIT – V
Statutory Institutions**:** Elections-Election Commission of India, National Human Rights Commission, National Commission for Women

Suggested Reading:

1	D.D. Basu, "*Introduction to the constitution of India"*, Lexis Nexis, New Delhi
2	Subhash Kashyap, "*Our Parliament"*, National Book Trust, New Delhi
3	Peu Ghosh, "*Indian Government &Politics"*, Prentice Hall of India, New Delhi
4	B.Z. Fadia & Kuldeep Fadia, "*Indian Government &Politics"*, Lexis Nexis, New Delhi

MATHEMATICS - I

BS201MT

Instruction: 3+1 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 4

Objectives:

1. To introduce the concepts of sequences, series and their properties
2. To introduce the concepts of functions of several variables and multiple integrals
3. To study vector differential and integral calculus

Outcomes:

The students will able to
1. Find the nature of sequences and series
2. Evaluate multiple integrals
3. Apply this knowledge to solve the curriculum problems

Unit-I
Sequences and Series: Sequences, Series, General properties of series, Series of positive terms, Comparison tests, tests of Convergence D'Alembert's ratio test, Cauchy's n^{th} root test, Raabe's test, Logarithmic test, Alternating series, Series of positive and negative terms, Absolute convergence and Conditional convergence.
Unit-II:
Calculus of one Variable: Rolle's theorem, Lagrange's, Cauchy's mean value theorems, Taylor's series, Curvature, Radius of curvature, Circle of curvature, Envelope of a family of curves, Evolutes and Involutes.
Unit-III
Multivariable Calculus (Differentiation): Functions of two variables, Limits and continuity, Partial derivatives, Total differential and differentiability, Derivatives of composite and implicit functions (Chain rule), Change of variables, Jacobian, Higher order partial derivatives, Taylor's series of functions of two variables, Maximum and minimum values of functions of two variables, Lagrange's method of undetermined multipliers
Unit-IV
Multivariable Calculus (Integration): Double integrals, Change of order of integration, Change of Variables from Cartesian to plane polar coordinates, Triple integrals.
Unit-V
Vector Calculus: Scalar and vector fields, Gradient of a scalar field, Directional derivative, Divergence and Curl of a vector field, Line, Surface and Volume integrals, Green's theorem in a plane, Gauss's divergence theorem, Stoke's theorem (without proofs) and their verification.

Suggested Reading:

1	R.K. Jain & S.R.K Iyengar, "*Advanced Engineering Mathematics"*, Narosa Publications, 2014.
2	Erwin Kreyszig, "*Advanced Engineering Mathematics"*, John Wiley, 9^{th} Edition, 2012.
3	B.S. Grewal, "*Higher Engineering Mathematics"*, Khanna Publications, 43^{rd} Edition, 2014
4	G.B. Thomas, Maurice Weir and Joel Hass, "*Thomas' Calculus"*, Peterson, 12^{th} Edition,2010.
5	B.V. Ramana, "*Higher Engineering Mathematics"*, 23^{rd} reprint, 2015.

ENGINEERING PHYSICS

BS202PH

Instruction: 3+1 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 4

Objectives:

1. Aware of limits of classical free electron free theory and to apply band theory of solids
2. Acquire knowledge on various properties of semiconductors.
3. Grasp the intricacies in semiconductor-optical interaction

Outcomes:

1. Distinguish materials based on band theory of solids
2. Classify semiconductors on the basis doping and to estimate conductivity and learn transport phenomenon in semiconductors
3. Appreciate use of optical absorption by semiconductors.

Unit-I
Crystallography: Introduction, Types of crystal systems, Bravais lattices, Lattiee planes and Miller Indices (Cubic system), Inter planar spacing (Cubic system), Bragg's law, Powder diffraction method. ***Crystal Defects*****:** Classification of point defects, Concentration of Schottky defects in metals and ionic crystals, Concentration of Frankel defects, Line defects, Screw and Edge dislocations, Burger's vector**.**
Unit-II:
Band Theory of Solids & Semiconductors**:** Classical free electron theory (qualitative), Kronig Penney model (qualitative treatment), Energy band formation in solids, Intrinsic and Extrinsic semiconductors, Concept of a hole, Carrier concentration and conductivity in intrinsic semiconductors, Formation of P-N junction diode and its I – V characteristics, Thermistor and its characteristics, Hall effect and its applications. ***Dielectric Materials*****:** Dielectrics, Types of polarizations, Electronic, Ionic, Orientational and Space charge polarizations, Expression for Electronic polarizability, Frequency and temperature dependence of dielectric polarizations, Determination of dielectric constant by capacitance Bridge method, Ferro electricity, Barium titanate, Applications of Ferroelectrics.
Unit-III
Wave Mechanics: Matter waves –de-Broglie wavelength, properties of wave function, Physical significance, Schrodinger time dependent and time in-dependent wave equation. Particle in a 1-D box. ***Electromagnetic theory:*** Basic laws of electricity and magnetism, Maxwell's equations in integral and differential forms, Conduction and displacement current, Relation between D, E and P – ***Electromagnetic waves*****:** Equation of plane wave in free space, Poynting theorem.
Unit-IV
Magnetic Materials: Classification of magnetic materials: dia, para, ferro, antiferro and ferrimagnetic materials, Weiss molecular field theory of ferromagnetism, Magnetic domains, Hysteresis curve, soft and hard magnetic materials, Ferrites: Applications of ferrites. ***Superconductivity:*** Introduction, General properties of super conductors, Meissner effect, Type I and Type II superconductors, BCS theory (qualitative), Introduction to High T_c superconductors, Applications of superconductors

Unit-V
Lasers: Characteristics of Lasers, spontaneous and stimulated emission of radiation, Einstein's Coefficients, population inversion, Ruby Laser, Helium Neon Laser, Semi-Conductor Laser and applications of lasers. ***Fiber Optics:*** Introduction, Propagation of light through an optical fiber, Acceptance angle, Numerical aperture (NA), Types of Optical fibers and Refractive index profiles, Fiber drawing process (double Crucible Method), Losses in optical fibers, applications of optical fibers.

Suggested Reading:

1. B.K. Pandey and S. Chaturvedi "*Engineering Physics"* Cengage Learning 2012
2. A.K. Bhandhopadhya, "*Nano Materials"*, New Age International, 1st Edition, 2007
3. M.S. Avadhanulu and P.G. Kshirusagar, "*Engg. Physics"*, S. Chand & Co. 1st Edition, 1992.
4. C.M. Srivastava and C. Srinivasan – "*Science of Engg Materials"*, New Age International.
5. R.K Gaur and S.L Gupta- "*Engineering Physics"*, Dhanpathrai Publications, New edition.
6. Sanjay D Jain & Girish G Sahasrabudhe –"*Engineering Physics"*, University Press

BASIC ELECTRICAL ENGINEERING

ES301EE

Instruction: 3+1 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 4

Objectives:

1. To provide an understanding of basics in Electrical circuits.
2. To explain the working principles of Electrical Machines and single phase transformers.

Outcomes:

1. To analyze Electrical circuits to compute and measure the parameters of Electrical Energy.
2. To comprehend the working principles of Electrical DC Machines.
3. To Identify and test various Electrical switchgear, single phase transformers and assess the ratings needed in given application.
4. To comprehend the working principles of electrical AC machines.

Unit-I
***DC Circuits*:** Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems.
Unit-II:
***AC Circuits*:** Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, and RL, RC, RLC combinations (series only). Three phase balanced circuits, voltage and current relations in star and delta connections.
Unit-III
Transformers and 3-ph Induction Motors: Transformers: Electromagnetic induction, Faradays laws, statically induced emf, Lenz law, BH characteristics, ideal and practical transformer, losses and efficiency, Auto-transformer and three-phase transformer connections. ***Three Phase Induction motor:*** Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, squirrel cage IM, slip-ring IM, Applications.
Unit-IV
Single-phase induction motor & DC Machines: Single-phase induction motor: Construction and principle of operation, Capacitor start & capacitor run motor, applications ***DC Generators*:** Dynamically induced emf, Flemming's Right hand and Left hand rules, Construction and principle of operation of DC generator, EMF equation, Types of DC Generators, OCC characteristics, applications ***DC Motors*:** principle of operation of DC Motor, Types of DC motors, applications.
Unit-V
***Electrical Installations*:** Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Suggested Reading:

1. N.K. De, "*Basic Electrical Engineering*", Universities Press, 2015.
2. J.B. Gupta, "*Fundamentals of Electrical Engineering and Electronics*" S.K. Kataria

& Sons Publications, 2002
3. J.B. Gupta, "*Utilization of Electric Power and Electric Traction*" S.K. Kataria & Sons Publications, 2010
4. Abhijit Chakrabarti, Sudipta Nath, Chandan Kumar Chanda, "*Basic Elactrical Engineering"* Tata McGraw Hill, Publications,2009
5. Hughes, "*Electrical Technology"*, VII Edition, International Student -on, Addison Welsey Longman Inc., 1995.

PHYSICS LAB

BS251PH

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 25 marks *SEE: 50 marks*
Credits: 1.5

Objectives:

1. Make precise measurements using basic physical principles and acquire skills to handle the instruments.
2. Relates the theoretical Knowledge to the behavior of Practical Physical world.
3. Analyze errors in the experimental data.
4. Plot graphs between various physical parameters.

Outcomes:

1. Conduct experiments, take measurements independently.
2. Write appropriate laboratory reports.
3. Compute and compare the experimental results and draw relevant conclusions.
4. Use the graphical representation of data and estimate results from graphs.

List of Experiments:
1. To determine the Dielectric constant and Phase transition temperature of Lead Zirconium Titanate (PZT).
2. To draw the I - V Characteristics of P-N Junction diode and to evaluate the resistance.
3. To find the values of Electrical conductivity and energy gap of Ge crystal.
4. Determination of rigidity of modulus of Torsion pendulum.
5. Determination of carrier concentration, Mobility and Hall Coefficient of Ge crystal using Hall Effect Experiment.
6. To determine the constants of A, B and α using Thermistor characteristics.
7. To draw the curve between the magnetizing field and the intensity of magnetization of the specimen (soft iron rod) and to find out i) Coercivity ii) Retentivity and iii) Hysteresis loss.
8. To draw the I - V Characteristics of a solar cell and to calculate the i) Fill factor Efficiency and ii) Series resistance.
9. To Determine the Numerical aperture (NA) of Optical fiber.
10. To determine the wave length of the given Laser source.

Note: Minimum eight experiments should be conducted in the semester

Suggested Reading:

1. Textbook of Engineering Physics Practical Dr. Ruby Das ,C. S. Robinson ,Rajesh Kumar ,Prashant Kumar Sahu , First Edition,2010.
2. Engineering Physics : Theory and Experiments by S.K. Srivastava, 8th Edition, 2011.
3. Engineering Practical Physics by Kakani S.L.,2007.
4. Engineering Physics Practicals by Dr. B. Srinivasa Rao, V. K. V. Krishna, K. S. Rudramamba Laxmi Publications.

BASIC ELECTRICAL ENGINEERING LAB

ES354EE

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 25 marks *SEE: 50 marks*
Credits: 1

Objectives:

1. To impart the practical knowledge on testing of DC and AC Machines and the usage of common electrical measuring instruments

Outcomes:

1. Get an exposure to common electrical components and their ratings.
2. Analyze the performance of DC and AC Machines.
3. Comprehend the usage of common electrical measuring instruments.
4. Test the basic characteristics of transformers and electrical machines.

Suggested List of Laboratory Experiments/Demonstrations:
Dem1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
Exp 1. Verification of KVL and KCL, superposition theorem (with DC excitation)
Exp 2 Verification of Thevinens and Nortons theorems (with DC excitation)
Exp 3. Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage. Power factor calculation
Exp 4. Transformers: Observation of the no-load current waveform on an oscilloscope (nonsinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a discussion about harmonics).
Exp 5. Loading of a transformer: measurement of primary and secondary voltages and currents, and power.
Exp 6. Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line- line voltage, phase-to-neutral voltage, line and phase currents).
Exp 7. Measurement of phase voltage/current, line voltage/current and power in a balanced three-phase circuit connected in star and delta
Dem2. Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
Exp 8. OCC characteristics of DC Generator
Exp 9. Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections.
Exp 10. Power factor improvement of Induction Motor using static capacitors
Exp 11. Load Test of DC Motor

Note - 1:

(i) List of Experiments and Demonstrations suggested above are already available in the Laboratory of the electrical department. No need to purchase any extra equipment except Demonstration2 equipments

(ii) Procurement of Demonstration 2 equipments can be done during the course work of that semester. It can be included in the laboratory.

Note - 2:

(i) Experiments 9, 10 and Demonstration 3 can be incorporated in the Lab syllabus if the topics concerned to the above experiments are considered in new BEE syllabus.

Suggested Reading:

1. J.B. Gupta, "*Fundamentals of Electrical Engineering and Electronics"* S.K. Kataria & Sons Publications, 2002.
2. J.B. Gupta, "*Utilization of Electric Power and Electric Traction*" S.K. Kataria & Sons Publications,2010
3. Abhijit Chakrabarti, Sudipta Nath, Chandan Kumar Chanda, "*Basic Elactrical Engineering"* Tata McGraw Hill, Publications,2009
4. Hughes, "*Electrical Technology*", VII Edition, International Student -on, Addison Welsey Longman Inc., 1995.

ENGINEERING GRAPHICS

ES353CE

Instruction:2X3 periods per week *Duration of SEE: 3 hours*
CIE: 50 marks *SEE: 50 marks*
Credits: 3

Objectives:

1. To prepare you to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
2. To prepare you to communicate effectively
3. To prepare you to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Outcomes:

The students will able to
1. Introduction to engineering design and its place in society
2. Exposure to the visual aspects of engineering design
3. Exposure to engineering graphics standards
4. Exposure to solid modeling
5. Exposure to computer-aided geometric design
6. Exposure to creating working drawings
7. Exposure to engineering communication

Sheet No	Description of the Topic	Contact Hours	
		Lecture	Drawing
1	Principles of Engineering Graphics and their significance, usage of drawing instruments.	1	
2	***Conic Sections – I*** Construction of ellipse, parabola and hyperbola given focus and eccentricity.	1	2
3	***Conic Sections – II*** Construction of ellipse (given major and minor axis), parabola (given base and height), rectangular hyperbola.		2
4	***Cycloids*** (cycloid & epicycloid)	1	2
5	***Involutes*** (involute of triangle, square & circle)		2
6	***Scales*** (plain & diagonal scales)	1	2 + 2
7	***Introduction to AutoCAD*** Basic commands and simple drawings.		2 + 2
8	***Orthographic Projection*** Projections of points situated in different quadrants.	1	2
9	***Projections of straight lines – I*** Line parallel to both the reference planes, line perpendicular or inclined to one reference plane.	1	2
10	***Projections of straight lines – II*** Line inclined to both the reference planes.	1	2
11	***Projections of planes – I*** Perpendicular planes	1	2
12	***Projections of planes – II*** Oblique planes		2

13	***Projections of solids – I*** Polyhedra and solids of revolution, Projections of solids in simple position.	1	2
14	***Projection of solids – II*** Projections of solids when the axes inclined to one or both the reference planes.	1	2 + 2
15	***Section of solids – I*** When the sectional plane is parallel or perpendicular to one reference plane.	1	2
16	***Section of solids – II*** When the sectional plane is inclined to one reference plane.		2
17	***Development of surfaces – I*** Prisms and Cylinders	1	2
18	***Development of surfaces – II*** Pyramids and Cones		2
19	***Intersection of surfaces – I*** Intersection of cylinder and cylinder	1	2
20	***Intersection of surfaces – II*** Intersection of cylinder and cone		2
21	***Isometric projection – I*** planes and simple solids	1	2
22	***Isometric projection – II*** combination of two or three solids		2
23	Conversion of Isometric Views to Orthographic Views	1	2
24	***Floor plans*** of 2 or 3 rooms including windows, doors, and fixtures such as WC, bath, sink, shower, etc.	1	2

Suggested Reading:

1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), "*Engineering Drawing"*, Charotar Publishing House
2. Shah, M.B. & Rana B.C. (2008), "*Engineering Drawing and Computer Graphics"*, Pearson Education
3. S.N Lal, "*Engineering Drawing with Introduction to Auto CAD"*, Cengage Learning India Pvt Lid, New Delhi, 2018.
4. Agrawal B. & Agrawal C. M. (2012), "*Engineering Graphics"*, TMH Publication
5. Narayana, K.L. & P Kannaiah (2008), Text book on "*Engineering Drawing"*, Scitech Publishers
6. (Corresponding set of) CAD Software Theory and User Manuals

NOTE:

1. At least 20 sheets must be covered.
2. Sheet number 1 to 6 (Graph sheets / drawing sheets)
3. Sheet number 7 to 24 (AutoCAD drawings)

SCHEME OF INSTRUCTION & EXAMINATION
AICTE Model Curriculum
B. E. II – Semester (MECHANICAL ENGINEERING)
(Proposed for the Academic year 2020-2021)

S. No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in Hours	
Theory Course										
1	MC802CE	Environmental Science	2	-	-	2	30	70	3	-
2	MC803PY	Essence of Indian Traditional Knowledge	2	-	-	2	30	70	3	-
3	HS101EG	English	2	-	-	2	30	70	3	2
4	BS203MT	Mathematics-II	3	1	-	4	30	70	3	4
5	BS204CH	Engineering Chemistry	3	1	-	4	30	70	3	4
6	ES302CS	Programming for Problem Solving	3	-	-	3	30	70	3	3
Practical / Laboratory Course										
7	HS151EG	English Lab			2	2	25	50	3	1
8	BS252CH	Chemistry Lab			3	3	25	50	3	1.5
9	ES351CS	Programming for Problem Solving Lab			2	2	25	50	3	1
10	ES352ME	Workshop Practice	-	-	6	6	50	50	3	3
Total										**19.5**

MC: Mandatory Course **BS**: Basic Science **ES:** Engineering Science
L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:

1. Each contact hour is a clock hour
2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

ENVIRONMENTAL SCIENCE

MC802CE

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: Nil

Objectives:

1. To create awareness and impart basic knowledge about the environment and its allied problems.
2. To know the functions of ecosystems.
3. To understand importance of biological diversity.
4. To study different pollutions and their impact on environment.
5. To know social and environment related issues and their preventive measures.

Outcomes:

After completing this course, the student will be able to:
1. Adopt environmental ethics to attain sustainable development.
2. Develop an attitude of concern for the environment.
3. Conservation of natural resources and biological diversity.
4. Creating awareness of Green technologies for nation's security.
5. Imparts awareness for environmental laws and regulations.

Unit-I

The Multidisciplinary Nature of Environmental Studies: Definition, scope and importance, need for public awareness.

Natural Resources**:** Water Resources – Use and over utilization of surface and ground water, flood, drought, conflicts over water, Dams: Benefits and Problems. Food Resources –World Food Problems, effects of modern agriculture, fertilizer-pesticides problems, water logging, salinity, Forest Resources –Use and over exploitation, deforestation & its effect on tribal people. Land Resources –Land Degradation, environmental effect of mining, man induced landslides, soil erosion and desertification**.** Energy Resources –Growing energy needs, Renewable and Non-renewable energy resources.

Unit-II:

Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in ecosystem, food chains, ecological pyramids, ecological succession, types of ecosystems (marine, pond, river, forest, grassland, desert)

Unit-III

Biodiversity**:** Levels of Biodiversity, Bio-geographical classification of India, Value of biodiversity, Threats to biodiversity, endangered and endemic species of India, Conservation of biodiversity, global and national efforts

Unit-IV

Environmental Pollution: Definition, Causes, effects and control measures of air pollution, water pollution, soil pollution, noise pollution, thermal pollution, solid waste management.

Environment Protection Act: Air, water, forest and wildlife Acts, issues in the enforcement of environmental legislation.

Unit-V

Social Issues and the Environment: Watershed management and environmental ethics.

Climate change, global warming, acid rain, ozone layer depletion.

Environmental Disaster Management: Types of disasters, impact of disasters on environment, infrastructure, and development. Basic principles of disaster mitigation, disaster management, and methodology. Disaster management cycle and disaster management in India.

Field Work:

- Visit to a local area to document environmental issues- agricultural area/ pond/lake/terrestrial ecosystem
- Visit to a local polluted area- market/slum area/Industrial area/traffic area

Suggested Reading:

1. A.K. De, "*Environmental Chemistry",* Wiley Eastern Ltd.
2. E.P. Odum, "*Fundamentals of Ecology",* W.B. Sunders Co., USA
3. M.N. Rao and A.K. Datta, "*Waste Water Treatment",* Oxford and IBK Publications.
4. Benny Joseph, "*Environmental Studies",* Tata McGraw Hill, 2005.
5. V.K. Sharma, *Disaster Management*, National Centre for Disaster Management, IIPE,1999

ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

MC803PY

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: Nil

Objectives:

The course will introduce the students to
1. To get a knowledge in Indian Culture
2. To Know Indian Languages and Literature and the fine arts in India
3. To explore the Science and Scientists of Medieval and Modern India

Outcomes:

After successful completion of the course the students will be able to
1. Understand philosophy of Indian culture.
2. Distinguish the Indian languages and literature.
3. Learn the philosophy of ancient, medieval and modern India.
4. Acquire the information about the fine arts in India.
5. Know the contribution of scientists of different eras.

Unit-I
Introduction to Culture: Culture, civilization, culture and heritage, general characteristics of culture, importance of culture in human literature, Indian Culture, Ancient India, Medieval India, Modern India.
Unit-II:
Indian Languages, Culture and Literature: Indian Languages and Literature-I: the role of Sanskrit, significance of scriptures to current society, Indian philosophies, other Sanskrit literature, literature of south India. **Indian Languages and Literature-II**: Northern Indian languages & literature.
Unit-III
Religion and Philosophy: Religion and Philosophy in ancient India, Religion and Philosophy in Medieval India, Religious Reform Movements in Modern India (selected movements only).
Unit-IV
Fine Arts in India (Art, Technology& Engineering): Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama, Indian Architecture (ancient, medieval and modern), Science and Technology in India, development of science in ancient, medieval and modern India.
Unit-V
Education System in India: Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Science and Scientists of Medieval India, Scientists of Modern India.

Suggested Reading:

1. Kapil Kapoor, "*Text and Interpretation: The India Tradition''*, ISBN: 81246033375, 2005

2. "*Science in Samskrit*", Samskrita Bharti Publisher, ISBN-13:978-8187276333,2007
3. NCERT, "*Position paper on Arts, Music, Dance and Theatre''*, ISBN 81-7450-494-X, 2006
4. S. Narain, "*Examination in Ancient India*", Arya Book Depot, 1993
5. Satya Prakash, "*Founders of Sciences in Ancient India*", Vijay Kumar Publisher, 1989
6. M.Hiriyanna, "*Essentials of Indian Philosophy*", Motilal Banarsidass Publishers, ISBN-13: 978-8120810990,2014

ENGLISH

HS101EG

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 2

Objectives:

To enhance the English language abilities of Engineering students, especially in reading and writing, by
1. using authentic material for language learning
2. exposing them to a variety of content-rich texts
3. strengthening their grammar and vocabulary
4. improving their reading and comprehension skills
5. honing their writing skills
6. encouraging them to think creatively and critically

Outcomes:

On successful completion of the course, the student will be able to
1. read, understand, and interpret a variety of written texts
2. use appropriate vocabulary and correct grammar
3. Undertake guided and extended writing with confidence.

Unit-I
Reading : RK Narayan, "A Horse and Two Goats" Vocabulary : Word formation—Prefixes, Suffixes, Root Words Grammar : Articles, Prepositions, Determiners Writing : Guided Writing (Expanding the outline/Writing from verbal cues)
Unit-II:
Reading : Rudyard Kipling, "If" Vocabulary : Word formation—Compounding and Blending, Contractions Grammar : Transitions, Connectives Writing : Paragraph Writing
Unit-III
Reading : Martin Luther King Jr., "I Have a dream" Vocabulary : Synonyms, Antonyms, One Word Substitutes Grammar : Voice Writing : Letter Writing
Unit-IV
Reading : Robert Frost, "Road Not Taken" Vocabulary : Homophones, Homonyms, Homographs Grammar : Narration (Direct-Indirect Speech) Writing : Report Writing
Unit-V
. Reading : George Orwell, "The Sporting Spirit" (Excerpt) Vocabulary : Inclusive Language, Euphemisms Grammar : Tense Writing : SOP

Suggested Reading:

1. Board of Editors. "*Language and Life: A Skills Approach"*. Orient BlackSwan, 2018.
2. Sudharshana, NP and C Savitha. "*English for Engineers"*. Cambridge University

Press, 2018

3. Kumar, Sanjay and Pushp Lata. "*English Language and Communication Skills for Engineers."* Oxford University Press, 2018.

MATHEMATICS-II

BS203MT

Instruction: 3+1 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 4

Objectives:

1. To study matrix algebra and its use in solving system of linear equations and in solving eigen value problems
2. To provide an overview of ordinary differential equations
3. To study special functions like Legendre and Beta Gamma functions
4. To learn Laplace Transforms and its properties

Outcomes:

The students will able to
1. Solve system of linear equations and eigen value problems
2. Solve certain first order and higher order differential equations
3. Solve basic problems of Beta Gamma and Legender's Function.
4. Apply Laplace Transforms; solve ordinary Differential Equations by using it.

Unit-I
Matrices: Rank of a matrix, Echelon form, System of linear equations, Linearly dependence and independence of vectors, Linear transformation, Orthogonal transformation, Eigen values, Eigenvectors, Properties of eigen values, Cayley - Hamilton theorem, Quadratic forms, Reduction of quadratic form to canonical form by orthogonal transformation, Nature of quadratic forms.
Unit-II:
***Differential Equations of First Order*:** Exact differential equations, Integrating factors, Linear differential equations, Bernoulli's, Riccati's and Clairaut's differential equations, Orthogonal trajectories of a given family of curves.
Unit-III
Differential Equations of Higher Orders: Solutions of second and higher order linear homogeneous equations with constants coefficients, Method of reduction of order for the linear homogeneous second order differential equations with variable coefficients, Solutions of non-homogeneous linear differential equations, Method of variation of parameters, solution of Euler-Cauchy equation
Unit-IV
Special Function: Gamma Functions, Beta Functions, Relation Between Beta and Gamma Function, Error Functions. Power Series Method, Lengender's Differential Equations and Legender's Polynomial $P_n(x)$, Rodrigue's Formula (without proof).
Unit-V
.***Laplace Transforms:*** Laplace Transforms, Inverse Laplace Transforms, Properties of Laplace Transforms and inverse Laplace Transforms, Convolution Theorem (without proof). Solution of ordinary Differential Equations using Laplace Transforms.

Suggested Reading:

1. R.K. Jain & S.R.K. lyengar, "*Advanced Engineering Mathematics"*, Narosa Publications, 4th Edition,2014.
2. Erwin Kreyszig, "*Advanced Engineering Mathematics"*, John Wiley, 9th Edition, 2012.
3. Dr.B.S. Grewal, *"Higher Engineering Mathematics"*, Khanna Publications, 43rd

Edition,2014.
4. B.V. Ramana, "*Higher Engineering Mathematics"*, 23rd reprint, 2015.
5. N. Bali, M. Goyal, A text book of Engineering *"Mathematics"*, Laxmi publications,2010
6. H.K. Dass, Er. Rajnish Varma, "*Higher Engineering Mathematics"*, Schand Technical Third Edition.

ENGINEERING CHEMISTRY

BS204CH

Instruction: 3+1 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 4

Objectives:

1. Correlate the properties of materials with their internal structure and use the for Engineering applications
2. Apply the principals of electrochemistry in storage of electrical energy in batteries.
3. Gains knowledge in causes of corrosion and its prevention.
4. Attains knowledge about the disadvantages of hard water for domestic and industrial purposes. Also learns the techniques of softening of hard water and treatment of water for drinking purpose.
5. Exposed to qualitative and quantitative parameters of chemical fuels.
6. Aware eco friendly materials and processes.

Outcomes:

On successful completion of this course, students will be able to:
1. Apply concept of electrode potential in identifying feasibility of electrochemical reaction; illustrate electro analytical techniques and working of batteries.
2. Identify the mechanism of corrosion of materials on basis of electrochemical approach and devise corrosion control methods.
3. Estimate the physical & chemical parameters of quality of water and explain the process of water treatment.
4. Explain the influence of chemical structure on properties of materials and their choice in engineering applications.
5. Classify chemical fuels and grade them through qualitative analysis.
6. Relate the concept of green chemistry to modify engineering processes and materials.

Unit-I

Electrochemistry and Battery Chemistry: Electrochemistry: Electrochemical cells, Electrolytic and Galvanic cells-notation, cell reaction and cell potentials. Types of electrodes, Calomel Quinhydrone and Glass electrodes. Determination of pH of a solution by using Quinhydrone electrode. Thermodynamics of emf of cells, Nernst equation and its derivation. Applications of Nernst equation to electrode potential and emf of cells. Numerical problems.

Batteries: Primary batteries: Zn - Carbon battery. **Secondary batteries**: Pb-Acid battery and Li-Ion battery, Applications. **Flow batteries (Fuel cells):** Methanol-Oxygen fuel cells, Construction, Applications

Unit-II:

Water Chemistry and Corrosion: Water Chemistry*:* Hardness of Water-Types and units of hardness, estimation of temporary and permanent hardness of water by EDTA method. Alkalinity of water and its determination. Water softening by Ion exchange and Reverse Osmosis methods. Numerical problems. Specifications of potable water. Sterilization by Chlorination. Break Point Chlorination.

Corrosion: Causes and its effects. Types of Corrosion-Dry or Chemical corrosion and Wet or Electrochemical corrosion and their mechanism. Electrochemical corrosion –Waterline and Pitting Corrosion. Factors influencing rate of corrosion.

Corrosion control methods: Cathodic protection methods - Sacrificial anodic and

impressed current methods. Surface coating methods: Hot Dipping-Galvanizing

Unit-III

Engineering Materials: Polymers: Basics of terms polymers: Monomer and its functionality, Polymers and degree of polymerization. Classification of polymers - Thermoplastics & Thermosetting resins.

Types of Polymerization (i) Addition (ii) Condensation (iii) Co-Polymerization. Mechanism of free radical polymerization

Preparation, Properties & Uses of the following polymers*:* Plastics - PVC and Bakelite, Fibres - Nylon 6:6, and Kevlar, Elastomers - Buna-S, Butyl and Silicone Rubbers.

Conducting polymers : Introduction, Classification and Mechanism of conduction in Poly-acetylene, Applications of conducting polymers.

Biodegradable polymers: Introduction preparation, properties and applications of polylactic acid

Unit-IV

Chemical Fuels: Classification of fuels**:** Introduction, definition and classification of chemical fuels- Primary and secondary fuels. Solid, liquid and gaseous fuels. Requirements of a good fuel. Calorific Value – HCV and LCV. Theoretical calculations of calorific value by Dulong's formula – Numerical problems.

Solid Fuels**:** Coal and its Ranking. Analysis of coal - Proximate and Ultimate analysis.

Liquid Fuels: Fractionation of Petroleum. Composition and uses of Gasoline, Diesel and Kerosene. Cracking & its Significance- Catalytic cracking by moving bed method, Knocking. Fuel rating – Octane and Cetane numbers.

Gaseous Fuels: LPG, CNG -Composition and Uses.

Combustion: Ignition temperature of a fuel, calculation of air quantities by weight and volume required for combustion of a fuel- Numerical problems.

Unit-V

Green Chemistry and Composites: Green Chemistry: Concept, Principles of green chemistry – Atom Economy, Catalysis. and examples of clean technology.

Biodiesel: Sources, Concept of Trans esterification and carbon neutrality. Properties and significance ***Composites:*** Introduction to composites, composition and characteristic properties of composites. Classification of composites based on matrix, reinforcement and ply. Applications of composites.

Suggested Reading:

1. "Principles of Physical Chemistry" by Puri, Sharma and Pathania S.N. Chand & Co. New Delhi (Latest edition).
2. "Engineering Chemistry" by P C Jain and M Jain Dhanpat Rai & Sons (15th Edn), New Delhi.
3. "Chemistry in Engineering and Technology" by J C Kuriacose and J Rajaram, TMH, New Delhi.
4. "Engineering Chemistry" by O G Palanna, TMH, and New Delhi.
5. "Engineering Chemistry" by S S Dara, S Chand & Sons, New Delhi.
6. "Engineering Chemistry" by Sashi Chawla. Dhanpat Rai & Sons, New Delhi.
7. "Engineering Chemistry" by Shikha Agrawal, Cambridge, New Delhi.
8. "Engineering Chemistry" by Prasanta Rath, Cengage Learning India Pvt. Ltd.

PROGRAMMING FOR PROBLEM SOLVING

ES302CS

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. To introduce the basic concepts of Computing environment, number systems and flowcharts
2. To familiarize the basic constructs of C language – data types, operators and expressions
3. To understand modular and structured programming constructs in C
4. To learn the usage of structured data types and memory management using pointers
5. To learn the concepts of data handling using pointers

Outcomes:

The students will able to
1. Formulate simple algorithms for arithmetic and logical problems.
2. Translate the algorithms to programs (in c language).
3. Test and execute the programs and correct syntax and logical errors.
4. Implement conditional branching, iteration and recursion.
5. Decompose a problem into functions and synthesize a complete program using divide and conquer approach.
6. Use arrays, pointers and structures to formulate algorithms and programs.
7. Apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
8. Apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration.

Unit-I
Introduction to Programming: Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.). ***Idea of Algorithm:*** steps to solve logical and numerical problems. ***Representation of Algorithm:*** Flowchart / Pseudocode with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.
Unit-II:
Control Structures: Arithmetic expressions and precedence, Conditional Branching and Loops**,** Writing and evaluation of conditionals and consequent branching. ***Arrays*****:** Arrays (1-D, 2-D), Character arrays and Strings
Unit-III
Basic Algorithms: Searching, Basic Sorting Algorithms (Bubble and Selection), Finding roots of Equations. ***Functions:*** Functions (including using built in libraries), Parameter passing in functions, call by value. ***Passing arrays to functions:*** idea of call by reference
Unit-IV
Recursion**:** Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series. ***Structure:*** Structures, Defining structures and Array of Structures

Unit-V
Pointers **-** Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation), Introduction to File Handling.

Suggested Reading:

1. Byron Gottfried, "*Schaum's Outline of Programming with C"*, McGraw-Hill
2. A.K. Sharma, "*Computer Fundamentals and Programming in C"*, Universities Press, 2nd Edition, 2018.
3. E. Balaguruswamy, "*Programming in ANSI C"*, Tata McGraw-Hill
4. Brian W. Kernighan and Dennis M. Ritchie, "*The C Programming Language*", Prentice Hall of India.

ENGLISH LAB

HS151EG

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 25 marks *SEE: 50 marks*
Credits : 1

Objectives:

To enhance the listening and speaking skills of students by
1. Giving them sufficient practice in listening with comprehension
2. Providing them ample opportunities to improve their public speaking skills
3. Training them in the use of correct pronunciation, stress, and intonation
4. Sensitizing them to the use of verbal and non-verbal communication appropriate to the context
5. Encouraging them to learn the art of conversation to suit formal and informal situations
6. Preparing them to make formal presentations and face interviews

Outcomes:

On successful completion of the course, students will be able to
1. Listen, understand, and interpret formal and informal spoken language
2. Speak English with acceptable pronunciation, stress, and intonation
3. Present themselves with confidence in formal situations
4. Participate in individual and group activities with relative ease

List of Experiments:
1. Listening for Comprehension
2. Pronunciation, Intonation, Stress, and Rhythm
3. Conversation Skills
4. Introducing Oneself and Others
5. Asking for and Giving Information
6. Making Requests and Responding to them Appropriately
7. Giving Instructions and Responding to them Appropriately
8. Making Formal Announcements and Emceeing
9. Group Discussions
10. JAM
11. Role Play
12. Debate
13. Public Speaking Skills and Body Language
14. Interviews
15. Formal Presentations

Suggested Reading:

1. Board of Editors.Language and Life: A Skills Approach. Orient Black Swan, 2018.
2. Balasubramanian, T. A Textbook of English Phonetics for Indian Students. Macmillan, 1981.
3. CIEFL.Exercises in Spoken English. Parts. I-III. Oxford University Press.
4. Pillai, Radhakrishna G. Spoken English For You - Level II. 8th Edition. Emerald Publishers, 2014.
5. Sethi, J and PV Dhamija. A Course in Phonetics and Spoken English. 2nd Edition, Prentice Hall India Learning Private Limited, 1999.

CHEMISTRY LAB

BS252CH

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 25 marks *SEE: 50 marks*
Credits : 1.5

Objectives:

1. Conduct experiments, take measurements and analyze the data though hands-on experience in order to demonstrate understanding of the theoretical concepts of quantitative Analysis while working in small group.
2. Interpret the electro analytical principles with experimental results graphically
3. Demonstrate writing skills through clear laboratory reports

Outcomes:

On successful completion of this course, students will be able to:
1. Apply the principles of Colourimetry and Electrochemistry in quantitative estimations.
2. Estimate the rate constants of reactions from concentration of reactants/ products as a function of time.
3. Synthesize small drug molecules.

List of Experiments:
1. Introduction to Chemical Analysis. 2. Techniques of Weighing.
Volumetric Analysis: 3. Preparation of Standard Mohr's salt solution, Standardization of $KMnO_4$ and estimation ferrous ion. **4.** Estimation Iron(II) by Dichromatometry
Water Analysis: 5. Preparation of Standard Magnesium sulphate solution, standardization of EDTA and Estimation of Total Hardness. 6. Preparation of Standard Sodium Carbonate Solution, Standardization of HCl and Estimation of Carbonate and Bicarbonate Alkalinity.
Conductometry: 7. Estimation of HCl **8.** Estimation of CH_3COOH and mixture of acids
Potentiometry 9. Estimation of HCl 10. Estimation of Iron
pH Metry: **11.** Estimation of HCL
Colorimetry: 12. Verification of Beer-Lambert's law and estimation of Manganese
Chemical Kinetics: 13. Determination of rate constant of acid catalyzed hydrolysis of methyl acetate. ***Drug Synthesis*** Preparation of Aspirin

Note: Minimum ten experiments should be conducted in the semester

Suggested Reading:

a. *"Senior Practical Physical Chemistry"*, B.D. Khosla, A. Gulati and V.Garg (R. Chand & Co., Delhi)
b. *"An Introduction to Practical Chemistry"*, K. K. Sharma and D.S. Sharma (Vikas publishing, N. Delhi)

PROGRAMMIMG FOR PROBLEM SOLVING LAB

ES351CS

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 25 marks *SEE: 50 marks*
Credits : 1

Objectives:

1. Understand the fundamentals of programming in C Language.
2. Write, compile and debug programs in C.
3. Formulate solution to problems and implement in C.
4. Effectively choose programming components to solve computing problems

Outcomes:

The students will able to
1. Choose appropriate data type for implementing programs in C language.
2. Design and implement modular programs involving input output operations, decision making and looping constructs.
3. Implement search and sort operations on arrays.
4. Apply the concept of pointers for implementing programs on dynamic memory management and string handling.
5. Design and implement programs to store data in structures and files

Programming Exercise:
1. Finding maximum and minimum of given set of numbers, finding roots of quadratic equation.
2. Sin x and Cos x values using series expansion.
3. Conversion of binary to decimal, octal, hexadecimal and vice versa.
4. Generating Pascal triangle, pyramid of numbers.
5. Recursion: factorial, Fibonacci, GCD.
6. Matrix addition and multiplication using arrays, linear search and binary search using recursive and non-recursive procedures.
7. Bubble sort and selection sort.
8. Programs on pointers: pointer to arrays, pointer to functions.
9. Functions for string manipulations.
10. Programs on structures and unions.
11. Finding the number of characters, words and lines of given text file.
12. File handling programs

Suggested Reading:

1. Byron Gottfried, "*Schaum's Outline of Programming with C"*, McGraw-Hill
2. A.K. Sharma, "*Computer Fundamentals and Programming in C"*, Universities Press, 2018.
3. E. Balaguruswamy, "*Programming in ANSI C"*, Tata McGraw-Hill
4. Brian W. Kernighan and Dennis M. Ritchie, "*The C Programming Language"*, Prentice Hall of India.

WORSHOP PRACTICE

ES352ME

Instruction: 2X3 periods per week *Duration of SEE: 3 hours*
CIE: 50 marks

SEE: 50 marks

Credits : 3

Objectives:

1. Identify and use marking out tools, hand tools, measuring equipment and to work to prescribed tolerances.
2. To provide hands on experience about use of different engineering materials, tools, equipments and processes those are common in the engineering field.
3. To gain a good basic working knowledge required for the production of various engineering products.
4. To Study different hand operated power tools, uses and their demonstration.
5. Adopt safety practices while working with various tools

Outcomes:

The students will able to
1. Demonstrate an understanding of and comply with workshop safety regulations.
2. Identify and apply suitable tools for different trades of Engineering processes including drilling, material removing, measuring, chiseling.
3. Study and practice on machine tools and their operations
4. Undertake jobs connected with Engineering Workshop trades including fitting, carpentry, sheet metal, house wiring, welding, smithy and foundry.
5. Apply basic electrical engineering knowledge for house wiring practice

A. TRADE FOR EXERCISES:
1. Carpentry
2. Fitting
3. House wiring
4. Sheet metal working
5. Smithy
6. Welding
7. Plumbing
B. TRADES FOR DEMONSTRATION AND EXPOSURE:
1. Machining (Lathe & Drilling)
2. Injection molding
3. Mould making and casting
4. Basic Electronics lab instruments
C. PRESENTATIONS AND VIDEO LECTURES
1. Manufacturing Methods
2. Rapid Prototyping
3. Glass Cutting
4. 3D printing
5. CNC LATHE
D. ***IT WORKSHOP***: Computer hardware, identification of parts, Disassembly, Assembly of computer to working condition, operating system installation.

Suggested Reading:

1. Venugopal, K, "*Workshop manual*", Anuradha Publications, Kumbakonam, TN, 2012
2. K.C. John, "*Mechanical Workshop*" 2nd Edn., PHI, 2010.

3. Hajra Choudary, "*Elements of Workshop Technology"* Vol. 1, Asian Publishers, Edn., 1993.
4. G.S. Sawhney, "*Mechanical Experiments and Workshop Practice",* I.K. International Publishing House, New Delhi, 2009.

Note: At least two exercises from each trade.

For the academic years 2020-2024

SCHEME OF INSTRUCTION & EXAMINATION
AICTE Model Curriculum
B. E. III – Semester (MECHANICAL ENGINEERING)
(Proposed for the Academic year 2020-2021)

S. No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in Hours	
Theory Course										
1	HS102EG	Effective Technical Communication in English	2	-	-	2	30	70	3	2
2	HS103CM	Finance and Accounting	3	-	-	3	30	70	3	3
3	BS205MT	Mathematics-III	3	-	-	3	30	70	3	3
4	ES303ME	Engineering Mechanic-I	3	-	-	3	30	70	3	3
5	ES304EC	Basic Electronics	3	-	-	3	30	70	3	3
6	PC401ME	Metallurgy and Material Science	3	-	-	3	30	70	3	3
7	PC402ME	Thermodynamics	3	-	-	3	30	70	3	3
Practical / Laboratory Course										
8	PC451ME	Metallurgy and Material Testing Lab	-	-	2	2	25	50	3	1
9	PC452ME	Machine Drawing and Modeling Lab	-	-	2	2	25	50	3	1
Total										**22**

MC: Mandatory Course **BS**: Basic Science **ES:** Engineering Science
L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:

1. Each contact hour is a clock hour
2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

EFFECTIVE TECHNICAL COMMUNICATION IN ENGLISH

HS102EG

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 2

Objectives:

To expose the students to:
1. Features of technical communication
2. Types of professional correspondence
3. Techniques of report writing
4. Basics of manual writing
5. Aspects of data transfer and presentations.

Outcomes:

On successful completion of the course, the students would be able to:
1. Handle technical communication effectively
2. Use different types of professional correspondence
3. Use various techniques of report writing
4. Acquire adequate skills of manual writing
5. Enhance their skills of information transfer and presentations

Unit-I
Definition and Features of Technical communication: Definition and features of technical communication (precision, relevance, format, style, use of visual aids), Differences between general writing and technical writing, Types of technical communication (oral and written)
Unit-II:
Technical Writing-I (Official correspondence): Emails, IOM, Business letters, Business proposals.
Unit-III
Technical writing-II (Reports): Project report, Feasibility report, Progress report, Evaluation report.
Unit-IV
Technical writing- III (Manuals): Types of manuals, User manual, Product manual, Operations manual.
Unit-V
Information Transfer and Presentations**:** Non-verbal (bar diagram, flow chart, pie chart, tree diagram) to verbal (writing), Verbal (written) to non-verbal, Important aspects of oral and visual presentations.

Suggested Reading:

1. Raman, Meenakshi& Sharma, Sangeeta. (2015). "*Technical Communication: Principles and Practice*(3rd ed.)". New Delhi.
2. Rizvi,Ashraf, M. (2017). "*Effective Technical Communication"*(2nd ed.). New Delhi, Tata McGraw Hill Education.
3. Sharma, R. C., & Mohan, Krishna. (2017). "*Business Correspondence and Report*

	Writing: A Practical Approach to Business & Technical Communication" (4th ed.). New Delhi, Tata McGraw Hill Education.
4.	Tyagi, Kavita & Misra, Padma. (2011). "*Advanced Technical Communication"*. New Delhi, PHI Learning.
5.	Jungk, Dale. (2004). "*Applied Writing for Technicians"*. New York, McGraw-Hill Higher Education.

FINANACE AND ACCOUNTING

HS103CM

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

The course will introduce the students
1. To provide basic understanding of Financial and Accounting aspects of a business Unit.
2. To provide understanding of the accounting aspects of business.
3. To provide understanding of financial statements.
4. To provide the understanding of financial system.
5. To provide inputs necessary to evaluate the viability of projects.
6. To provide the skills necessary to analyse the financial statements.

Outcomes:

After successful completion of the course the students will be able to
1. Evaluate the financial performance of the business unit.
2. Take decisions on selection of projects.
3. Take decisions on procurement of finances.
4. Analyze the liquidity, solvency and profitability of the business unit.
5. Evaluate the overall financial functioning of an enterprise.

Unit-I
Basics of Accounting: Financial Accounting–Definition- Accounting Cycle – Journal - Ledger and Trial Balance-Cash Book-Bank Reconciliation Statement (including Problems)
Unit-II
Final Accounts*:* Trading Account-Concept of Gross Profit- Profit and Loss Account-Concept of Net Profit- Balance Sheet (including problems with minor adjustments)
Unit-III
Financial System and Markets: Financial System-Components-Role-Considerations of the investors and issuers- Role of Financial Intermediaries. Financial Markets-Players-Regulators and instruments - Money Markets Credit Market- Capital Market (Basics only)
Unit-IV
Basics of Capital Budgeting techniques: Time Value of money- Compounding-Discounting- Future Value of single and multiple flows- Present Value of single and multiple Flows- Present Value of annuities- Financial Appraisal of Projects– Payback Period, ARR- NPV, Benefit Cost Ratio, IRR (simple ratios).
Unit-V
Financial statement Analysis**:** Financial Statement Analysis- Importance-Users-Ratio Analysis-liquidity, solvency, turnover and profitability ratios.

Suggested Reading:

1. Satyanarayana. S.V. and Satish. D., "*Finance and Accounting for Engineering"*, Pearson Education
2. Rajasekharan, "*Financial Accounting"*, Pearson Education

3. Sharma.S.K. and Rachan Sareen, "*Financial Management"*, Sultan Chand
4. Jonathan Berk, "*Fundamentals of Corporate Finance*," Pearson Education
5. Sharan, "*Fundamentals of Financial Management"*, Pearson Education

MATHEMATICS-III

BS205MT

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. To introduce the solution methodologies for second order Partial Differential Equations with applications in engineering
2. To provide an overview of probability and statistics to engineers

Outcomes:

After completing this course, the student will be able to:
1. Solve field problems in engineering involving PDEs.
2. They can also formulate and solve problems involving random variables and apply statistical methods for analyzing experimental data.

Unit-I
Formation of Partial Differential Equations, First order partial differential equations, solutions of first order linear Partial Differentiation Equations, Lagranges's equation, Non-linear First Order equations, Charpit's method.
Unit-II:
Second-order linear equations and their classification, Method of separation of variables, vibration of stretched string wave equation, one dimensional heat equation, two dimensional heat equation, solution of Laplace's equation.
Unit-III
Probability distributions: Poisson, Uniform and Normal distributions, Mean, variance, moment generating function and evaluation of statistical parameters for these distributions, Moments, Skewness and Kurtosis.
Unit-IV
Curve fitting by the method of least squares: Fitting of straight lines, second degree parabolas and more general curves, Correlation, regression and Rank correlation. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.
Unit-V
Test for single mean, difference of means and correlation coefficients, test for ratio of variances , Chi-square test for goodness of fit and independence of attributes

Suggested Reading:

1. R.K.Jain & Iyengar, "*Advanced Engineering Mathematics",* Narosa Publications.
2. B.S. Grewal, "*Higher Engineering Mathematics*", Khanna Publishers, 2000.
3. P.Sivaramakrishna Das & C.Vijaya Kumar, "*Engineering Mathematics"* , Pearson India Education Services Pvt. Ltd.
4. N.P. Bali & M. Goyal, "*A Text Book of Engineering Mathematics",* Laxmi Publications, 2010.
5. S.C.Gupta & V.K.Kapoor, "*Fundamentals of Mathematical Statistics"* , S.Chand Pub.
6. P. G. Hoel, S. C. Port & C. J. Stone, "*Introduction to Probability Theory",* Universal Book Stall, 2003.

7. W. Feller, "*An Introduction to Probability Theory and its Applications*", Vol. 1, Wiley, 1968.

For the academic years 2020-2024

ENGINEERING MECHANICS-I

ES303ME

Instruction: 2+1 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

The objectives of this course is to impart knowledge of
1. The resolution of forces, equilibrium and compatibility conditions of static loads
2. Centroid, moment of inertia and mass moment of inertia for various regular and composite bodies
3. Friction, laws of friction and its applications in different fields
4. Trusses, finding the forces in the members and analyze the trusses with various methods
5. Principle of virtual work, potential energy and stability

Outcomes:

After completing this course, the student will be able to:
1. Analyze the effect of a coplanar and non- coplanar system of forceson a body and equilibrium conditions for staticloads
2. Determine the Centroid, Area Moment of Inertia & Mass moment of Inertia of different areas
3. Determine the effect of friction and its governing laws on simple and connected systems
4. Analyse forces in members of a truss using method of joints and method of sections
5. Extracting information regarding hidden or unknown variables in a system using Principle of Virtual work and potential energy

Unit-I
Introduction to engineering mechanics: Basic concepts. ***System of forces:*** concurrent forces, components in space - resultant of coplanar and special systems moment of force and couple varignon's theorem. ***Equilibrium of systems of forces***: free body diagrams equations of equilibrium and applications to coplanar systems special system of forces moment and couple.
Unit-II:
Centroid: centroid of simple areas (from basic principles), centroid of composite area theorem of pappus. ***Area moment of inertia:*** definition moment of inertia of simple areas polar moment of inertia transfer formula moment of inertia of composite area. ***Centre of gravity and mass moment of inertia:*** Centre of gravity and mass moment of inertia of simple bodies (from basic principles)
Unit-III
Fiction: theory of friction, laws of friction, friction connected to single and connected bodies ***Applications of friction:*** wedge, screws, flexible belts, rolling resistance.
Unit-IV
Truss members: plain trusses, truss connections and supports, force representation and free body diagrams. ***Methods:*** method of joints method of sections statically determinant and indeterminate space trusses
Unit-V

Virtual work: work of a force, couple dimensions of work, equilibrium of a particle, rigid body, principle of virtual work. ***Potential energy and stability:*** elastic potential energy, gravitational potential energy, energy equation, principle of virtual work.

Suggested Reading:

1. Ferdinand L. Singer, "*Engineering Mechanics"*, Collins, Singapore, 1975.
2. Reddy Vijay Kumar K. and K. Suresh Kumar, "*Singer's Engineering Mechanics*", 2010.
3. S.S Bhavakatti, "*Engineering Mechanics"*, New age International publishers.
4. Rajeshakharam, S. and Sankarasubrahmanyam, "*G.,Mechanics"*, Vikas Publications, 2002.
5. Junarkar, S.B. and H.J. Shah., "*Applied Mechanics"*, Publishers, 2001.

BASIC ELECTRONICS

ES304EC

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

The objectives of this course is to impart knowledge of
1.To understand the characteristics of diodes and transistor configurations
2.To understand the design concepts of biasing of BJT and FET
3.To understand the design concepts of feedback amplifiers and oscillators
4.To study the design concepts of OP Amp and data converters

Outcomes:

After completing this course, the student will be able to:
1. Study and analyze the rectifiers and regulator circuits.
2. Study and analyze the performance of BJTs, FETs on the basis of their operation and working.
3. Ability to analyze & design oscillator circuits.
4. Ability to analyze different logic gates & multi-vibrator circuits.
5. Ability to analyze different data acquisition systems

Unit-I
PN Junction Diode: Characteristics, Half wave rectifier, Full wave rectifier, filters, ripple, regulation, TIF and efficiency, Zener diode and Zener diode regulators. CRT construction and CRO applications
Unit-II:
Transistors: BJT construction and working, modes of operation, configurations of BJT (CB, CE, CC), small signal h-parameter model of CE, CE amplifier analysis. Construction and working of JFET, V-I characteristics of JFET.
Unit-III
Feedback concepts: Types of negative feedback – modification of gain, bandwidth, input and output impedances, applications. ***Oscillators:*** RC Phase shift, Wein bridge, LC and crystal Oscillators (Qualitative treatment only).
Unit-IV
Operational Amplifier: OP-AMP Block diagram, Ideal OP-AMP, DC and AC Characteristics, Inverting and Non-Inverting Amplifiers, Adder/Subtractor, Integrator, Differentiator. ***Logic gate circuits*** - Introduction to Digital systems- AND, NAND, NOR, XOR gates, Binary half adder, full adder.
Unit-V
Data Acquisition Systems: Construction and Operation of transducers- Strain gauge LVDT, Thermocouple, Instrumentation systems. ***Data Converters:*** R-2R Ladder DAC, Successive approximation and Flash ADC.

Suggested Reading:

1. Robert Boylestad L. and Louis Nashelsky, "*Electronic Devices and Circuit Theory"*, PHI, 2007
2. Helfrick D and David Cooper, "*Modern Electronic Instrumentation and Measurements Techniques"*,1st edition, Prentice Hall of India, 2006.
3. Salivahanan, Suresh Kumar and Vallavaraj, "*Electronic Devices and Circuits"*, 2nd edition, Tata McGraw-Hill, 2010.

For the academic years 2020-2024

METALLURGY AND MATERIAL SCIENCE

PC401ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. Enable to understand structure property relations, analyse the failures of metals and their prevention.
2. To broad understanding of phase diagrams.
3. Acquire basic knowledge in various heat treatment operations, their purpose and applications.
4. Expose to various methods of extractive metallurgy techniques.
5. Understand various modes of failure and suggest mechanisms for preventions of failures.
6. Understand applications of conventional metals and alloys.

Outcomes:

1. Know the fundamental science and engineering principles relevant to material.
2. Suggest appropriate physical metallurgical methods (phase diagrams).
3. The type of heat treatment operation to be given to any metal in order to improve desired Mechanical properties.
4. Basic ability to plan an extraction process for given ore.
5. Suggest the appropriate methods for prevention of failures.
6. Analyse the applications of conventional metals and alloys

Unit-I
Introduction to Materials engineering, Space lattice, unit cell, crystal structure, crystal directions and planes, crystal imperfections- point defects, line defects, surface defects, volume defects.Effect of slip and twinning on the plastic deformation, Jogs and its effect on yield phenomenon, Hall-Petch equation, Orange peel effect, cold and hot working, strain hardening and Bauchinger effect. Recovery, Recrystallisation, Grain growth and its effect on mechanical properties of metals. Mechanical properties of materials- Tensile properties, stress-strain diagrams, elasticity, plasticity, ductility, toughness, modulus of elasticity, resolved shear stress, tensile and compression test, hardness and its measurement
Unit-II:
Fracture: Ductile and Brittle fracture, modes of fracture, ductile to brittle transition, crack initiation and propagation. ***Fatigue:*** S-N curve, Structure of fatigue fracture specimen, Fatigue crack propagation, Effect of metallurgical variables on fatigue of metal, Experimental determination of fatigue strength (RR-Moore Test). ***Creep:*** Creep strength, Creep curve, Creep deformation mechanisms, Creep Test, Differences between creep curve and stress rupture curve.
Unit-III
Structure of Alloys: Types of solid solution, Substitutional and Hume Rothary's rules for solid solution, Construction and interpretation of Binary equilibrium diagram, Isomorphous,

Eutectic and Peritectic diagrams, Intermediate phases and phase rule, Iron-Iron Carbide equilibrium diagram, construction and interpretation. Types of Plain Carbon Steels, Cast Iron and their properties and Characteristics.
Unit-IV
Alloy Steels: Effects of alloying elements like Nickel, Chromium, Manganese, Silicon and Tungsten. Titanium. Study about Stainless steels, HSS, Maraging steels, Brass,their composition and Properties. ***Heat Treatment:*** Annealing, Normalising, Hardening, Tempering, Construction and interpretation of T.T.T Curve. Austempering and Martempering. Case Hardening: Carburising, Nitriding, Carbo-nitriding, Flame Hardening, Induction Hardening. Brief introduction of Age Hardening.
Unit-V
Non-ferrous metals and alloys: Properties and applications of –Cu and its alloys, Al and its alloys, Age hardening, Ti and its alloys, Ni- based alloys. Bronze, Muntz Metal, Invar, Duralumin and Ti Alloy (Ti-6Al-4V)-their composition properties. Ceramics, Polymers and Composites: Ceramics, crystalline ceramics, glasses, properties and applications of ceramics, polymers-polymerization, thermoplastics and thermosetting plastics, properties and applications of polymers. Composites: concept of composites, matrix and reinforcement, rule of mixtures, classification of composites, applications of composites.

Suggested Reading:

1. V.Raghavan, *Material Science and Engineering*, Prentice Hall of India Ltd., 4th Edition, 1994.
2. S.H. Avner, *Introduction to Physical Metallurgy*, Tata McGraw Hill, 2nd Edn.1997.
3. S.P. Nayak, *Engineering Metallurgy and Material Science*, Charotar Publishing House, 6th Edition, 1995.
4. E. Dieter, Mechanical Metallurgy, Metric Editions, Tata McGraw Hill, 3rd Edn,1997.
5. Robert M Jones, Mechanics of Composite Materials, Taylor and Francis.

THERMODYNAMICS

PC402ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. Basic definitions of thermodynamics and significance of Zeroth law of thermodynamics.
2. The importance and application of first law of thermodynamics.
3. The various laws associated with second law of thermodynamics.
4. Properties of pure substances and use of Mollier diagram.
5. Various air standard cycles, their importance and their comparison.
6. Calculation procedures of the air-fuel ratio.

Outcomes:

1. Correlate the study of thermodynamics with the fundamental conceptual terminologies and Distinguish the different forms of energy
2. Analyse the Laws of Thermodynamics and correlate them for real life problem solving.
3. Read data from the chart of Mollier diagram and its applications.
4. Assess the importance of entropy and recognize the various curves of phase transformation
5. Identify the various air standard cycles, gas cycles and gas laws toward solving practical applications.

Unit-I
Introduction: Definition and Concept of Thermodynamics, Microscopic and Macroscopic approach of thermodynamics, system, surroundings and property, intensive and extensive properties, Measurement of temperature, Zeroth law of thermodynamics, Temperature Scales, ideal gas and ideal gas thermometer, Reversibility and irreversibility quasi– static process, Specific heats for ideal gases, Thermodynamic Equilibrium.
Unit-II:
First law of Thermodynamics: Statement of First Law, Heat and work interactions, Thermodynamics work and Internal energy, Energy as property of system, First Law applicable to Closed system, Thermodynamic processes and calculation of work, Heat transfer, and internal energy, Heat as Path Function, first law analysis of flow processes and limitation, Calculation of work done during flow processes
Unit-III
Second Law of Thermodynamics: Physical description of second law, Kelvin– Planck and Clausius statement of Second Law of thermodynamics, Equivalence of Kelvin– Planck and Clausius statement, Reversible and irreversible processes, Carnot Theorem, Clausius Inequality, Calculation of entropy change during various thermodynamic processes, principle of Entropy increase, T– S diagram, Available and Unavailable energies in steady flow, Second Law Analysis of Control Volume, Helmholtz and Gibb's functions, Available function for flow and non– flow processes and applications.
Unit-IV

Thermodynamic properties of Fluids: Properties of pure substances, Concept of phase change, Graphical representation of pressure, Volume and Temperature, (PVT)– T and H diagrams, Properties of steam, Use of steam Tables and Mollier diagram, Thermodynamic relations involving entropy, Enthalpy, Internal Energy, Maxwell relations and Clapeyron equation
Unit-V
Analysis of Thermodynamic Cycles**:** Air standard cycles: Otto, Diesel, Dual Combustion Cycle, Joule/ Brayton cycle. Vapour Power cycles: Rankine cycle. Refrigeration cycles: Reversed Carnot cycle, Bell Coleman cycle, Vapour compression refrigeration cycle.

Suggested Reading:

1. P.K. Nag, *Basic & Applied Thermodynamics*, Tata McGraw Hill, 2nd Edn., 2008.
2. Yunus A Cengel & Michael A Boles, *Thermodynamics- An Engineering Approach*, Tata McGraw- Hill, 7th Edition in SI Units (Special Indian Edition),2011
3. Y.V.C.Rao, *An Introduction to Thermodynamics*, Universities Press, 2nd Edn., 2010.
4. P.L Ballaney, *Thermal Engineering*, Khanna Publishers 2004.
5. E. Rathakrishnan, *Fundamentals of Engineering Thermodynamics*, PHI Learning Pvt. Ltd, 2005

For the academic years 2020-2024

METALLURGY AND MATERIAL TESTING LAB

PC451ME

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 25 marks *SEE: 50 marks*
Credits : 1

Objectives:

1. Acquire basic knowledge by understanding iron-carbide diagram and its application in engineering.
2. Expose to Metallographic study and analysis of various metals.
3. Acquire knowledge in determining the hardness of metals before and after various Heat treatment operations.
4. Understand differences between different heat treatment methods.
5. Expose to T-T-T curve and its application in engineering metallurgy.
6. Understand the relation between micro structure and properties.

Outcomes:

After completing this course, the student will be able to:
1. Prepare specimen for metallographic observation
2. Analyse and identify low, medium and high carbon steels, different types of cast irons, non-ferrous alloys, from the study of their microstructure
3. Underlines the importance of grain size in evaluating the desired mechanical properties.
4. Correlate the heat treatment methods and the mechanical properties obtained.
5. Analyse and identify microstructures after annealing, normalizing, hardening and tempering Relate the properties of the materials using image analyser

List of Experiments:
A: Metallurgy Experiments:
1. Study of: Metallurgical Microscope, Iron-Iron Carbide diagram, Procedure for specimen preparation
2. Metallographic Study of Pure Iron& Low carbon steel
3. Metallographic Study of Medium carbon steel, Eutectoid steel& Hyper Eutectoid steel
4. Metallographic Study of, White cast-iron, Malleable cast iron, Nodular cast iron &Grey cast-iron
5. Metallographic Study of Aluminium, Brass & Bronze
6. Metallographic study of Muntz metal and Babbit Material
7. Jominy Quench test or Study of microstructure after heat treatment
B: Materials testing Lab
1. Uni-axial tension test, to draw stress- strain diagram, and estimate modulus of elasticity, % of elongation and toughness.
2. Compression test on bricks and Impact test
3. Hardness test: Brinell & Vickers
4. Shear force & bending moments tests.
5. Bending test on fixed beam, simply supported beam

6. Spring test and torsion test
7. Heat treatment of Metals, Annealing, Normalizing and Quenching

Note: At least ten experiments should be conducted

MACHINE DRAWING AND MODELLING LAB

PC452ME

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 25 marks *SEE: 50 marks*
Credits : 1

Objectives:

1. To understand format of drawing sheet, angle of projections, isometric projections and practice on simple machine elements
2. To practice free hand sketching of machine elements
3. To understand Modelling of assembly drawings of typical machine parts.

Outcomes:

At the end of the course, the student
1. Will be able to draw isometric and orthogonal projections and sectional views of various mechanical components.
2. Will be able to draw free hand sketches of various mechanical components
3. Will be able to understand the shape and structure of different types of joints, screws, keys and Couplings
4. Will be sufficiently knowledgeable to use both the software and drafter to produce assembly views of various mechanical components from part drawings.

List of Experiments:
I. Machine Drawing (AutoCAD):
1. Format of drawing sheet & title block,
2. Conventions of drawing lines and dimensions,
3. Convention for sectional views.
4. Simple machine elements.
5. Riveted and screwed fastenings.
6. Joints and coupling.
II. Assembly drawing (SOLIDWORKS/ CATIA/ PRO-E):
8. Connecting rod.
9. Eccentric.
10. Cross head.
11. Stuffing box.
12. Lathe Tool Post.
13. Revolving centre.
14. Pedestal bearing (Plummer block).
15. Screw Jack.

Note: The test is for the ability of the student to read and interpret drawing. The drawing should include part list in standard format.

Suggested Reading:

1. N.D. Bhatt, *Machine Drawing*, Charotar Publishing house, Anand, New Delhi, 28th edition, 1994.
2. K.L. Narayana, P. Kannaiah, K. Venkat Reddy, *Machine Drawing*, New Age International (P) Ltd., 2nd edition 1999.
3. N. Siddeshwar, *Machine Drawing*, Tata McGraw Hill Publishing Co. Ltd., 5th edition, 1994
4. K. C. John, *Text book of Machine Drawing*, PHI Learning,

For the academic years 2020-2024

SCHEME OF INSTRUCTION & EXAMINATION
AICTE Model Curriculum
B. E. IV – Semester (MECHANICAL ENGINEERING)
(Proposed for the Academic year 2020-2021)

S. No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in Hours	
Theory Course										
1	ES304ME	Engineering Mechanic-II	3	-	-	3	30	70	3	3
2	PC403ME	Fluid Mechanics	3	-	-	3	30	70	3	3
3	ES305ME	Energy Sciences and Engineering	2	-	-	2	30	70	3	2
4	PC404ME	Mechanics of Materials	3	-	-	3	30	70	3	3
5	PC405ME	Applied Thermodynamics	3	-	-	3	30	70	3	3
6	PC406ME	Kinematics of Machinery	3	-	-	3	30	70	3	3
7	PC407ME	Manufacturing Processes	3	-	-	3	30	70	3	3
Practical / Laboratory Course										
7	PC453ME	Thermal Engineering Lab -I	-	-	2	2	25	50	3	1
8	PC454ME	Manufacturing Processes Lab	-	-	2	2	25	50	3	1
Total										**22**

MC: Mandatory Course **BS**: Basic Science **ES:** Engineering Science
L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:

1. Each contact hour is a clock hour
2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

ENGINEERING MECHANICS-II

ES304ME

Instruction: 2+1 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

The objectives of this course is to impart knowledge of
1. Concepts of motion of particles, dynamic loads, their behaviour, analysis
2. Principles of kinetics and its application to solve the problems of dynamics
3. Rotation motion of rigid bodies in dynamic analysis
4. Plane motion of rigid bodies in dynamic analysis
5. to identify faults within a machines using the basic concepts of vibrations

Outcomes:

After completing this course, the student will be able to:
1. Apply the laws of motion to study the kinematic parameters of rigid body motion
2. Solve the problems involving translation of particle &rigid bodies by applying principles of kinetics.
3. Analyze the rotation motion of rigid bodies by applying the principles of kinematics and kinetics of rotation
4. Apply the laws of motion, kinematic and kinetic parameters of rigid bodymotion toanalyse plane motion of rigid bodies.
5. Formulate mathematical models of problems in vibrations

Unit-I
Kinematics of Particle: Motion of a particle – Rectilinear motion – Motion Curves – Normal and tangent coordinate systems – Projectile motion. ***General principles of Dynamics:*** Newtons laws of motion for a particle – fundamental equations of a particle.
Unit-II:
Kinetics of Particles: Kinetics of Rectilinear and curvilinear motion – D'Alembert's Principle – Principle of Impulse and Momentum – Work Energy and power – Direct and Oblique collision.
Unit-III
Rotation of Rigid Bodies: Moment of Inertia of Material bodies –Kinematics and Kinetics of Rotation – Equation of motion – Principle of Work and Energy – Principle of Impulse Momentum.
Unit-IV
Plane Motion of Rigid Bodies: Translation of a rigid body in a plane – Kinematic of Plane motion – Instantaneous center of rotation – Kinetics of Plane motion – Equation of motion – Principle of Work and Energy – Principleof Impulse Momentum.
Unit-V
Vibrations: Introduction – Simple Hormonic motion – Free Vibrations – Simple pendulum – Compound Pendulum – Torsion Pendulum – Free Vibration analysis by work energy method.

Suggested Reading:

1. Ferdinand L. Singer, *Engineering Mechanics*, Collins, Singapore, 1975.

2. Reddy Vijay Kumar K. and K. Suresh Kumar, *Singer's Engineering Mechanics*, 2010.
3. J.L. Meriam, *Engineering Mechanics: Statics and Dynamics*, John Wiley & Sons, Inc., N.J, 2003.
4. R.C. Hibbeler, *Engineering Mechanics: Statics and Dynamics*, Pearson Prentice Hall, New Jersey, 2016.
5. Beer & Johnston, *Vector Mechanics for Engineers: Statics and Dynamics*, McGraw-Hill Education, New York, 2019
6. S. Timoshenko & D.H. Young, *Engineering Mechanics*, McGraw-Hill Book Company, New York, 1959.

FLUID MECHANICS

PC403ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. To know various fluid properties, concept and method of fluid pressure measurement.
2. To understand the basic concepts of fluid motion.
3. To study different equations of fluid motion and fluid dynamics.
4. To analyze different flow characteristics of laminar and turbulent flows.
5. To study the motion of gasses for different conditions of expansion.
6. To lay the groundwork for subsequent studies in courses like Hydraulics Machinery and Systems, Thermal Turbomachinery and Gas Dynamics etc.

Outcomes:

1. To explain the laws and terminology of fluid flows, classify fluid flows, state law of mass conservation and derive relevant equations
2. To apply principles of energy and momentum conservation to analyze fluid flow and compute forces exerted on control volumes due to change of momentum
3. To describe flow and pressure measurement devices and obtain relevant equations for computing flow in pipes and open channels.
4. To describe flow regimes in pressure conduits and boundary layer development; compute drag and lift forces on aerofoil and also frictional losses in pressure conduits.
5. To develop and apply laws of mass, energy and momentum conservation in compressible flow.

Unit-I
Properties of fluids*:** Definition of fluid and concept of continuum. Fluid properties; pressure, density, specific weight, specific volume, dynamic and kinematic viscosity. Classification of fluids; ideal and real fluids. ***Fluid Kinematics: General concepts of path lines, stream lines, streak lines and stream tubes. Classification of fluid flow; steady and unsteady, uniform and non-uniform, laminar and turbulent, rotational and irrotational, one-, two-and three-dimensional flows. Definition and properties of stream function and velocity potential function, and use of flow nets.
Unit-II:
Fluid Dynamics: Energy of a fluid body, potential energy and potential head, pressure energy and pressure head, kinetic energy and kinetic head, energy equation. Derivation of Euler's and Bernoullis' equations, and their applications. Impulse momentum equation and its applications.
Unit-III
Measurement of Fluid Flows: Measurement of pressure, and use of pressure measuring devices such as manometers, Bourdon's pressure gauge and transducers. Measurement of velocity, and use of velocity measuring devices such as pitot tube and hot wire anemometer. Measurement of discharge, and use of discharge measuring devices such as venturimeter, orifice meter and rotameter; derivation of relevant formulae. Discharge formulae for weirs and notches.
Unit-IV

Laminar and Turbulent Flow through Pipes: Distinction between laminar and turbulent flows; Reynold's number and its significance. Upper and lower critical values of Reynold's numbers for flow in pipes. Development of laminar and turbulent flow in circular pipes. Hagen-Poiseuille equation; frictional losses in pipes. Darcy's equation. Estimation of Darcy's friction factor. Empirical formulae and Moody's chart. ***Boundary Layer Theory:*** Development of laminar and turbulent boundary layers on a flat plate, pressure gradient, and phenomenon of separation. Fluid flow over an aerofoil, flow around a cylinder at rest, rotational flow around a cylinder at rest, lift and drag forces, and coefficients; circulation and Magnus effect.
Unit-V
Compressible fluid flow: Concepts of compressible flow, continuity, momentum and energy equation of compressible flow. Velocity of sound in compressible and incompressible fluids. Mach Number. Classification of compressible flow; adiabatic flow in perfect gas, stagnation pressure and temperature. Temperature, pressure, density ratios as functions of Mach number.

Suggested Reading:

1. K. L. Kumar, *Engineering Fluid Mechanics.* Eurasia Publishing House, 1997.
2. R. K. Rajput, *Fluid Mechanics and Hydraulic Machines,* S. Chand & Co., 2003.
3. P. N. Modi and S. M. Seth, *Hydraulic and Fluid Mechanics,* Standard Book House, Delhi, 1995.
4. V. L. Streeter, *Fluid Mechanics.* McGraw-Hill Co. Ltd.,
5.Bansal, R.K., "*Fluid Mechanics and Hydraulics Machines*", (5^{th} edition), Laxmi publications (P) Ltd. Delhi, 1995.
6.Kumar D. S., "*Fluid Mechanics and Fluid Power Engineering*", S. K. Kataria & Sons.

For the academic years 2020-2024

ENERGY SCIENCES AND ENGINEERING

ES305ME

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 2

Objectives:

The objectives of this course is to impart knowledge of
1. Able to identify various sources of energy.
2. Understand the difference between Conventional and renewable energy sources.
3. Identify various storage devices of Energy.
4. Able to estimate the costing of power plant.

Outcomes:

After completing this course, the student will be able to:
1. Understand the basics of various sources of energy
2. Analyse the present status of conventional energy sources.
3. Understand the working principles of Renewable Energy systems
4. Design and develop waste heat recovery systems.
5. Relate energy economics, standards and future challenges.

Unit-I
Introduction: Various sources of energy, relative merits and demerits, Statistics and prospects of conventional and Renewable energy sources.
Unit-II:
Conventional Energy Sources: Fossil Fuels: Power generation using steam turbine and gas turbine power plants, Nuclear Fuels: Parts of reactor core, Nuclear power plant outline, Methods to dispose radioactive waste. Hydro Energy: Spillways, Hydroelectric power plant outline
Unit-III
Renewable Energy Systems: Solar Energy – Types of collectors and concentrators, Solar Photo Voltaic Cell. Wind Energy – Types of Wind Turbines and their working, geothermal power plant, Biomass conversion, Wave Energy power plant, Tidal Energy power plant, Ocean thermal energy power plant.
Unit-IV
Storage: Methods to store Mechanical Energy, Electrical Energy, Chemical Energy and Thermal Energy. Co-generation &Tri-generation: Definition, application, advantages, classification, saving Potential. Energy waste, waste heat recovery classification, advantages and applications, commercially viable waste heat recovery devices
Unit-V
Power Plant Economics and Environmental Considerations: Costing, Estimation of power production - Pollutants and Pollution Standards -Methods of pollution control. Energy Efficiency rating and BEE standards, Future energy needs and challenges.

Suggested Reading:

1. Wakil MM, "*Power Plant Technology"*, McGraw Hill.
2. P.K. Nag, "*Power Plant Engineering"*, McGraw-Hill.
3. G.D. Rai, "*Non-Conventional Energy Sources"*, Khanna Publishers.
4. Mili Majumdar, "*Energy Efficient Buildings in India"*, Ministry of Non-Conventional Energy Sources.

MECHANICS OF MATERIALS

PC404ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. To understand the basic concept of stress and strains for different materials.
2. To know the mechanism of the development of shear force and bending moment in beams and the stresses in thin cylinders & spheres.
3. To know the theory of simple bending, direct & bending stress and distribution of shear stress.
4. To analyse and understand shear stress, torsional stress and spring applications.
5. To study the deflections and its applications.

Outcomes:

1. To understand the theory of elasticity and Hooke's law
2. To analyse beams to determine shear force and bending moments
3. Analyse shear stress distribution in different sections of beams.
4. To analyse and design structural members subjected to combined stresses
5. To solve problems on bars and to determine deflections at any point of the beams

Unit-I

Simple Stresses & Strains: Types of stresses & strains, Stress-Strain relations (Hooke's law), Relation between elastic constants, Volumetric strain, Composite bars, Temperature stresses.

Strain energy**:** Gradual, Sudden, Impact and Shock loading.

Compound Stresses**:** Stresses on oblique planes, Principal stresses and Principal planes. Mohr's circle and ellipse of stresses & strains.

Unit-II:

Shear Force and Bending Moment**:** Construction of S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, uniformly distributed loads, uniformly varying loads and combination of these loads, Point of contra flexure and Relation between S.F & B.M.

Thin Cylinders & Spheres: Derivation of formulae for longitudinal stress, Circumferential (hoop) stress, Volumetric strains, Changes in diameter and volume.

Unit-III

Bending stresses in Beams: Assumptions made in pure bending, Derivation of bending moment equation, Modulus of section, Moment of resistance, Determination of bending stresses. Distribution of shear stress: Equation of shear stress, Distribution across rectangular section. Circular, triangular cross sections.

Unit-IV

Torsion of Circular Shafts**:** Theory of pure torsion, Assumptions made, Derivation of basic torsion equation, Torsional moment of resistance, Polar section modulus, Power transmitted by shafts, Combined bending and torsion.

Columns and Struts: Introduction to columns and struts, Buckling and Stability, types of

supports, critical load, Euler's formulae and Rankine formulae, Equivalent length of the column, eccentric axial loads
Unit-V
Deflection of Beams: Deflections of cantilever and simply supported beams including overhanging beams for point loads and uniformly distributed loads by Double integration method, Macaulay's method, Strain energy method, Moment area method.

Suggested Reading:

1. S. Ramamrutham, "*Strength of Materials"*, Dhanpat Rai & Sons, 1993.B.C. Punmia, Strength of Materials and Theory of Structures, Laxmi Publishers, Delhi, 2000.
2. R.K. Rajput, "*Strength of Materials"*, S. Chand & Co., 2003.
3. EgorP.Popov, "*Engineering Mechanics of Solids"*, Prentice Hall of India, NewDelhi, 2001.
4. Gere & Timoshenko, "*Mechanics of Materials"*, 2nd Edition, CBS Publishers and Distributors Pvt. Ltd.
5. Ferdinand P. Beer et.al., "*Mechanics of Materials",* Tata McGraw-Hill Publishing Co. Ltd., New Delhi,2005

For the academic years 2020-2024

APPLIED THERMODYNAMICS

PC405ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. To study the application of thermal science in mechanical engineering, consisting of the fundamental laws and processes for energy conversion.
2. To understand thermal design aspects of reciprocating machinery-reciprocating compressors and IC Engines.
3. To analyse Rankine cycle applied to thermal power plants and its improvements.
4. To gain the knowledge on the power plant thermal Devices-Boilers, Condensers, Pumps & Nozzles.

Outcomes:

1. Expected to be able to quantify the behaviour of reciprocating compressors.
2. Expected to be able to explain thermal design and working principles of IC Engines, their supporting systems and Combustion chambers.
3. Expected to be able to quantify the behaviour of power plants based on the Rankine cycle, including the effect of enhancements such as superheat, reheat and regeneration.
4. Expected to be able to explain the thermal design and working principles of Power plant devices.
5. Expected to be able to explain working principles of Boilers, Condensers, Pumps & Nozzles.

Unit-I
Reciprocating Air Compressors: Classification and applications. Ideal and actual P-V diagrams, work input and efficiency relations for single and multi-stage compressors. Effect of clearance volume on work input and efficiency. Inter cooling and after cooling concepts.
Unit-II:
Internal Combustion Engines: Classification and applications. Working principles of four stroke and two stroke engines, Spark Ignition and Compression ignition engines. Performance parameters of I.C. Engines. Heat balance sheet of I. C. Engine. Overview of Engine supporting systems- Cooling Systems, Lubrication systems. Working principles of S.I. Engine fuel systems- Carburettors, Battery and Magneto Ignition systems. Working principles of C.I. Engine fuel systems- Fuel pump and Fuel injector.
Unit-III
***I.C. Engine Combustion phenomena*:** Stages of combustion in S.I. Engines- Ignition delay, Flame front propagation and After burning. Abnormal combustion- Pre-ignition and Knocking. Factors affecting Knocking. Stages of combustion in C.I. Engines, Delay period, Period of Uncontrolled Combustion, Period of Controlled Combustion and after burning. Abnormal Combustion-Knocking. Factors affecting Knocking. Octane and Cetane rating of fuels. Type of combustion chambers of S.I. engines and C.I. engines

Unit-IV
Steam Boilers: Classification and Working Principles. Water tube boilers- Babcok & Wilcox and Stirling boilers. Fire tube boilers- Cornish, Cochran, Locomotive and Lancashire boilers. High Pressure boilers / Supercritical boilers: La-mont, Benson boiler, Loeffler boiler and Velox boiler. Boiler Mountings and Accessories. Boiler Draught. Calculation of Chimney height. ***Steam Condensers:*** Jet and Surface condensers, Principle of Operation and Applications.
Unit-V
Steam Power Plant Cycles: Carnot and Rankine cycles of operation and their efficiencies. Analysis of Rankine cycle with superheating, reheating and regeneration (Direct and Indirect types). ***Steam Nozzles*****:** Flow of steam through convergent - divergent nozzles, velocity of steam flowing through the nozzle, mass of steam discharge through the nozzle, condition for maximum discharge, critical pressure ratio and nozzle efficiency.

Suggested Reading:

1. R.K. Rajput, " *Thermal Engineering",* Laxmi Publications, 9th Edn., 2013
2. V. Ganesan, "*Internal Combustion Engines*", Tata McGraw Hill Publishing, 2007
3. P.L. Ballaney, "*Thermal Engineering*", Khanna Publishers, 19th Edn., 1993.
4. Richard Stone, "*Introduction to I.C. Engines*", Mac Millan, 2nd Edn., 1997

KINEMATICS OF MACHINERY

PC406ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. The objectives of this course is to impart knowledge of
2. Analysis of mechanisms.
3. Drawing displacement diagrams for followers with various types of motions.
4. Cam profile drawing for various followers.
5. Estimation of transmission of power by belts and application of various gears and gear trains.

Outcomes:

After completing this course, the student will be able to:
1. Understand the principles of kinematic pairs, chains and their classification, DOF, inversions, equivalent chains and planar mechanisms.
2. Analyse the planar mechanisms for position, velocity and acceleration.
3. Design frictional systems like belt drives, rope drives, clutches, bearings and screw threads
4. Design cams and followers for specified motion profiles.
5. Evaluate gear tooth geometry and select appropriate gears for the required applications

Unit-I
Definition of link, pair, kinematic chain, mechanism and machine, Kutzbach and Grubler criterion, Grashoff's law, inversions of quadratic cycle chain, inversions of single and double slider crank chains. Fundamentals of coupler curves, Robert's law, Pantograph, Geneva mechanism, Hooke's joint, Davis and Ackerman's Steering gearmechanisms. ***Straight Line Motion Mechanisms*:** Peaucellier and Hart Mechanisms.
Unit-II:
***Analysis of Mechanisms*:** Instantaneous centre, body centrode and space centrode, Kennedy's theorem, Graphical methods (relative velocity method, instantaneous center method) to find velocities and accelerations including Coriolis component of acceleration of planar mechanisms. Angular velocity theorem.
Unit-III
***Laws of Friction**:* Friction in screw threads, pivots, collars and clutches, friction axis and friction circle of a link ***Belts and Rope drives*:** Open and closed belt drives, length of belt, ratio of tensions, effect of centrifugal tension and initial tension on power transmission, condition for maximum power transmission ***Brakes**:* Block or shoe brake, internal expanding shoe brake, differential band brake, block& band brake. ***Dynamometers**:*Prony brake, Rope brake, belt transmission and Torsion type dynamometers
Unit-IV

Cams: Types of cams and followers, Displacement, velocity, acceleration diagrams for follower motion, Analysis of uniform motion, parabolic motion, simple harmonic motion and cycloidal motion profiles. *Design of Cam profiles*: Cams with knife edge, roller and flat face followers.
Unit-V
Gears :Classification of gears. Spur gears- Nomenclature, law of gear tooth action, involute as gear tooth profile, interference of involute gears, minimum number of teeth to avoid interference, contact ratio, cycloidal tooth profile, comparison of involute and cycloidal toothprofile. ***Gear trains***- Simple, compound, reverted, and epi cyclic gear trains.

Suggested Reading:

1. S.S. Rattan, "*Theory of Machines"*, Tata McGraw-Hill, 3rd Edition,2009.
2. J. E. Shigley, "*Theory of Machines and Mechanisms"*, McGraw-Hill Publications,2005.
3. Thomas Bevan, "*Theory of Machines"*, Pearson Education
4. Norton RL, "*Kinematics and Dynamics of Machinery"*, McGraw-Hill Publications
5. Amitabha Ghosh and Ashok Kumar Mallik, "*Theory of Mechanisms and Machines"*, East West Press Pvt. Ltd,2008

For the academic years 2020-2024

MANUFACTURING PROCESS

PC407ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. To understand the basic principles of major manufacturing processes such as metal casting, welding and forming of engineering materials.
2. To know the advantages and limitations of each process.
3. To be able to select the optimal process to produce a product.
4. To know the basic principle of advanced forming processes.

Outcomes:

1. Describe the concepts of Foundry Technologies consisting of pattern making, mould making, gating design and solidification.
2. Discuss the importance of special casting processes, categorize various casting defects and describe the processing of plastics and powder metallurgy concepts.
3. Classify and differentiate various Arc welding, Gas welding and Advanced welding processes, discuss their advantages, applications and limitations.
4. Differentiate various Solid State welding and Resistance welding processes, discuss their applications, and identify various welding defects.
5. Describe various forming processes, sheet metal operations and discuss the importance of unconventional forming processes.

Unit-I
Casting Process : Casting terms, pattern materials, types of patterns, pattern allowances, colour code for patterns, Moulding sands, core sands, properties of moulding sand and its ingredients, different types of moulding machines, Directional solidification, use of chaplets, chills, gating and risering systems.
Unit-II:
Special Casting Processes: Shell moulding, CO_2 moulding, die casting, centrifugal casting, investment or lost wax process; Casting defects, causes and remedies, Inspection and testing of castings. ***Processing of Plastics*** - Extrusion, Injection moulding, Blow moulding and Thermoforming. ***Introduction to Powder Metallurgy***- Process, Production of powders, blending, mixing, compaction techniques and finishing operations employed in powder metallurgy processes
Unit-III
Welding Processes: Introduction, Classification of welding processes, principle of gas welding, gas welding equipment and techniques, types of flames and applications, advantages, limitations and applications of gas welding. Arc welding equipment electrode materials and specifications, polarity, types of arc welding.- SMAW, SAW, GMAW, GTAW, PAW, Atomic hydrogen welding, principle of Electro slag welding, Gas cutting, Brazing and Soldering.

Unit-IV
Solid State Welding Process: Forge Welding, Friction Welding, Friction Stir Welding, and Explosive Welding. ***Resistance welding processes*** - Spot welding, Seam welding, Projection welding, Butt welding, weldability, Welding defects
Unit-V
Forming Processes: Cold & Hot working, Process description of Forging, Rolling, Extrusion and Drawing operations. ***Sheet Metal Operations:*** Blanking, Piercing, Bending, Deep drawing, Stretch forming, Spinning. ***Advance Forming Processes***- High energy rate forming processes such as Explosive forming, Electro- magnetic forming and Electro-hydraulic forming; Rubber pad forming

Suggested Reading:

1. P.N. Rao, "*Manufacturing Technology*," Vol. 1, Tata McGraw Hill Publ., 3nd Ed., 2011
2. Amitabh Ghosh & Mallick, "*Manufacturing Science*", Assoc. East west Press Pvt. Ltd. 4th Ed., 2011
3. Roy A. Lindberg, *"Processes and Materials of Manufacture*", 3rd Edition, Pearson Education, 2015.
4. Serope Kalpakjian, "*Manufacturing Engineering and Technology*", Pearson Education, 2018
5. George. E. Dieter, *"Mechanical Metallurgy*", SI Metric Edition McGraw-Hill Book Company
6. J.P.Kaushish, *"Manufacturing Processes*", PHI Learning Pvt. Ltd., 2nd, 2010

THERMAL ENGINEERING LAB-I

PC453ME

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 25 marks *SEE: 50 marks*
Credits : 1

Objectives:

1. To understand applications of thermal engineering concepts through experimentation.
2. To provide knowledge in testing of properties of fuels and lubricating oils
3. To demonstrate and conduct experiments, Interpret and analyse data and report results of IC engine testing

Outcomes:

1. Perform experiments to find the efficiency of Petrol and Diesel engines.
2. Find the properties of unknown fuels/lubricants.
3. Perform experiments on CI and SI engines.
4. Perform experiments on Reciprocating Air Compressor.

List of Experiments:
1. To determine volumetric efficiency, isothermal efficiency and mass flow rate of a two stage reciprocating air compressor.
2. To determine valve timing diagram of a Petrol/Diesel engine.
3. To determine port timing diagram of a Petrol/Diesel engine.
4. To conduct performance test on single cylinder Diesel engine.
5. To conduct heat balance test on a Diesel engine.
6. To conduct Morse test on multi cylinder Petrol engine.
7. To conduct performance test on multi cylinder Petrol engine.
8. To conduct performance test on a two-stroke Petrol engine.
9. To conduct performance test on multi cylinder Diesel engine.
10. To study the performance of a Petrol engine under different compression ratios.
11. Exhaust gas analysis of Petrol engine for carbon-monoxide and unburnt hydrocarbons.
12. Exhaust gas analysis of Diesel engine for carbon deposits using smoke meter.
13. Determination of viscosity of lubricating oil.
14. Determination of flash and fire points of a fuel
15. Study of Boiler Models

Note: At least ten experiments should be conducted in the Semester

MANUFACTURING PROCESS LAB

PC454ME

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 25 marks *SEE: 50 marks*
Credits : 1

Objectives:

1. To gain knowledge and skill in various manufacturing processes such as casting, welding and forming.
2. To understand and perform operations like pattern making, sand testing and casting.
3. To join metal pieces by various welding techniques and gain hands on experience.
4. To understand the working principle and produce some components by various metal forming techniques

Outcomes:

1. Conduct experiments and put hands-on experience on various processes in foundry, welding, forging, forming and plastic manufacturing technologies.
2. Demonstrate the understanding of the theoretical concepts of above technologies while working in small groups.
3. Demonstrate writing skills through clear laboratory reports
4. Identity the defects / imperfections and discuss their causes and suggest remedies to eliminate them.
5. Transfer group experience to individual performance of exercises and demonstrate effective oral communication skills.

List of Experiments:
Foundry
1. Producing different types of patterns considering draft, shrinkage and machining allowances.
2. Green sand mould making processes with complete gating and risering systems.
3. Testing of moulding sand properties
4. Melting and pouring of aluminium to produce casting.
Welding
I. Evaluation of strength and hardness of
1. Butt Joint prepared by gas welding using different types of flames
2. Lap joint by resistance welding process
3. V-Joint by Arc welding process
II. Exercises using TIG and MIG welding processes.
III. Performing Brazing and Soldering operations.
Forming:
1. Evaluation of formability using Erichsen cupping test
2. Performing drawing operation on different materials (ex. MS, Cu, Al, etc)
3. Performing blanking and piercing operations using hydraulic/fly presses.
4. Manufacturing of a simple component using Plastic Injection moulding machine

Note: At least ten experiments should be conducted in the Semester

SCHEME OF INSTRUCTION & EXAMINATION
AICTE Model Curriculum
B. E. V – Semester (MECHANICAL ENGINEERING)
(Proposed for the Academic year 2020-2021)

S. No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in Hours	
Theory Course										
1	PC408ME	Hydraulic Machines	3	-	-	3	30	70	3	3
2	PC409ME	Design of Machine Elements	3	-	-	3	30	70	3	3
3	PC410ME	Dynamics of Machines	3	-	-	3	30	70	3	3
4	PC411ME	Metrology and Instrumentation	3	-	-	3	30	70	3	3
5	PC412ME	Heat Transfer	3	-	-	3	30	70	3	3
6	PE51ME	Professional Elective-I	3	-	-	3	30	70	3	3
Practical / Laboratory Course										
7	PC455ME	Thermal Engineering Lab-2	-	-	2	2	25	50	3	1
8	PC456ME	Dynamics of Machines Lab	-	-	2	2	25	50	3	1
9	PC457ME	Fluid Mechanics and Hydraulics Machinery Lab	-	-	2	2	25	50	3	1
Total										**21**

Professional Elective-I		
S. No.	**Course Code**	**Course Title**
1	PE511ME	CAD/CAM
2	PE512ME	Automobile Engineering
3	PE513ME	Industrial Engineering

MC: Mandatory Course **BS**: Basic Science **ES:** Engineering Science
L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:
1. Each contact hour is a clock hour
2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

HYDRAULIC MACHINES

PC408ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

It is intended to make the students to
1. The purpose of this course is to learn the Fluid properties and fundamentals of Fluid statics and fluid flow
2. To introduce the concepts of flow measurements and flow through pipes
3. To introduce the concepts of momentum principles
4. To impart the knowledge on pumps and turbines.

Outcomes:

After completing this course, , the student is able to
1. Apply conservation laws to fluid flow problems in engineering applications
2. Design and analyze the performance of the reciprocating pumps
3. Design, estimate the unit quantities and specific parameter of centrifugal pumps
4. Design, working of various types of turbines and could draw the characteristic curves of turbines
5. Estimate the performance of various hydraulic equipment and systems and design with Hydraulic power controls and fluidics

Unit-I
Hydraulic Machines: Classification – Impulse momentum equation – Layout of hydraulic power plant – Working principle – Impact of jets on Flat & Curved plates – Force exerted by a jet striking on a i) Fixed:-flat, Curved plates (Symmetrical & Unsymmetrical) ii) Moving:- Flat & Curved plates (Symmetrical & Unsymmetrical).
Unit-II:
Reciprocating Pumps: Classification, working principle-single and double acting pumps – discharge, work done and power required to drive the pumps-slip, % slip and negative slip variation of pressure head in the suction and delivery pipes due to acceleration of piston – variation of pressure head due to friction in the suction and delivery pipes. Indicatior diagrams – Ideal and actual diagrams. Effect of piston acceleration and pipe friction on indicator diagram – Maximum speed at which the pump must run to avoid separation during suction and delivey strokes – Air vessels – Function of air vessels – Work saved by fitting air vessels to single and double acting pumps – Discharge of liquid into and out of air vessels – Performance characteristic curves.
Unit-III
Centrifugal Pumps: Classification - Working principle – Comparison over Reciprocating pumps, Velocity triangles, Manometric head – Work done per second – Head equivalent of work done – Manometric, Mechanical and Overall efficiencies – Pressure rise in the impeller. Minimum starting speed – Physical significance of specific speed – Model testing – Conditions of similarity of CF pumps – Priming – Performance characteristic curves – Troubles (operational difficulties), reasons and remedies in CF pumps – Cavitation – Effects of cavitation – Precautions against cavitation
Unit-IV
Hydraulic Turbines: Classification of impulse and reaction turbines – Construction and working of Pelton wheels, Francis turbine and Kaplan turbine – Velocity triangles – Work done (power developed) – Hydraulic, Mechanical and Overall efficiencies – Maximum efficiency – Comparison between Impulse and Reaction turbines - Comparison between

Francis and Kaplan turbines –Specific speed – Physical significance of specific speed – Unit quantities – Draft tubes – functions and types of draft tubes – Surge tanks functions and types of surge tanks – Performance characteristic curves
Unit-V
Industrial Hydraulics: Basic components of hydraulic circuits; Properties and types of hydraulic oils, Working principles of external pumps – gear, lobe, vane, radial piston and axial piston. Specification of D.C. valve: Working of – flow control, pressure relief, pressure relief, pressure reducing and sequencing valves; Symbolic representation of various components; Working of various servo systems – hydro mechanical, hydraulic – hydraulic, electro-hydraulic; Construction details of oil reservoir and selection criteria for pumps.

Suggested Reading:

1. Bansal, R.K. “A text book of Fluid Mechanics and Hydraulic Machines” Laxmi Publication (P) Ltd., New Delhi, 2004.
2. Modi, P.N. and Seth, S.M. “Hydraulic and Fluid Machines”, Standard Book House, New Delhi, 2004. 3. Ramamrutham, S., “Hydraulics, Fluid Mechanics and Fluid Machines”, Dhanpat Rai & Sons, New Delhi, 2004.
3. Kumar, D.S., “Fluid Mechanics and Fluid Power Engineering”, S.K. Kataia & Sons, 2008.
4. Majumdar, S.R., “Oil Hydraulics Systems – Principles and Maintenance” , Tata-McGrawhill, New Delhi, 2004.

DESIGN OF MACHINE ELEMENTS

PC409ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. Importance of codes, materials, manufacturing process in design of mechanical components
2. Importance of theories of failure and effects of fatigue and stress concentration on the life of the component
3. Learn the concepts required to design machine components like keys, shafts, couplings
4. Will learn to determine size of rivets, welds and cotter joints for specific applications
5. Will Understand the concepts used for designing machine components like cotters, bolts, nuts

Outcomes:

1. Identify & Use codes and standards, selection proper material & perform static design.
2. Analyze cyclic loading conditions and provide fatigue design of components
3. Analyze machine elements like keys, shafts and couplings,
4. Evaluate various joining techniques like welding, riveting and cotter joints.
5. Synthesize an d design screw threads for fasteners and power screw applications.

Unit-I
Introduction: Materials used in Machine design, General Classification and Procedure in Machine design, preferred numbers, Review of type of loads and stresses. Stresses due to Bi-axial and Tri-axial loads, Factor of Safety, Stress concentration, Theories of failures for Bi-axial stress system, Fluctuating stresses, Fatigue strength, Notch sensitivity, Factor effecting fatigue strength, Gerber's, Soderberg's and Goodman's diagrams for fatigue design, Cumulative fatigue damage.
Unit-II:
Shafts: Introduction, Types of Shafts, Shafts subjected to twisting moment only, bending moment only, combined twisting & bending moment, axial loads in addition to combined twisting & bending moment and fluctuating loads. Keys: Introduction, Types of keys, Forces acting on sunk keys, Strength of a sunk key, Effect of keyways on shafts.
Unit-III
Couplings: Introduction, Types of Couplings, Rigid couplings-Muff, Spilt Muff, Flange and Flexible couplings- Bushed–pin. Cotter and Knuckle joints: Introduction, Type of Cotter joints, Design of Socket and Spigot Cotter joints, Sleeve Cotter joints and Knuckle joints.
Unit-IV
Riveted joints: Introduction, Type of Riveted joints, Terms used in Riveted joints, Caulking and Fullering, Failures of a Riveted joints, Efficiency of a Riveted joints, Design of Boiler joints and Lozenge joint, Riveted joints under eccentric loads. Welded joints: Introduction, Type of Welded joints, Strength of Transverse, Parallel and

Circular Fillet Welded joints, Strength of Butt joints, axially loaded Unsymmetrical sections Welded joints, eccentrically loaded Welded joints.
Unit-V
Screwed joints: Introduction, Type of Screwed joints, Locking devices, Stresses in Screwed joints due to static loads, Bolts of uniform strength, Bolted joints under eccentric loading. Power screws: Introduction,Design of a Screw Jack, Differential and Compound screws

Suggested Reading:

1. V. B. Bhandari, "Design of Machine Elements", Tata McGraw-Hill Publ, 3rd Edn. 2010.
2. J.E. Shigley & Charles R. Mischke "Mechanical Engineering Design", Tata McGraw-Hill.,6th ed.2010.
3. P. Kannaiah, Machine Design, Sci-Tech Publ., 2009.
4. P.C. Sharma & D.K. Aggarwal, "Machine Design", S.K. Kataria & Sons, 10th edn, 2003
5. V. B. Bhandari, "Design Data Book " 2nd edition, ", Tata McGraw-Hill Publ, 2019

DYNAMICS OF MACHINES

PC410ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. To know effect of inertia of links, and external forces on the input torque, and forces developed at joints in typical mechanisms in motion; understand the gyroscopic couple and its effect on vehicles inmotion.
2. To know the working principles and characteristics of typical governors, as also the function of flywheels.
3. To know the concept of unbalancing rotating and reciprocating masses in single and multi-cylinder in line and radial engines.
4. To understand the phenomena of free of free and forced, including the effect of damping for single dof systems, and concepts of isolating vibration.
5. To determine natural frequencies of undammed, damped and forced vibrating systems of one, two and multi degree freedom systems

Outcomes:

1. Analyse static and dynamic forces in slider crank and other mechanisms; determine the magnitude of gyroscopic couple and its effect on vehicles in motion.
2. Evaluate the performance of various types of governors and design flywheels considering speed and energy fluctuation
3. Analyse problems of balancing in rotating and reciprocating machinery.
4. Evaluate the natural frequencies of single and two degree of freedom systems in free and forced vibration mode, also considering the effect of damping.
5. Determine the natural frequencies and mode shapes of multi degree of freedom systems, including byDunkerley, Raleigh and Holzer methods.

Unit-I
Static and Dynamic Force Analysis: Static equilibrium: Constraint and Applied forces, Static Force analysis of Single slider crank mechanism without Friction and four bar mechanism. Dynamic Equilibrium: d'Alambert's Principle, Dynamic force Analysis of Slider Crank Mechanism. Engine Force Analysis: Piston effort ,Force along connecting rod, thrust on sides of cylinder, crank effort. Thrust on bearing. Dynamically Equivalent System for Connecting Rod. Gyroscope: Gyroscopic Couple, gyroscopic effects on aeroplanes, naval ships. Stability of two wheeler and four wheeler.
Unit-II:
Flywheels: Turning Moment Diagrams for different engines, Functions of flywheel, Differences between flywheel and governor, turning moment diagrams, flywheel analysis for I-C Engines and shearing/punching/riveting machines. Governors: Working principle of governor, Classification & types of governors, analysis of Watt, Porter, Proelland Hartnell governors. Characteristics of governors:Controlling Force, Stability, Isochronism, Sensitivity, Powerand Effort of governors.
Unit-III
Balancing: Static balancing, Dynamic balancing, balancing of several masses rotating in several planes, balancing of reciprocating masses, primary balancing shaking forces in single

cylinder engine, partial balancing and its effects, secondary balancing. Balancing of locomotives, hammer blow, variation of traction effort and swaying couple
Unit-IV
Vibrations: Vibrations of Single degree freedom system (axial, transverse and torsional),,Stepped shaft,Whirling speed of shafts. Damped Vibrations: Types of damping, Vibrations with viscous damping, damping factor and logarithmic decrement. Forced Damped Vibrations: Magnification factor, Resonance, Vibration isolation and Transmissibility
Unit-V
Torsional Vibrations of Two rotor, three rotor and Geared systems. Natural frequencies of two degree freedom systems Modes of vibration approximate methods for determining natural frequencies: Dunkerley's method, Rayleigh's method.

Suggested Reading:

1. S.S. Rattan, Theory of Machines, Tata McGraw-Hill, 3rdEdition,2009.
2. J. E. Shigley, Theory of Machines and Mechanisms, McGraw-HillPublications,2005.Thomas Bevan, Theory of Machines, PearsonEducation
3. Norton RL, Kinematics and Dynamics of Machinery, McGraw-HillPublications
4. Amitabha Ghosh and Ashok Kumar Mallik, Theory of Mechanisms and Machines, East West Press Pvt.Ltd,2008
5. Thomas Bevan, the Theory of Machines, CBS Publishers & Distributors, 2004.
6. J.S. Rao and Gupta, Theory and Practice of Mechanical Vib rations, Prentice Hall, 1984.

METROLOGY & INSTRUMENTATION

PC411ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

The objectives of this course is to impart knowledge of
1. To familiarize with Limits & fits, I.S.O. system and the instruments used to measure these limits.
2. To have knowledge of various precision linear and angular measuring instruments.
3. To learn the importance of form and how to measure form errors.
4. To understand the working principles of various instruments used for the measurement of strain, forces, pressure, temperature and vibrations.

Outcomes:

After completing this course, the student will be able to:
1. To understand limits, fits and tolerances and their applications. Linear and angular measurements and measuring instruments.
2. To understand the design of limit gauges, evaluate roughness and its measurement.
3. To understand basic measuring system, static and dynamic characteristics of instruments
4. To understand various principles to measure pressure, temperature, displacement, force, torque and vibrations.

Unit-I
Introduction to Engineering Metrology, Role of metrology in quality assurance, Linear and Angular measurements – Slip gauges and End bars – Gauge material and manufacturing methods, Different types of Micrometers, Height gauges, Tomlinson gauges. Precision polygon, Sine bar, Auto collimator. Limits and Fits, ISO system: Types of interchangeability Taylor's Principle or plain limit gauges, Use of Plug, Ring and Snap gauges. Indicating type limit gauges.
Unit-II:
Comparators: Dial indicator, Sigma and Mechanical comparator, free flow and Back pressure type Pneumatic comparator. Optical projector, Chart gauges, screen gauges and measuring methods.Tool maker's Microscope applications. Form measurements – Measurement of Straightness and Flatness. Roundness measurement with bench centers and talyrond, Coordinate Measuring Machine in complex geometries.
Unit-III
Surface Roughness Measurements, Profilometer, Taylor Hobson Talysurf. Application of Thread metrology - 2 wire, 3 wire method and best wire methods, Gear measurement - Gear tooth thickness, Parkinson gear tester, General geometric tests for testing machine tools – Lathe, drill and Mill.
Unit-IV
Elements of instrumentation system. Static and Dynamic characteristics. Instrument types - zero, first and second order instruments, Types of errors. Displacement transducers. LVDT. Strain measurement -Wire and foil type resistance strain gauges. Rosette Gauges. Bonding procedure. Lead resistance compensation. Adjacent arm and self-compensating gauges.

Proving ring. Strain gauge load cells, measurement of axial load and torsion by strain gauges. Piezo-electric load cell.
Unit-V
Introduction to Seismic Transducers -displacement and acceleration measurement, Pressure measurement -Bourdon pressure gauge, bulk modulus gauge, pirani gauge, Temperature measurement by thermo couples. Laws of thermo electricity. Types of materials used in thermocouples. Protection tubes. Extension wire. Series and parallel circuits. Ambient temperature compensation.

Suggested Reading:

1. I.C. Gupta – "Engineering metrology", Dhanpat Rai Publications, New Delhi.
2. Rega Rajendra, "Principles of Engineering Metrology", Jaico Publishing House, Mumbai.
3. RK Jain, "Engineering Metrology", Khanna Publications, 1996.
4. Doeblin,"Measurement Systems Application and Design", Tata Mc¬Graw Hill,5th ed., 2004.
5. Beckwith, Buck, Lienhard, Mechanical Measurements, Paerson education india.
6. P. Donald Echman, "Industrial Instrumentation", John Wiley and Sons, 1996.
7. Hume, "Engineering Metrology", Kalyani Publications, 1985.

HEAT TRANSFER

PC412ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

The objectives of this course is to impart knowledge of
1. The basic concepts of heat transfer.
2. The concepts of conduction, convection, radiation and heat exchangers applicable for commercial and industrial use.
3. The applications of various experimental heat transfer correlations in engineering applications.
4. Thermal analysis and sizing of heat exchanger.
5. solving problems on different modes of heat transfer which are related to thermal power plants, refrigeration and air conditioning

Outcomes:

After completing this course, the student will be able to:
1. To understand the basic concepts of heat transfer.
2. To understand the concepts of heat transfer through extended surfaces.
3. To Familiarize with time dependent heat transfer and compute convective heat transfer coefficients in forced, natural convection.
4. To understand radiation heat transfer
5. To understand , heat exchangers and mechanism involved in boiling and condensation.

Unit-I
Conduction: Modes of Heat Transfer, Laws of Heat Transfer - Fourier, Newton, Stefan-Boltzmann General conduction equation in cartesian, cylindrical and spherical coordinates, One dimensional steady state conduction through slabs, hollow cylinders and spheres with and without heat generation, Effects of variable thermal conductivity in heat transfer of one dimensional steady state conduction of plate, cylinders and spheres, Steady state heat transfer through composite slabs, cylinders and spheres, Critical radius of insulation.
Unit-II:
Fins: Heat transfer analysis of tips with heat dissipation environment - rectangular straight and pin fins, Application of fin to temperature measurement, unsteady state conduction, Lumped parameter, analysis of a body with negligible internal temperature gradients, Transient heat transfer analysis of finite slab with specified temperature and convective boundary conditions, Use of Grober and Heisler charts for solving problems of infinite slabs, cylinders and spheres.
Unit-III
Free and forced convection: Dimensional analysis and its use in free and forced convection, Buckingham theorem, Physical significance of different dimensionless numbers, Application of Von-Karman integral equation for the analysis of thermal

boundary layer in forced convection of flat plate, Reynold's analogy for flow over plane surfaces, calculation of heat transfer for flow over plates, cylinders, spheres and for flow through tubes in free and forced convection using empirical formulae.
Unit-IV
Radiation: Definition of absorptivity, reflectivity and transmissivity, Concept of black-body and emissivity. Kirchoffs law, Planck's black body spectral distribution, Wien's and Steffan Boltzmann law, Monochromatic and total emissive power, radiant heat exchange between two gray surfaces, Shape factor, Thermal circuit for radiant heat exchange between infinite parallel plates and between concentric, cylinders, Enclosures with black and gray surfaces, Radiation shields and re-radiation surfaces.
Unit-V
Heat Exchangers: Classification and applications of heat exchangers in industry, Analysis and design of counter flow and parallel flow heat exchanger, Fouling factors, solving problems for multi pass heat exchanger using non dimensional parameter plots. **Change of Phase:** Boiling-pool boiling regimes nucleate pool boiling, effect of surface wettability on bubble contact angle, Critical heat flux, boiling in forced convection, Condensation: Film condensation, Drop wise condensation, Condensation film thickness, Heat transfer coefficient in film condensation.

Suggested Reading:

1. Holman, J.P., "Heat Transfer", McGraw Hill Publication, New Delhi, 2010 2.
2. Rajput, R.K., "Heat and Mass Transfer", S. Chand & Company Ltd, New Delhi, 2004.
3. Yadav, R., Sanjay. and Rajay., "Heat and Mass Transfer ', Central Publishing House, Allahabad, 2004
4. Sachdeva,R.C., "Fundamentals of Engineering Heat and Mass Transfer ", New Age International (P) Ltd Publishers, New Delhi,
5. Arora, S.C. and Domkandwar., "A course in Heat and Mass Transfer ", DhanpatRai& Sons, New Delhi, 2004.

CAD/CAM

PE511ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. To introduce the concepts of CAD and advanced modeling techniques
2. To help the students in understanding the functioning of computer numerical control machine tools and also in writing programs for operating this machines.
3. To help the student in understanding advanced manufacturing concepts like Group technology, flexible manufacturing systems, Computer aided Process Planning, Computer aided quality control, Artificial Intelligence etc.

Outcomes:

The Students will be able to
1. Understand the fundamental applications of computer in design, manufacturing and geometric transformation techniques in CAD
2. Develop mathematical Model for curves, surfaces, solid models and understand the fundamental concepts of Finite Element Analysis
3. Write CNC Part program for manufacturing components
4. Understand the concepts of Machining Centres, adaptive control and as well as fundamentals knowledge of robotics
5. Understand the working of various components of an modern manufacturing systems

Unit-I
CAD Fundamentals, Product life cycle in conventional and computer-based manufacturing system, Hardware integration and networking. CAD Software: Definitions of system software and application software. Graphic Standards and Exchange Formats. CAD database and structure.
Unit-II:
Geometric modeling: 3-D wire frame modeling: wire frame entities and their definitions, Interpolation and approximation of curves, synthetic curves and curve fitting. Definitions of cubic, Bezier, and B-spline curves. Surface modeling: Definitions of basic surfaces, surface of revolution, blends, intersection, and Cubic, Bezier, B-spline surfaces. Solid Modeling: Solid entities, Boolean operations, B-rep and C-rep approaches. Feature based modeling: Concepts and applications, Assembly modeling.
Unit-III
Numerical Control of machine Tools: Features and elements of NC. Positional, paraxial and contouring types. Definitions of axes, punched type, formats of tape preparation. Definitions of interpolation, post-processor, preparatory and miscellaneous functions, canned cycles, tool length and cutter radius compensation. Manual and computer aided part programming (APT) for simple components. Programming with MACROS.
Unit-IV
CNC, DNC and adaptive control systems. Their types, typical configurations and relative features. Industrial Robots: Classification based on manipulator configurations, relative characteristics, Online and offline programming methods, controls and drives, applications.
Unit-V

Group Technology: Organization, G.T. layout, part classification and coding, CAPP: Variant and Generative approaches and their relative features. Computer Aided Quality Control: Computer in quality control, Contact and non-contact inspection, optical and non-optical computer aided testing, Experts systems. Artificial intelligence, CAD/CAM integration

Suggested Reading:

1. Ibrahim Zeid, "CAD/CAM, theory and practice", McGraw Hill Inc, N.Y.1991.
2. Grover, MP and Zimmers E.W., "CAD/CAM", Prenctice Hall of India 1989.
3. Rao P.N., Tiwari N.K., Kundra T.K., "Computer Aided Manufacturing", Tata McGraw Hill, New Delhi, 1993.
4. Radhakrishnan. P, Subramanyan. S, Raju. V, "CAD/CAM/CIM", New Age international (P) Ltd., 2nd Edn., 2004.

AUTOMOBILE ENGINEERING

PE512ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

The objectives of this course is to impart knowledge of
1. Understand the Working of Fuel, Ignition, and cooling Systems.
2. Understand the Working of Lubrication and Electrical Systems
3. Understand the Working of Suspension, Steering and Braking Systems.
4. Understand the Working of Power Transmission.
5. Understand the Necessity of Pollution Control and Maintenance.

Outcomes:

After completing this course, the student will be able to:
1. Generalize the different types of automobiles, list the engine components, describe the functioning of IC engines and classify the fuel supply system for S.I and C.I engines
2. Differentiate the types of lubrication system; identify different lubrication and cooling systems used in vehicles. Classify ignition system and describe the functioning of battery and automobile air conditioning system.
3. List the salient features of different steering mechanisms, describe the importance of wheel alignment and wheel balancing, describe the importance of different suspension systems and shock absorbers used in an automobile
4. Identify different components in power transmission system design a system, components, or process to meet desired needs with in realistic constrains such as economic, environmental, health and safety, describe about braking system
5. Adapt techniques, skills and modern engineering tools necessary to control the pollution, record the automobile parts maintenance, design and build components and system to reduce pollution of automobile vehicles

Unit-I
Types of automobiles: Normal, Hybrid and Hydrogen fuel vehicles. Engine location and its components, chassis layout, crank shaft proportion, firing order, piston and piston rings, cylinder liners, valves and operation mechanism, inlet and exhaust manifolds, carburetion and fuel injection system, mechanical fuel injection system & electronic fuel injection system.
Unit-II:
Lubricating systems: Wet sump, dry sump and petrol systems, and Cooling systems: Water pumps, radiators, thermostat control anti freezing compounds. Types of Ignition systems, modern ignition systems, types of batteries and charging systems, starting motors, lighting and electrical accessories, automobile air-conditioning.
Unit-III

Steering systems: Linkage arrangements and its components modified Ackerman linkage, wheel alignment, caster and camber. Rack and pinion assembly – recent trends Wheel and tyres: Tyre construction, specification. Tyre wear and causes, wheel balancing, types of suspension system, independent suspension coil and leaf springs, torsion bar, shock absorbers.
Unit-IV
Power Train: Clutches, gear and gearbox manual, semi-automatic and automatic gearboxes. Torque converter, propeller shaft, universal coupling differential, four-wheel drive system.Brake systems: Description and operation of hydraulic brake, leading and trailing shoe layout, disc brakes, master cylinder, hand brake linkage, recent trends.
Unit-V
Maintenance: Pollution control, trouble shooting and servicing procedure overhauling, engine tune up, tools and equipment for repair and overhaul, testing equipment, pollution control technologies used for petrol and diesel engines, types and study of catalytic converters, Euro norms 2 & 3 and Bharat Norms – recent trends.

Suggested Reading:

1. Crouse & Anglin, 'Automotive Mechanics' Tata McGraw Hill, Publishing Co., Ltd., New Delhi, Tenth edition - 2004..
2. Kirpal Singh, "Automobile Engineering", Vol I & II Standard Publishers, Delhi.
3. Joseph Heitner, 'Automotive Mechanics', Affiliated East West Pvt., Ltd.,
4. C.P. Nakra, "Basic Automobile Engineering", Dhanpat Rai Publishing Co.(P) Ltd., New Delhi, 2003

INDUSTRIAL ENGINEERING

PE513ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. To learn the concept of Management.
2. To understand role of Production Planning and Control in Industry.
3. To learn various material procurement policies.
4. To understand importance of quality control and various methods.
5. To interpret the role of Decision theory in Industry.

Outcomes:

After completing this course, the student will be able to
1. Explain various approaches for industrial management. Able to infer concept of management in human resource domain
2. Apply Philosophy of Production Planning and Control in Industry and control the activities in delivering the products in time
3. Determine the optimum requirement of inventory by developing the various quantitative models.
4. Develop various models or methods for ensuring the required quality of the products or processes.
5. Elaborate the role of Decision theory and apply various approaches under Uncertainty and Risk conditions

Unit-I
Management: Introduction to Management, Scientific Management, Systems approach to Management, MBO, and Decision Making Process. **Personnel Management:** Functions of personnel management, types of training, Job evaluation and Merit rating, Collective bargaining and labour participation in management.
Unit-II:
Production Planning & Control: Definition, Objectives, Importance and Functions of Production Planning & Control. **Production Control:** Routing, Scheduling, Dispatching, Follow-up and progress Report.
Unit-III
Inventory Control: Importance of inventory control, types of inventory models Inventory costs deterministic inventory models Basic EOQ models, production model without shortages, Purchase model with instantaneous replenishment and with shortages production model with shortages Inventory model with price breaks, Fixed order quality system, periodic review system Inventory model with probabilistic demand.
Unit-IV
Quality Control: Concept of quality, evolution of quality control, assignable and chance causes of variation, Variable Control charts (X and R charts) **Attributes control charts:** P chart and C chart

Acceptance Sampling – Single Sampling, Double Sampling and Multi sampling plans – OC curves of single
Unit-V
Decision Theory: Introduction, Decision, Decision Making & Decision Theory, Types of Decisions, decision making process, Types of Decision making Environment: **Decision making under Uncertainty**- Criterion of Optimism or Maximax, Criterion of Pessimism or Maximin, Minimax decision criteria **Decision making under Risk:** Expected Monetary Value(EMV), Expected Opportunity Loss (EOL) Criterion & Expected Value of Perfect Information(EVPI) Criterion **Decision Trees.**

Suggested Reading:

1. M.Mahajan, "Industrial Engineering and Production Management", Dhanpatrai& sons, New Delhi
2. S.K. Sharma and Savitasarma, "Industrial Engineering and Organization Management", SK Kataria& Sons, New Delhi.
3. S.D. Sharma, "Operations Research", Kedarnnath, Ramnath& Co., Meerut, 2009
4. S Kalavathi, "Operations Research", Vikas Publishing House Pvt. Ltd, 2009
5. V. K. Kapoor, "Operations Research", S. Chand, New Delhi.
6. SK Sharma &Savita Sharma," A course in Industrial Engineering & Operations Management", S K Kataria& Sons, 2008

THERMAL ENGINEERING LAB-II

PC455ME

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 25 marks *SEE: 50 marks*
Credits : 1

Objectives:

1. Determining thermal conductivity of an insulating powder in composite slab or cylinder. The concepts of conduction, convection, radiation and heat exchangers applicable for commercial and industrial use
2. Evaluating the heat transfer coefficients under natural convection and forced convection phenomena Thermal analysis and sizing of heat exchanger.
3. determining the necessary constants pertaining to radiation
4. understanding the working principles of axial flow fan and its overall efficiency
5. estimating overall efficiency of a centrifugal compressors and pressure distribution over cylinder and an aerofoil section on turbo machines.

Outcomes:

After completing this course, the student will be able to:
1. Interpret the link between refrigeration effects, work done and COP of the system, describe different methods adopted to evaluate COP, list the different psychrometric processes and describe how those processes can be maintained
2. Calculate the overall efficiency of centrifugal blower and axial flow fan at different volume flow rates, show the variation of overall efficiency with load and speed graphically To understand radiation heat transfer, heat exchangers and mechanism involved in boiling and condensation.
3. Identify the various components of low speed wind tunnel, plot a graph showing variation of pressure over the entire length of aerofoil blade and also evaluate the lift and drag coefficient values for a given aerofoil blade at different angle of assign
4. Describe the modes of heat transfer, calculate thermal conductivity, heat transfer coefficient subjected to natural and forced convection environment and Stefan Boltzmann constant value of thermal radiation.
5. Express the working principle of heat exchangers and its application in real life, calculate the LMTD and effectiveness of a given heat exchanger for both parallel and counter flows.

List of Experiments:
1. Determination of thermal conductivity of metal bar
2. Determination of thermal conductivity of composite wall.
3. Determination of the efficiency of pin-fin subjected to natural and forced convection
4. Determination of effectiveness of parallel flow and counter flow heat exchanger
5. Determination of emissivity of given test plate
6. Determination of Stefan Boltzmann constant.
7. Determination of COP of the Air conditioning system
8. Determination of percentage relative humidity and study of humidification and

dehumidification process in Air Conditioning systems
9. Determination of COP of refrigeration systems using capillary tube/ thermostatic expansion valve
10. Determination of overall efficiency of centrifugal blower
11. Determination of overall efficiency of axial flow fan
12. Pressure distribution on symmetrical and non-symmetrical specimen in wind tunnel
13. Measurement of lift and drag force of the models in wind tunnel test section
14. Study of Nozzles.

Note: At least ten experiments should be conducted.

DYNAMICS OF MACHINES LAB

PC456ME

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 25 marks *SEE: 50 marks*
Credits : 1

Objectives:

1. To understand the effects and importance of kinematic and dynamic analysis of mechanisms
2. To understand effects and analysis of Single degree freedom vibration systems
3. To study the gyroscope, governors and cams
4. To carry out the static and dynamic analysis of four bar mechanisms and drives

Outcomes:

1. Evaluate performance characteristics of centrifugal governors and compare their sensitivity
2. Estimate the Gyroscopic couple and its effect on a Precessing rotating member.
3. Determine the magnitude, location and orientation of a balancing mass required to balance the unbalance rotating system and verify the static and dynamic balancing.
4. Sketch the CAM profiles for different combinations of CAM and Follower and examine the operating speed limit for each combination.
5. Determine the time response of single and two-degree freedom systems with free and forced vibrations and evaluate the critical speed of the shaft.

List of Experiments
1. Centrifugal Governors: Experiment on Performance Characteristic Curves.
2. Estimation of Gyroscopic Couple & Understanding of Gyroscopic Effects on a rotating disc.
3. Static and Dynamic Balancing of Rotating Masses.
4. Determination of Moment of Inertia of Connecting Rod by compound pendulum method.
5. Damped and Undamped Torsional Vibrations of Single and Double Rotor System.
6. Single DOF (Degrees of Freedom) of Spring Mass Damper System. (Damped and Undamped Systems).
7. Free and Forced Vibration of Simply Supported Cantilever Beam.
8. Dunkerley Method to Find Fundamental Frequencies.
9. Critical Speed of Shaft Whirling.
10. Modal Analysis of Beam.
11. Cam Analysis of Cams.
12. Any Experiment explaining dynamic aspects of mechanical systems.
13. Determination of Moment of Inertia of Flywheel.
14. Experiment with Bifilar System.
15. Model analysis of disc.

Demonstration Experiments (Can't be allocated in final exams)
1. Velocity Ratios of Simple, Compound, Epicyclic and Differential Gear Trains.
2. Virtual Lab Experiment I – Governors.
3. Virtual Lab Experiment II – Natural Frequency of Cantilever beam.

Note: Minimum ten experiments should be conducted in the semester.

Suggested Reading:

1. S.S. Rattan, Theory of Machines, Tata McGraw Hill, 2010
2. John J.Uicker, J r. G o r d o n, R.Pennock, Joseph E.Shigley, Theory of Machines and Mechanisms, Oxford University Press, 2003.
3. Lab manual supplied by department.

FLUID MECHANICS & HYDRAULIC MACHINES LAB

PC457ME

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 25 marks *SEE: 50 marks*
Credits : 1

Objectives:

Students able to understand
1. the working of pumps of different kinds and their behaviour.
2. the working of turbines of different kinds and their behaviour.
3. the theory of working of various flow measuring devices and their utility in industry.

Outcomes:

After completing this course, the student will be able to:
1. Practice and experiment on different types of turbines and analyse their performance at rated and off design conditions.
2. Investigate through experimentation different types of pump models and estimate their performance.
3. Apply the priniciple of different flow measuring instruments and their adoptability to the industry.
4. Develop the hydraulic circuits to cater the needs of the industry.

List of Experiments:
1. Performance and characteristic curves of Self Priming pump
2. Performance and characteristic curves of Centrifugal/ Submergible pump
3. Performance and characteristic curves of Reciprocating pump
4. Performance and characteristic curves of Gear pump
5. Impact of Jets on Vanes
6. Performance and characteristic curves of Pelton Wheel
7. Performance and characteristic curves of Francis Turbine
8. Performance and characteristic curves of Kaplan Turbine
9. To determine coefficient of discharge of venturi meter
10. To determine coefficient of discharge of orifice meter
11. Study of Hydraulic Circuits
12. Study of pneumatic Circuits

SCHEME OF INSTRUCTION & EXAMINATION
AICTE Model Curriculum
B. E. VI – Semester (MECHANICAL ENGINEERING)
(Proposed for the Academic year 2020-2021)

S. No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in Hours	
Theory Course										
1	PC413ME	Machine Design	3	-	-	3	30	70	3	3
2	PC414ME	Metal Cutting and Machine Tools	3	-	-	3	30	70	3	3
3	PC415ME	Finite Element Analysis	3	-	-	3	30	70	3	3
4	PE52ME	Professional Elective-II	3	-	-	3	30	70	3	3
5	PE53ME	Professional Elective-III	3	-	-	3	30	70	3	3
6	OE61	Open Elective-I	3	-	-	3	30	70	3	3
Practical / Laboratory Course										
7	PC458ME	Metrology and Machine Tools Lab	-	-	2	2	25	50	3	1
8	PC459ME	Computer Aided Engineering Lab	-	-	2	2	25	50	3	1
9	PW701ME	Summer Internship*						50		2
Total										**22**

Professional Elective-II			**Professional Elective-III**		
S. No.	**Course Code**	**Course Title**	**S. No.**	**Course Code**	**Course Title**
1.	PE521ME	Thermal Turbo Machines	1.	PE531ME	Composite Materials
2.	PE522ME	Production and Operations management	2.	PE532ME	Product Design And Process Planning
3.	PE523ME	Design For Manufacture	3.	PE533ME	Power Plant Engineering

Open Elective-I		
S. No.	**Course Code**	**Course Title**
1	OE611ME	Industrial Robotics (Not for Mech. Engg. students)

MC: Mandatory Course **BS**: Basic Science **ES:** Engineering Science
L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note: 1. Each contact hour is a clock hour

2..The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

** **At the end of VI semester students should undergo Summer Internship. Credits for Summer Internship will be awarded in VII semester.***

MACHINE DESIGN

PC413ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. Importance of helical coil springs and leaf springs in mechanical systems
2. Understand the design of gears such as spur, Helical and bevelgears
3. How to apply design concepts in bearing design
4. Importance of design procedure in designing IC engine components
5. Utilization of curved beams on mechanical components

Outcomes:

1. Analyze helical coil springs and leaf springs for mechanical systems
2. Evaluate kinematic transmission systems using gears
3. Select bearing system for specific applications
4. Design various IC engine components
5. Determine load carrying capacity of curved beams

Note: Standard Design data book is allowed in University exam.

Unit-I
Mechanical Springs: function of springs, Types of springs and materials used. Eccentric, Buckling and Surge of Compression Springs. Stress, Energy and Deflection of Helical Springs, Springs in Series and Parallel connection, Concentric or Composite Springs. Leaf Springs: Construction of Leaf Springs Equalized, Stress in Spring Leaves (Nipping)
Unit-II:
Gears: Types of gears and materials used. Standards for gear specifications. design of Spur gears, Helical and Bevel Gears based strength criterion -Lewis equation, Wear considerations, Static and dynamic tooth load, Types of gear tooth failure and preventive measures. Proportions and force analysis of worm gears.
Unit-III
Bearings: Materials used for Bearings. Classification of Bearings. Viscosity of Lubricants Theory of Hydrostatic and Hydrodynamic lubrication. Design of sliding contact bearings - for axial and thrust loads *Rolling Contact Bearings*: Different types of rolling element bearings and their constructional details. Static and Dynamic load carrying capacity, Load-life relationship.
Unit-IV
I.C. Engine Parts: Design of piston, connecting rod and crank shafts when the crank is at dead centre.
Unit-V
Curved beams: Theory of bending of members with initial curvature - rectangular,

circular and Trapezoidal sections. Design of crane Hooks, Machine frames and C-clamps. Advantages and Disadvantages of Chain Drive over Belt or Rope Drive. Terms Used in Chain Drive. Classification of Chains. Velocity Ratio of Chain Drives.

Suggested Reading:

1. V. B. Bhandari, “Design of Machine Elements”, Tata McGraw-Hill Publ, 3rd Edn. 2010.
2. J.E. Shigley & Charles R. Mischke “Mechanical Engineering Design”, Tata McGraw-Hill.,6th ed.2010.
3. P. Kannaiah, Machine Design, Sci-Tech Publ., 2009.
4. P.C. Sharma & D.K. Aggarwal, "Machine Design", S.K. Kataria & Sons, 10th edn, 2003
5. V. B. Bhandari, “Design Data Book ” 2nd edition, ”, Tata McGraw-Hill Publ, 2019

Data Handbook:

1. K. Balaveera Reddy and K. Mahadevan “Design Data Handbook for Mechanical Engineers in Si and Metric Units”4th Edition, CBS Publishers & Distributors, 2018.
2. Design Data: Data Book of Engineers By PSG College.

Note : Solution of Numerical problems using Design data book should be practiced

METAL CUTTING & MACHINE TOOLS

PC414ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. To learn the tool material, geometry and mechanics of metal cutting for turning, drilling and milling.
2. To know the heat distribution, tool wear, tool life, and machinability
3. To learn the principle and working of various machine tools like lathe, shaper, planer, milling, drilling and grinding machines etc.
4. To learn various types of fixtures, conventional and unconventional machining processes.

Outcomes:

1. Understand the cutting tool geometry, mechanism of chip formation and mechanics of orthogonal cutting.
2. Understand the thermal aspects of metal cutting, influence of tool wear on tool life and machinability.
3. Identify basic parts and operations of machine tools including lathe, shaper, planer, milling, drilling, and boring machines.
4. Design locating and clamping devices to produce a component.
5. Understand the principles of various finishing processes and gear manufacturing processes
6. Understand the principle and working of various unconventional machining processes.

Unit-I
Cutting Tool Materials: High carbon steel, HSS, Stellites, Carbides, Coated carbides, Diamonds, Tool material properties; **Tool Geometry:** Nomenclature of single point cutting tool by ASA & ORS systems. Geometry of drills, milling cutters; **Chip Formation:** Types of chips, BUE, Chip breakers; **Machining:** Orthogonal and oblique cutting, Mechanics of metal cutting, Merchant's analysis, Shear angle, Solutions of Merchant and Lee & Shafer
Unit-II:
Thermal Aspects of Metal Cutting: Sources of heat and heat distribution, various methods of measurement of temperature, Cutting fluids and applications; **Tool Wear, Tool Life and Machinability:** Types of wear, mechanism of tool wear, Tool life & Machinability, Machinability index. Taylor's tool life equation; **Economics of Machining:** Optimum Cutting Speeds for maximum production rate and minimum cost.
Unit-III
Machine Tools: Constructional features and specifications of machine tools, various operations on Lathe, Types of Lathes - capstan and turret Lathes; Drilling, Milling and Boring machines. Indexing methods, differences between shaper, planer and slotter, Tool holding and work holding devices Quick return mechanisms.
Unit-IV
Grinding Machines: Types of grinding, Abrasives and bonds used for grinding wheels.

Specification and selection of grinding wheels; Broaching, Lapping, Honing, Polishing, Buffing, Super Finishing and Burnishing. **Screws and Gear Manufacturing:** Tapping, Chasers, Thread rolling, Thread milling, Thread grinding. Gear shaping, Gear hobbing, Gear shaving and grinding.
Unit-V
Jigs and Fixtures: Design principles for location and clamping. Quick clamping devices Types of Jigs and fixtures. Applications of Jigs and Fixtures. **Unconventional Machining:** Principle of working, merits, demerits and applications of USM, AJM, EDM, ECM, LBM and EBM

Suggested Reading:

1. B.L. JuneJa and Shekon, "Fundamentals of Metal Cutting & Machines Tools", Wiley Eastern Ltd. 1987.
2. P.N. Rao, "Manufacturing Technology – Metal Culling & Machine Tools", Vol. 2, Tata McGraw Hill Education Pvt. Ltd, 2010.
3. Amitab Ghosh and Mallick, "Manufacturing Science", Affiliated East West Press 1985.
4. P.K Misha, "Non Traditional Machining Processes", Narosa Publications, 2006.
5. V.K.Jain "Advanced Machining Processes" Allied Publishers, Hyderabad, 2011.
6. A. Bhattacharyya, "Metal Cutting Theory and Practice" New Central Book Agency (P) Ltd. Calcutta, 1996.
7. Stephan Radavich, "Gear Manufacturing", CRC Press, ,1 Edn,2011

FINITE ELEMENT ANALYSIS

PC415ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. Equip the students with the Finite Element Analysis fundamentals and formulations
2. Enable the students to formulate the axial, truss, beam and 2d problems
3. Enable the students to formulate the heat conduction and dynamics problems
4. Able to understand use of numerical integration and Gaussian quadrature
5. Enable the students to perform engineering simulations using FE software (ANSYS)

Outcomes:

By the end of this course, the students will be able to
1. Summarize basic equations of elasticity and formulate finite element modelling of one dimensional element using Potential energy approach.
2. Formulate finite element modelling of truss and frame elements along with the concepts of transformation from local to global matrices.
3. Interpolate Hermitian shape function of beam element in natural coordinate system.
4. Develop stiffness matrix for a plane stress & plane strain conditions on a CST, Axisymmetric elements by interpolating shape functions in natural coordinate system.
5. Formulate finite element model to steady state heat transfer analysis using one & two dimensional elements.
6. Formulate mass and stiffness matrices of 1D & beam elements to establish Eigen values &Eigen vectors using Lagarangian and Hamilton principles

Unit-I
Introduction: Introduction to Finite Element Method for solving field problems, Stress and Equilibrium, Boundary conditions, Strain, Displacement, Stress-Strain relations. **One dimensional problems:** Finite element modelling coordinates and shapes functions, Potential Energy approach: Assembly of Global stiffness matrix and load vector, Finite element equations, Treatment of boundary conditions, Galerkin's approach, Quadratic shape functions.
Unit-II:
Analysis of trusses and frames: Element stiffness matrix for a truss member, Analysis of plane truss with two at each node. Analysis of frames with two translations and a rotational degree of freedom at each node, Analysis of Beams: Element stiffness matrix for two nodes (two degrees of freedom per node).
Unit-III
Finite element modelling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions. Finite element modelling of axi-symmetric solids subjected to axi-symmetric loading with triangular elements.
Unit-IV
Two dimensional four noded iso-parametric elements and numerical integration. Steady state heat transfer analysis: One dimensional analysis of a fin and two dimensional analysis of thin plate, Analysis of circular shaft subjected to torsion.

Unit-V
Dynamic Analysis: Formulation of finite element model, element matrices, Evaluation of Eigen values and Eigen vectors for a stepped bar and a beam, Time dependent field problems: Application to one dimensional heat flow in a rod. Introduction to finite element formulation of three dimensional problems in stress analysis, Convergence requirements. Introduction to Finite Element Analysis Software.

Suggested Reading:

1. G. Ramamurthy, Applied Finite Element Analysis, I.K. International Publishing House Pvt.Ltd., New Delhi, 2009.
2. Tirupathi R, Chandraputla and Ashok D Belagundu, Introduction to Finite Elements in Engineering, PHI,1997.
3. Rao S S, The Finite Element Method in Engineering, Pergamon Press, 1989.
4. Segerlind L J, Applied Finite Element Analysis, Wiley Eastern, 1984.
5. Reddy JN, An Introduction to Finite Element Method, McGraw-Hill, 1984.

For the academic years 2020-2024

THERMAL TURBO MACHINES

PE521ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. Understand isentropic flow for variable areas and relations
2. Understand and apply fanno flow, Rayleigh flow and shock flow.
3. Understand centrifugal and axial flow compressor with velocity triangles
4. Understand and analyze impulse and reaction steam turbines with velocity triangles
5. Understand and analyze gas turbines and rocket propulsion.

Outcomes:

1. Analyze situations of Thermal gradients in Turbo machines and apply the situation of fluid flow analysis with energy conversion principles for work transfer.
2. Develop knowledge about working principles of work absorption and work producing situations
3. Understand applications of Thermodynamics with fluid flow behavior and compressibility effects
4. Attain knowledge of Power production using External combustion engines, with methods of improving efficiencies
5. Demonstrate the learnt fundamentals in applying for real time situations such as undertaking final dissertation projects on Thermal turbo Machines and power plants with knowledge of International standards and testing.
6. Establish and compute one dimensional thermodynamic analysis of Compressors, Turbines (both for air & Vapour working fluids) and analyzing using velocity triangles for single and multi stages.

Unit-I
Introduction to compressible flows: Speed of propagation of pressure waves, Mach number, Acoustic velocity and Mach cone, limits of compressibility, pressure field due to a moving source of disturbance, one dimensional compressible flow. Isentropic flow with variable area, Mach number variation, Area ratio as function of Mach number, flow through nozzles and diffusers. Flow in constant area ducts with friction-Fanno flow, variation of flow properties, variation of Mach number with duct length, isothermal flow with friction.
Unit-II:
Flow in constant area duct with Heat Transfer, -The Rayleigh liner, Rayleigh flow relations, variation of flow properties, Maximum heat transfer. Flow with Shock Waves-Development of Normal Shock waves, governing equations, Prandtl -Meyer relation, Rankine-Hugoniot equations, Stagnation pressure ratio across shock.
Unit-III
Blade nomenclature of an aerofoil, Rotodynamic compressors: Introduction and general classification, Comparison of Reciprocating and Rotary compressors, Positive displacement Rotary compressors, Flow through rotary compressors. Static and total head quantities, Thermodynamic cycles and work done,calculation of various efficiencies. Velocity diagrams and prewhirl. Euler equation for energy transfer between fluid and rotor, Analysis of Centrifugal compressors and analysis of axial flow compressors, Chocking, Surging and Stalling.
Unit-IV

Steam Turbines: Classification, flow over blades, pressure velocity variations, Compounding of steam turbines- pressure compounding, velocity compounding and pressure-velocity compounding, Impulse turbine with several blade rings, Nozzle efficiency, Blade efficiency and Gross stageefficiency of Impulse turbine, Velocity diagrams for Impulse turbine-De Laval Turbine, blade efficiency of Impulse turbine, Optimum blade speed ratio, Maximum work done and blade efficiency of Impulse turbine, Degree of reaction of Reaction turbine, Parson Reaction turbine, Velocity diagram for Parson Reaction turbine, blade efficiency of Parson Reaction turbine, Maximum work done and blade efficiency of Parson Reaction turbine, Height of blades of Reaction turbine, Balancing of End thrust.

Unit-V

Gas Turbines: Applications and Classification of Gas Turbines- constant pressure and constant volume gas turbines, Joule cycle-configuration diagram and temp-entropy diagram, Thermal efficiency of Joules cycle, Maximum pressure ratio in terms of temperature ratio, optimum pressure ratio for maximum work output with and without considering machine efficiencies, Improvement of gas turbine plant performance- Inter-cooling, Reheating and Regeneration. Simple Problems on Joule cycle.

Air Craft Propulsion: Air craft engine types, air craft propulsion theory, Turbo jet engines, Ramjet engines, Pulse jet engines, Rocket Propulsion: Types of Propellants, Types of Rocket engines, Rocket propulsion theory-Rocket applications.

Suggested Reading:

1. Yahya S M, *Fundamentals of Compressible Flow,* New Age International Publishers, Third Edition, 2007.
2. Mathur ML, & Mehta F S, *Thermal Engineering,* Jain Brothers, New Delhi, 2003.
3. Dennis G Shepherd, *Aerospace Propulsion,* Elsevier Publishing Company, New York, 1995.
4. CohenH Rogers G F C, SaravanaMutto H I H, *Gas Turbine Theory,* Longman 5th Edition, New York, 2004.
5. Ganeshan V, *Gas Turbines*, Tata Me Graw Hills, New Delhi, 2003
6. Yadav, R *Steam and Gas Turbines*, Central Publishing House Ltd, Alllahabad, 2003.

PRODUCTION AND OPERATION MANAGEMENT

PE522ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. To understand the concept of Production & Operations Management.
2. To understand role of work study and work measurement in Industry.
3. To learn use of forecasting and various methods of it.
4. To understand importance Aggregate planning, Materials Requirement Planning for Industry.
5. To understand Project Management approaches in completion of Project.

Outcomes:

1. Explain various types of Production Systems, develop suitable layout for a given plant
2. Develop various methods for work study and apply suitable Recording techniques. Develop standard procedures and time for the operations.
3. Explain necessity of Forecasting and various methods of it. Develop suitable quantitative forecasting technique for the given past data. Compare accuracy of models in connection with forecast errors.
4. Explain Aggregate planning & Mater scheduling, Materials Requirement Planning Processes. Develop quantitative models for Material requirement and resources based on time span.
5. Elaborate the usages of PERT/CPM techniques for a give project and develop suitable quantitative model for the project in successful competition by identifying the time constraints for start and endof process activities.

Unit-I
Production & Operations Management: Introduction, Types of production Systems. Job shop, Batch, Flow shop. **Plant location and layout**: Factors affecting plant location, Break even analysis, plant layout objectives, Types of layouts, merits and demerits.
Unit-II:
Work Study: Introduction to method study, Steps in method study, Recording techniques- Flow process chart, String diagram, Therbligs, Principles of motion economy. **Work measurement**: Stop watch time study, Standard time calculation. Work sampling-procedure, applications, advantages and disadvantages, Wages and incentives, types of incentive plans.
Unit-III
Forecasting: Introduction, Forecasting objectives and uses, demand patterns, Qualitative models Market survey, Delphi Tech, Quantitative models, Moving average, Weighted moving average, Simple exponential smoothing, trend adjusted exponential smoothing, Least square method, Simple regression, multiple regression. **Forecast errors:** Mean absolute Deviation (MAD), Mean Square Error (MSE), Mean

Forecast Error(MFE), Mean absolute percentage error (MAPE).
Unit-IV
Aggregate Planning and Master Scheduling: Introduction, objectives of aggregate planning, Cost in aggregate planning, Strategies in aggregate planning, Master production scheduling. **Materials Requirement Planning MRP 1**: Importance of MRP, MRP system inputs and outputs, MRP calculations **Manufacturing Resource Planning MRP 2 & Enterprise Resource Planning (ERP):** Features of ERP packages like SAP, BANN, People soft etc.,
Unit-V
Project Management: Project management: Network fundamentals, difference between PERT/CPM Scheduling the activities. Fulkerson's rule. Earliest and latest times. Determination of ES and EF in the forward path. LS and LF in backward path. Determination of critical path. Free float, independent float, Total float, Program evaluation and review technique, crashing of network.

Suggested Reading:

1. Joseph Monk, *Operations Management*, TMH Publishers, New Delhi, 2004.
2. Buffa Elwood S, *Modern Production / Operations Management,* John Wiley Publishers, Singapore, 2002.
3. Everett E Adam, Jr and Ronald J. Ebert, *Production and Operations Management – Concepts, Models and Behaviour,* 5th Ed. 1998, (EEE), Prentice Hall of India(P) Ltd., New Delhi.
4. Panneer Selvam R, "*Operations Research*", Second Edition, PHI Learning Pvt. Ltd. New Delhi, 2006.
5. S.D. Sharma, "*Operations Research*", Kedarnnath, Ramnath & Co., Meerut, 2009.

DESIGN FOR MANUFACTURE

PE523ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. To understand and applications of the basics and working principles of manufacturing.
2. To grasp the knowledge of basic mechanical components and design the simple components.
3. To learn the knowledge of design of different types of machine components to meet varied functional and operational requirements.

Outcomes:

1. To recognize the strength and mechanical factors of metals and non metals.
2. To understand the design of metallic components and its processes.
3. To understand the advanced design of metallic and non metallic components.
4. To recognize the design of non metallic assembled mechanical components.
5. To understand the varies assemblies and part design with automation.

Unit-I
Introduction: General design principles for manufacturability, strength and mechanical factors, mechanisms selection, evaluation method, geometrical tolerances, tolerances control and utilization. Economic Use of Raw Materials: Ferrous steel, hot rolled steel, cold finished steel, stainless steel,non ferrous materials aluminium, copper, brass, non metallic materials, plastics, rubber and composites.
Unit-II:
Metallic components design: metal extrusion. Metal stamping , , spring and wire forms, spun metal parts, cold headed parts, tube and section bends, rolled formed parts, power metal parts, forging electro forming parts, special forming methods.
Unit-III
Metallic components design: Turned parts, machined round holes, drilled parts and milled parts. Planned shaped and slotted parts, screw threaded contoured and internal ground parts, center less ground, Electrical discharged, electro chemical and advanced machine parts.
Unit-IV
Non metallic components design: Sand cast , die cast, investment cast and other cast products, injection moulded and rotational moulded parts, blow moulded, welded plastic articles, ceramics.
Unit-V
Assembled parts design: bolted connections, welded parts, arc, resistance , brazed and soldered parts, gear box assembly, bearing assembly, flanged connections, press fitted connections, surface finishing, plated parts, Heat treated parts, NC machining , Group technology, low cost automation, computer aided manufacture, product design requirements.

Suggested Reading:

1	*Hand book of product design for manufacturing by James G.Bralla, MC Graw Hill Co., 1986.*
2	*Knowledge based design for manufacture by K.G. Swift, Kogan page limited, 1987.*
3	*Design for manufacturability by David M. Anderson, Productivity Press, 2014.*
4	*Design for Manufacturability Handbook, McGraw-Hill Handbooks,1998.*
5	*Product Design for Manufacture and Assembly by Geoffrey Boothroyd, CNC Press, 2010*

COMPOSITE MATERIALS

PE531ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

The objectives of this course are to:
1. Discuss the basic structure of composites
2. Define Elastic constants and Hygro-thermal stresses
3. identify stress-strain relations in composites
4. Describe the behaviour and Design with composites
5. Demonstrate the basic equations of plate bending

Outcomes:

On completion of the course the student will be able to:
1. demonstrate knowledge of composites and their structure
2. predict the Elastic constants and Hygrothermal stresses
3. analyse the stress - strain relationship in composites
4. summarise and apply the Design procedure and the failure criteria.
5. formulate Plate bending equations for various Boundary conditions of composite plates.

Unit-I
Introduction: Fibres, Matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composite, carbon fibre composites.
Unit-II:
Micromechanics of Composites: Mechanical Properties: Prediction of Elastic constant, micromechanical approach, Halpin-Tsai equations, Transverse stresses. Thermal properties: Hygrothermal stresses, mechanics of load transfer from matrix to fibre.
Unit-III
Macromechanics of Composites: Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation, inter-laminar stresses and edge effects. Simplified composite beam solutions. Bending of laminated beams.
Unit-IV
Strength, fracture, fatigue and design: Tensile and compressive strength of unidirectional fibre composites, fracture modes in composites: Single and multiple fracture, de-bonding, fibre pullout and de- lamination failure, fatigue of laminate composites, Effect of variability of fibre strength. **Strength of an orthotropic lamina:** Max stress theory, max strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria. Designing with composite materials.
Unit-V
Analysis of plates and stress: Plate equilibrium equations, Bending of composite plates, Levy and Navier solution for plates of composite material. Analysis of composite

cylindrical shells under axially symmetric loads.

Suggested Reading:

1. Jones, R.M., ‘Mechanics of Composite Materials’, Mc-Graw Hill Co., 1967.
2. Calcote, L.R., ‘The Analysis of Laminated Composite Structures’, Van Nostrand, 1969.
3. Whitney. I.M., Daniel, R.B. Pipes, ‘Experimental Mechanics of Fibre Reinforced Composite Materials’, Prentice Hall, 1984.
4. Hyer. M.W., ‘Stress Analysis of Fibre-Reinforced Composite Materials’, McGraw Hill Co., 1998.
5. Carl. T. Herakovich, ‘Mechanics of Fibrous Composites’, John Wiley Sons Inc., 1998.

For the academic years 2020-2024

PRODUCT DESIGN AND PROCESS PLANNING

PE532ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

A student shall understand
1. The Product Design and Process Functions
2. The essence of innovation in product development
3. The Human Machine Interactions (ergonomics)
4. The various Intellectual Property Rights
5. The interaction between Design, Manufacturing, Quality and Marketing
6. The awareness about overall view of Process Planning

Outcomes:

At the end of the course, the students will be able to
1. Identify the functions of design of a product in a system in a given situation and select a suitable product; identify the procedure for technological innovation of a product; explain the importance of brainstorming and Delphi techniques in innovation
2. Explain the importance of design, human machine interaction in project selection and evaluation methods including ergonomic considerations
3. Explain the importance of research in new product development; describe the process of patenting including search of patents, patent laws and international code and discriminate the scope of IPR for a product patent.
4. Discuss the features of design of a new product with respect to manufacture, quality testing and marketing; and steps to evaluate a new product for introduction;
5. Develop process planning including creating process sheets; explain value engineering, group technology and concurrent engineering in the selection of manufacturing process.

Unit-I
Product Design and Process Design functions. Selection of right product. Systematic procedure of product innovation. Factors contributing to successful technological innovation - need for creativity and innovation. Techniques of innovation like brain storming and Delphi techniques.
Unit-II:
Project Selection and Evaluation: Function of design - Design with Human Machine Interaction (HMI). Collection of ideas and purpose of project. Selection criteria - screening ideas for new products using evaluation techniques. Principles of ergonomics.
Unit-III
New Product Development: Research and new product development. Patents, definitions, patent search, patent laws, international code for patents -Intellectual Property Rights (IPR).
Unit-IV
New - Product Planning: Interaction between the functions of design, manufacture, quality & testing and marketing. Steps for introducing new products after evaluation. Product Design Practice and Industry – *Product Strategies, Analysis of the Product, The Three S's.*
Unit-V

Process-Planning: Process planning, process sheets. Selection of manufacturing process, estimation of machining time in various cutting operations - estimation of costs for manufacture. Value engineering in product design, group technology, concepts of concurrent engineering.

Suggested Reading:

1. Niebel BW & DraperAB: "*Production Design & Process Engg*.", McGraw Hill, Kogakusha, 1974.
2. Chitale, A. K & Gupta R.C., "*Product Design & Manufacturing*" -PHI, 1997
3. Harry Nystrom, "*Creativity and Innovation*", John Wiley & Sons, 1979.
4. Brain Twiss, "*Managing Technological Innovation*", Pittman Publ, 1992.
5. Harry, B. Waton, "*New Product Planning*", Prentice Hall Inc., 1992
6. G Dieter, "*Engineering Design - a materials and processing approach*", McGraw Hill, NY, 2000

For the academic years 2020-2024

POWER PLANT ENGINEERING

PE533ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

Student has to understand the
1. Operation of steam turbine and gas turbine power plants
2. About hydraulic power plant, hydrology, dams and spillways
3. Various types of nuclear power plants including Pressurized water reactor, Boiling water reactor, Liquid metal fast breeder reactor and Gas cooled reactor
4. The power plant economics
5. The environmental and safety aspects of power plant operation.

Outcomes:

At the end of the course, the students will be able to demonstrate
1. Select coal and ash handling methods for a coal fired power plant.
2. Comprehend basic working principle of steam and gas turbine power plant
3. Classify Dams and Spillways.
4. Demonstrate the basic principles of thermal-fission and fast-breeder nuclear power plants, such as pressurized- water, boiling-water, and heavy-water reactors.
5. Analyse load factor, capacity factor, average load and peak load on a power plant.
6. Illustrate the control methods of major pollutants emitted from fossil-fuel power plants.

Unit-I
Introduction to Sources of Energy-Resources and Development of Power in India. Steam ***Power Plant:*** Plant layout, working of different Circuits, Fuel and handling equipment, types of coal, coal handling, choice of handling equipment, coal storage, ash handling systems.
Unit-II:
Combustion Process: Properties of coal- overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components, combustion needs and draught system, cyclone furnace, design and construction, Dust collectors, cooling towers, and heat rejection, corrosion and feed water treatment. ***Gas Turbine Power Plant:*** Introduction -Classification-Layout with Auxiliaries-Principles of working of closed and open cycle gas turbines
Unit-III
Hydro Electric Power Plant: Water Power-Hydrological cycle, flow measurement- drainage area Characteristics-Hydrographs-storage and pondage- classification of dams and spill ways
Unit-IV
Nuclear Power Station: Nuclear fuel-breeding and fertile materials -Nuclear reactor-reactor Operation- Pressurized water reactor, boiling water reactor, sodium-graphite reactor, fast breeder reactor, homogeneous reactor, gas-cooled reactor. Radiation hazards and shielding -radioactive waste disposal.
Unit-V
Power Plant Economics and Environmental Considerations: Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, Load curves,

average load and load factor,delivery factor-related exercises Effluents from power plants and impact on environment -Pollutants and Pollution Standards -Methods of pollution control

Suggested Reading:

1. Rajput, RK, *A Text Book of 'Power Plant Engineering*, 3rd Edition. Laxmi Publications, New Delhi.
2. Arora SC, Domukundwar S, *A Course in Power Plant Engineering,* Dhanpat Rai & Sons, New Delhi.
3. YadavR, *Steam & Gas Turbines and Power Plant Engineering,* 7th Edition, Central Publishing House, Allahabad, 2007.
4. Nag P K, *Power Plant Engineering,* 2nd Edition, Tata McGraw Hills Co. Ltd, New Delhi, 2002.
5. Wakil M M, *Power Plant Technology*, Me Graw Hill Publications, New york, 2005.

INDUSTRIAL ROBOTICS

OE611ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. To familiarize the student with the anatomy of robot and their applications.
2. To provide knowledge about various kinds of end effectors usage.
3. To equip the students with information about various sensors used in industrial robots.
4. To make the student understand the importance of spatial transformation of robots using forward and inverse kinematics.
5. To specify and provide the knowledge of techniques involved in robot vision in industry.
6. To equip students with latest robot languages implemented in industrial manipulators.

Outcomes:

1. Able to demonstrate knowledge of the relationship between mechanical structures of industrial robots and their operational workspace characteristics and have an understanding of the functionality and limitations of robot actuators and sensors.
2. Able to demonstrate an ability to apply spatial transformation to obtain forward/Inverse kinematics equation of robot manipulators using analytical/numerical/simulation tools.
3. Able to apply knowledge and choose the best & economically suitable sensors/end effectors required for specific applications.
4. Able to understand the importance of robot vision and apply the learnt techniques to get the required information from input images.
5. Able to design and develop a industrial robot for a given purpose economically.
6. Appreciate the current state and potential for robotics in new application areas.

Unit-I
Introduction to Robotics: Basic structure of Robots. Degree of freedom of Robots, Work envelope, Classification of Robots based on Drive Technology, Work-Envelope and motion control methods. Application of Robots in Industry, Repeatability, Precision and Accuracy as applied to Robots, Specifications of robots used for various applications. End effectors, Grippers: Mechanical grippers, pneumatic and hydraulic grippers, magnetic grippers, vacuum grippers, RCC grippers, Two fingered and three fingered grippers, internal grippers and external grippers, Selection and design considerations
Unit-II:
Requirements of a Sensor: Principles and Applications of the following types of sensors- Position of sensors (Piezo electric sensor, LVDT, Resolvers, Optical encoders, Pneumatic position sensors), Range sensors (Triangulation principle, Structured, Lighting approach, Time of flight range finders, Laser range meters), Proximity sensors (Inductive, Hall effect, Capacitive, Ultrasonic and Optical proximity sensors), Touch sensors (Binary sensors, Analog sensors), Wrist Sensors, Compliance Sensors, Slip Sensors.
Unit-III

Kinematic Analysis of Robots: Rotation matrix. Homogeneous transformation matrix, Denavit & Hartenberg representation, Euler and RPY angles representation. Representation of absolute position and orientation in terms of joint parameters, Direct Kinematics of manipulators, Inverse kinematics of Robot arm for position and orientation. Redundancy in Robots, Static force analysis
Unit-IV
Introduction to Techniques used in Robot Vision: Image acquisition, illumination techniques, imaging geometry, basic relationship pixels, preprocessing, segmentation & description of 3- dimensional structures, their recognition and interpretation. Types of Camera, frame grabbing, sensing and digitizing image data, Signal conversion, Image Storage, Lighting techniques, Image processing and analysis, Data reduction, Segmentation, Feature extraction, Object recognition, and various algorithms, Applications, Inspection, identification, visual serving and navigation.
Unit-V
Robot Programming Languages: Characteristics of robot level languages, task level languages. Teach pendant programming, Lead through programming, Robot programming languages, VAL programming, Motion commands, Sensor commands. End effecter commands, Simple programs. RGV, AGV, Implementation of robots in industries, various steps, Safety considerations for robot operations. Economic analysis of robots, Pay back method, EUAC method and Rate of return method

Suggested Reading:

1. Groover M P, "Industrial Robotics", McGraw Hill Publications, 1999.
2. Fu. K.S., Gon Zalez R.C., Lee C.S.G. "Robotics, Control-sensing vision and Intelligence", McGraw Hill, Int. Ed., 1987.
3. Spong and Vidyasagar, "Robot Dynamics & Control", John Wiley and Sons, Ed.,1990.
4. Mittal and Nagrath, "Industrial Robotics", Tata McGraw Hill Publications, 2004.
5. Saha & Subir kumar saha, ‘Robotics’, TMH, India.

METROLOGY & MACHINE TOOLS LAB

PC458ME

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 25 marks *SEE: 50 marks*
Credits : 1

Objectives:

1. To have knowledge of various precision measuring instruments.
2. To familiarise machining and metal cutting operations.

Outcomes:

After completing this course, the student will be able to:
1. Select and apply the knowledge of measuring tools for external, internal and angular measurements for promoting the qualitative production management.
2. Adapt the principles of optical measurements in measurement of screw and gear profiles.
3. Choose and practice the appropriate methods of force measuring devices principles for required situation.
4. Demonstrate the need of machine alignment test for qualitative production.
5. Practice calibration principles for maintaining the required precision of instruments / tools.
6. Select and practice the methods of temperature measurement.
7. Select cutting tool materials and tool geometries along with appropriate cutting conditions for different work materials and grind the cutting tools to the required geometry.
8. Recognize and summarize the features and applications of various machine tools like Lathe, Milling, Drilling, Grinding, Shaping, Slotting etc.

List of Experiments:
A) Metrology & Instrumentation:
1. Measurement with inside, outside and depth micrometers, Vernier calipers and Height gauges.
2. Measurement of roundness errors with Bench Centres, V-block and dial guage.
3. Measurement of Linear and Angular dimensions with Tool Maker's Microscope: Flat specimens.Plain cylindrical specimens with centers and threaded components.
4. Measurement of angles with Sinebar, Bevel protractor and Precision level.
5. Measurement with Dial Indicator / Electrical Comparator / Mechanical Comparator / Dial Bore Gauge / Snap Gauge/Plug gauges.
6. Calibration and Force measurement with Strain gauge type load cell/Proving Ring/spring type sensor
B) Machining Operations:
1. Thread cutting exercise on lathe machine as single start and multi start threads.
2. Typical exercises on lathe machine (Turning,Step turning,Facin,Parting off &Taper turning).
3. Typical exercises on shaper, cylindrical grinding machine.
4. Exercise of simple gear manufacturing on milling machine.
5. Production of threads with taps and threading dies and milling cutters.
C) Metal Cutting:
1. Estimation of shear angle by measuring thickness and length of chips.
2. Measurement of Cutting forces with Lathe tool dynamometer and determination of friction angle and stresses on shear plane and rake plane.
3. Study of geometrical tests on lathe machine.

Note: At least ten experiments should be conducted

COMPUTER AIDED ENGINEERING LAB

PC459ME

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 25 marks *SEE: 50 marks*
Credits : 1

Objectives:

1. To introduce fundamentals of the analysis software, its features and applications.
2. To learn the basic element types in Finite Element analysis.
3. To know the concept of discretization of continuum. Loading conditions and analyze the structure using pre-processor and postprocessor conditions.

Outcomes:

Course Outcomes:
1. Classify the types of Trusses (Plane Truss & Spatial Truss) and Beams (2D & 3D) with various cross sections to determine Stress, Strains and deflections under static, thermal and combined loading
2. Generalized Plane stress, plane strain conditions & axi-symmetric loading on inplane members to predicting the failure behavior and finding the SCF
3. Analyse connecting rod with tetrahedron and brick elements, performing static analysis on flat & curved shells to determine stresses, strains with different boundary conditions.
4. Predict the natural frequencies and modes shapes using Modal, Harmonic analysis. Also finding the critical load using Buckling analysis
5. Simulate steady state heat transfer analysis of chimney, Transient heat transfer of castings, Non linear, Buckling analysis of shells CFD analysis
6. Evaluate the stiffness matrix, B matrix and loading matrices of beam in plane/solid elements using MATLAB / Python software

List of Experiments

1. Analysis of Plane Truss & Spatial Truss with various cross sections and materials to determine member forces, member strains & stresses, joint deflections under static, thermal and combined loading.
2. 2D & 3D beam analysis with different sections, different materials for different loads (forces and moments with different end supports.
3. 1D, 2D and 3D meshing with different element sizes for different CAD geometry (Proposed Experiment)
4. Static analysis of plates with a hole to determine the deformations, the Stresses to study the failure behavior and SCF.
5. Plane stress, plane strain and axi-symmetric loading on the in plane members with in plane landing to study the stresses and strains.
6. Static analysis of connecting rod with tetrahedron and brick elements
7. Buckling analysis of plates, shells and beams to estimate BF and modes.
8. Modal analysis of beams, plates and shells for natural frequencies and mode shapes

9. Harmonic analysis of a Shaft subjected to periodic force and transient analysis of plate subjected to stepped and ramped loading with varying time .
10. Steady state heat transfer Analysis Cross section of chimney and transient heat transfer analysis of solidification of castings.
11. Flow analysis of pipe with different fluids/gasses/air for velocity and pressure gradients.
12. CFD analysis of aerofoil design.
13. CFD analysis of ducts/impeller/fan.
14. Use of MATLAB / Python for finding B matrix, stiffness matrix and loading matrices of beam/in plane/solid elements and interfacing with CAE software's

Note : Any 10 experiments to be conducted

SUMMER INTERNSHIP

PW701ME

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 50 marks *SEE: -*
Credits : 2

Objectives:

1. Produce an accurate record of work performed during the Internship/Co-op
2. Apply engineering knowledge to a problem in industry
3. Produce a technical report
4. Discuss work in a team environment, if relevant to the project
5. Conduct herself/himself responsibly, safely, and ethically in a professional environment

Outcomes:

After completing this course, the student will be able to
1. Able to design/develop a small and simple product in hardware or software.
2. Able to complete the task or realize a prespecified target, with limited scope, rather than taking up a complex task and leave it.
3. Able to learn to find alternate viable solutions for a given problem and evaluate these alternatives with reference to prespecified criteria.
4. Able to implement the selected solution and document the same.

Summer Internship is introduced as part of the curricula of encouraging students to work on problems of interest to industries. A batch of three students will be attached to a person from the Government or Private Organisations/Computer Industry/Software Companies/R&D Organization for a period of 4-6 weeks. This will be during the summer vacation following the completion of the III-year Course. One faculty coordinator will also be attached to the group of 3 students to monitor the progress and to interact with the industry co- ordinate (person from industry).

The course schedule will depend on the specific internship/training experience. The typical time per topic will vary depending on the internship

- Overview of company/project
- Safety training
- Discussions with project teams
- Background research, review of documents, white papers, and scientific papers
- Planning, designing, and reviewing the planned work
- Executing the plans
- Documenting progress, experiments, and other technical documentation
- Further team discussions to discuss results
- Final report writing and presentation

After the completion of the project, each student will be required to:

1. Submit a brief technical report on the project executed and
2. Present the work through a seminar talk (to be organized by the Department)

Award of sessionals are to be based on the performance of the students at the workplace and awarded by industry guide and internal guide (25 Marks) followed by presentation

before the committee constituted by the department (25 Marks). One faculty member will co-ordinate the overall activity of Industry Attachment Program.

Note: Students have to undergo summer internship of 4-6 weeks at the end of semester VI and credits will be awarded after evaluation in VII semester.

Open Elective 1		
Sl.No	**Code**	**Name of Subject**
1	**OE601 EE**	Electrical Energy Conservation and Safety (Not for EEE & EIE Students)
2	**OE602 EE**	Reliability Engineering (Not for EEE & EIE Students)
3	**OE611 AE**	Basics of Automobile Engineering (Not for Mech./Prod./Automobile Engg. students)
4	**OE611 ME**	Industrial Robotics (Not for Mech./Prod./Automobile Engg. students)
5	**OE601 EG**	Soft Skills & Interpersonal Skills
6	**OE602 MB**	Human Resource Development and Organizational Behaviour
7	**OE601 LW**	Cyber Law and Ethics
8	**OE601 CS**	Operating Systems (Not for CSE Students)
9	**OE602 CS**	OOP using Java (Not for CSE Students)
10	**OE601 IT**	Database Systems (Not for IT Students)
11	**OE602 IT**	Data Structures (Not for IT Students)
12	**OE601 CE**	Disaster Mitigation (Not for Civil Engg. Students)

OPEN ELECTIVES - I
ELECTRICAL ENERGY CONSERVATION AND SAFETY

OE 601 EE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To understandthe concepts ofbasicenergyand variousformsofenergy.
2. To understandthe energymanagementand needof energyaudit.
3. To understandtheenergyefficiencytechnologies.

Outcomes:

At theend ofthe course studentswillbe ableto
1. Understandthecurrentenergyscenario and importanceofenergyconservation.
2. Understandtheconcepts ofenergy management.
3. Understandthemethods ofimprovingenergyefficiencyin differentelectricalsystems.
4. Understandtheconcepts ofdifferentenergyefficientdevices.Explain the basic concepts related to Infrastructure Projects.

UNIT – I

EnergyScenario:CommercialandNon-commercial energy,primaryenergy resources,commercialenergy production,finalenergyconsumption,energyneedsofgrowingeconomy,longterm energyscenario,energy pricing,energysectorreforms,energyandenvironment,energysecurity,energyconservationanditsimportance, restructuring oftheenergy supply sector, energy strategy for the future,airpollution, climatechange.Energy Conservation Act-2001 anditsfeatures.

UNIT – II

Basics of Energyanditsvariousforms:Electricity tariff,loadmanagementandmaximumdemandcontrol, owerfactorimprovement,selection&locationof capacitors,Thermal Basics-fuels,thermalenergycontentsof fuel,temperature&pressure,heatcapacity, sensibleandlatentheat,evaporation,condensation,steam,moistair and humidity&heattransfer, units andconversion.

UNIT – III

EnergyEfficiencyinElectricalSystems:Electricalsystem:Electricitybilling,electricalload managementand maximum demandcontrol,powerfactorimprovementanditsbenefit,selectionandlocationofcapacitors, performanceassessmentofPFcapacitors,distribution and transformerlosses.Electricmotors: Types, losses in inductionmotors,motorefficiency,factorsaffecting motorperformance,rewinding andmotorreplacement issues, energysavingopportunitieswithenergyefficientmotors.

UNIT – IV
EnergyEfficientTechnologies inElectricalSystems:Maximum demandcontrollers,automaticpowerfactor controllers,energy efficientmotors,softstarterswithenergy saver,variable speeddrives,energy efficient transformers,electronicballast,occupancysensors,energyefficientlightingcontrols,energysavingpotentialof eachtechnology.
UNIT – V
Electrical Safety: Physiological effects of Electricity, Important Susceptibility parameters, Distribution of Electric Power, Macro shock hazards, Micro Shock hazards, Electrical - Safety codes and Standards, Basic Approaches to protection against shock, Protection: Power distribution, Protection: Equipment Design, Electrical Safety Analyzers, Testing the Electrical System. Test of Electric Appliances.

Suggested Readings:

1.	Guide books forNationalCertification Examination for EnergyManager/EnergyAuditors Book-1, GeneralAspects (availableonline).
2.	Guide books forNationalCertification ExaminationforEnergyManager/EnergyAuditors Book-3, ElectricalUtilities (available online).
3.	S. C. Tripathy,*UtilizationofElectricalEnergy and Conservation*,McGraw Hill,1991.
4.	Success storiesofEnergyConservationbyBEE, New Delhi(www.bee-india.org).

RELIABILITYENGINEERING

OE 602 EE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. Description of the design aspects of different types spillways.
2. Knowledge regarding the design of energy dissipation arrangements.
3. Awareness about urban storm drainage and concepts of dam safety.

Outcomes:

At theend ofthe course studentswillbe ableto
1. Understandthemeaningofdiscrete and continuousrandomvariablesandtheirsignificance,causesof failuresofasystem.
2. Acquire the knowledge ofdifferentdistribution functions andtheirapplications.
3. Able to developreliabilityblockdiagrams and evaluation of reliabilityofdifferentsystems.

UNIT-I
Discreteandcontinuousrandom variables.Probabilitydensity functionandCumulativedistributionfunction. Meanand variance. Binomial, Poisson, Exponentialand WeibulIdistributions.
UNIT-II
Failureandcauses of failure.Failure rateandfailuredensity.Reliabilityfunctionand MTTF.Bathtubcurvefor differentsystems. Parametric methodsforabove distributions. Non-Parametricmethods fromfielddata.
UNIT-III
Reliability block diagram.Seriesandparallelsystems.Network reduction technique,Examples.Evaluation of failurerate,MTTFandreliability,ActiveandStandbyRedundancy,routofnconfiguration.Non-series–parallel systems. Path basedand cutsetmethods.
UNIT - IV
Availability,MTTRand MTBF, MarkovmodelsandStatetransitionmatrices. Reliability modelsforsingle component.twocomponents, Load sharingand standbysystems.

Reliabilityand availabilitymodelsoftwo-unit parallelsystemswith repairand standbysystems with repair.
UNIT – V
RepairableSystems.maintainability.Preventivemaintenance,Evaluation ofreliabilityandJ1TTF.Overhauling andreplacement.Optimummaintenancepolicy.Markovmodelofapowerplant with identicalunitsandnon- identicalunits. Capacityoutage probabilitytable. Frequencyoffailuresand Cumulative frequency.

Suggested Readings:

1.	CharlesE. Ebeling, *Reliabilityand MaintainabilityEngineering*, McGraw HillInternationalEdition, 1997.
2.	Balaguruswamy, *ReliabilityEngineering*, Tata McGraw HillPublishingCompanyLtd, 1984.
3.	R.N. Allan, *ReliabilityEvaluationofEngineeringSystems*, Pitman Publishing, 1996.
4.	Endrenyi, *ReliabilityModelingin Electric PowerSystems,*JohnWiley&Sons, 1978.

BASICS OF AUTOMOBILE ENGINEERING

OE 611 AE

For the academic years 2020-2024

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. Understand the Working of Fuel, Ignition, and cooling Systems
2. Understand the Working of Lubrication and Electrical Systems.
3. Understand the Working of transmission, Suspension, Steering and Braking Systems
4. To provide broad introduction to Alternative Energy Sources, Euro norms and Bharat Norms

Outcomes:

1. Generalize the different types of automobiles and engine components
2. Differentiate the Fuel system and electrical system
3. Describe and differentiate the Transmission Systems
4. To identify different components and working of Steering, Brakes and Suspension systems
5. Adapt techniques, skills and modern engineering tools necessary to control the pollution

UNIT – I
***Vehicle Structure and Engines*:** Types of Automobiles, Vehicle Construction, Chassis, Frame and Body , Components of Engine , Cooling and Lubrication systems in Engine, Turbo Chargers, Engine Emission Control by 3 Way Catalytic Controller, Electronic Engine Management System.
UNIT – II
Engine Auxiliary Systems:Carburettor working principle, Electronic fuel injection system, single-point and Multi-Point Injection Systems, Electrical systems, Battery, generator, Starting Motor and Lighting and Ignition.
UNIT – III
Transmission Systems-Clutch: *Types* and Construction, Gear Boxes-Manual and Automatic, , Over Drives, Transfer Box Fluid flywheel Torque convertors, Propeller shaft – Slip Joint – Universal Joints, Differential and Rear Axle, Hotchkiss Drive and Torque Tube Drive.
UNIT – IV
Steering, Brakes and Suspension:Wheels and Tires – Wheel Alignment Parameters, Steering Geometry and Types of steering gear box, Power Steering, Types of Front Axle – Suspension systems. Braking Systems, Types and Construction, Antilock Braking System.
UNIT – V
Alternative Energy Sources*:* Use of Natural Gas, LPG, Biodiesel, Gasohol and Hydrogen in Automobiles, Electric and Hybrid Vehicles, Fuel Cells. Euro and Bharat Norms. Recent trends.

Suggested Reading:

1	Crouse & Anglin, 'Automotive Mechanics' Tata McGraw Hill, Publishing Co., Ltd., New Delhi, Tenth edition - 2004.
2	Kirpal Singh, "Automobile Engineering", Vol I & II Standard Publishers, Delhi.
3	Joseph Heitner, 'Automotive Mechanics', Affiliated East West Pvt., Ltd
4	C.P. Nakra, "Basic Automobile Engineering", Dhanpat Rai Publishing Co.(P) Ltd., New Delhi, 2003

INDUSTRIAL ROBOTICS

OE 611ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
*CIE: 30 *marks* *SEE: 70 marks*
Credits: 3

Objectives:

1. To familiarize the student with the anatomy of robot and theirapplications.
2. To provide knowledge about various kinds of end effectorsusage.
3. To equip the students with information about various sensors used in industrialrobots.
4. To make the student understand the importance of spatial transformation of robots using forward and inversekinematics.
5. To specify and provide the knowledge of techniques involved in robot vision inindustry.
6. To equip students with latest robot languages implemented in industrialmanipulators.

Outcomes:

Student will be able to
1. Able to demonstrate knowledge of the relationship between mechanical structures of industrial robots and their operational workspace characteristics and have an understanding of the functionality and limitations of robot actuators andsensors.
2. Able to demonstrate an ability to apply spatial transformation to obtain forward/Inverse kinematics equation of robot manipulators using analytical/numerical/simulationtools.
3. Able to apply knowledge and choose the best & economically suitable sensors/end effectors required for specificapplications.
4. Able to understand the importance of robot vision and apply the learnt techniques to get the required information from inputimages.
5. Able to design and develop a industrial robot for a given purposeeconomically.
6. Appreciate the current state and potential for robotics in new applicationareas.

UNIT – I
Introduction to Robotics: Basic structure of Robots. Degree of freedom of Robots, Work envelope, Classification of Robots based on Drive Technology, Work-Envelope and motion control methods. Application of Robots in Industry, Repeatability, Precision and Accuracy as applied to Robots, Specifications of robots used for various applications. End effectors, Grippers: Mechanical grippers, pneumatic and hydraulic grippers, magnetic grippers, vacuum grippers, RCC grippers, Two fingered and three fingered grippers, internal grippers and external grippers, Selection and design considerations.
UNIT – II
Requirements of a Sensor: Principles and Applications of the following types of sensors- Position of sensors (Piezo electric sensor, LVDT, Resolvers, Optical encoders, Pneumatic position sensors), Range sensors (Triangulation principle, Structured, Lighting approach, Time of flight range finders, Laser range meters), Proximity sensors (Inductive, Hall effect, Capacitive, Ultrasonic and Optical proximity sensors), Touch sensors (Binary sensors, Analog sensors), Wrist Sensors, Compliance Sensors, Slip Sensors.
UNIT – III
Kinematic Analysis of Robots: Rotation matrix. Homogeneous transformation matrix, Denavit&Hartenberg representation, Euler and RPY angles representation. Representation of absolute position and orientation in terms of joint parameters, Direct

Kinematics of manipulators, Inverse kinematics of Robot arm for position and orientation. Redundancy in Robots, Static force analysis
UNIT – IV
Introduction to Techniques used in Robot Vision: Image acquisition, illumination techniques, imaging geometry, basic relationship pixels, preprocessing, segmentation & description of 3- dimensional structures, their recognition and interpretation. Types of Camera, frame grabbing, sensing and digitizing image data, Signal conversion, Image Storage, Lighting techniques, Image processing and analysis, Data reduction, Segmentation, Feature extraction, Object recognition, and various algorithms, Applications, Inspection, identification, visual serving and navigation.
UNIT – V
Robot Programming Languages: Characteristics of robot level languages, task level languages. Teach pendant programming, Lead through programming, Robot programming languages, VAL programming, Motion commands, Sensor commands. End effecter commands, Simple programs. RGV, AGV, Implementation of robots in industries, various steps, Safety considerations for robot operations. Economic analysis of robots, Pay back method, EUAC method and Rate of return method.

Suggested Readings:

1. Groover M P, "Industrial Robotics", McGraw Hill Publications, 1999.
2. Fu. K.S., Gon Zalez R.C., Lee C.S.G. "Robotics, Control-sensing vision and Intelligence", McGraw Hill, Int. Ed., 1987.
3. Spong and Vidyasagar, "Robot Dynamics & Control", John Wiley and Sons, Ed.,1990.
4. Mittal and Nagrath, "Industrial Robotics", Tata McGraw Hill Publications, 2004.
5. Saha&Subirkumarsaha, ‘Robotics’, TMH, India.

SOFT SKILLS AND INTERPERSONAL SKILLS

OE 601 EG

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. Learn conversational skills
2. Learn reading strategies
3. Learn time management
4. Learn stress management
5. Learn career planning

Outcomes:

Student will be able to
1. Express conversational skills
2. Specify reading strategies
3. Perform time management
4. Perform stress management
5. Explore career planning

UNIT – I
Conversation skills, Listening dialogues from TV/radio/Ted talk/Podcast Group discussion Interview skills, Making presentation Listening to Lectures and News Programmes, Listening to Talk show Watching videos on interesting events on Youtube,
UNIT – II
Reading different genres of tests ranging from newspapers to philosophical treatises Readingstrategies – graphic organizers, Readingstrategies – summarizing Readingstrategies – interpretation, Reports Cover letter, Resume,
UNIT – III
Writingfor publications, Letters, Memos, Emails and blogs Civil Service (Language related), Verbal ability Motivation, Self image Goal setting, Managing changes
UNIT – IV

Time management, Stress management Leadership traits Team work Career and life planning.
UNIT – V
Multiple intelligences Emotional intelligence Spiritual quotient (ethics) Interculturalcommunication Creative and critical thinking Learning styles and strategies

Suggested Readings:

1. Business English Certificate Materials, Cambridge University Press.
2. Graded Examinations in Spoken English and Spoken English for Work downloadable materials from Trinity College, London.
3. International English Language Testing System Practice Tests, Cambridge University Press.
4. Interactive Multimedia Programs on Managing Time and Stress.
5. Personality Development (CD-ROM), Times Multimedia, Mumbai.
6. Robert M Sherfield and et al. “Developing Soft Skills” 4th edition, New Delhi: Pearson Education, 2009.

Web Sources:

1. http://www.slideshare.net/rohitjsh/presentation-on-group-discussion
2. http://www.washington.edu/doit/TeamN/present_tips.html
3. http://www.oxforddictionaries.com/words/writing-job-applications
4. http://www.kent.ac.uk/careers/cv/coveringletters.htm
5. http://www.mindtools.com/pages/article/newCDV_34.htm

HUMAN RESOURCE DEVELOPMENT AND ORGANIZATIONAL BEHAVIOR

OE 602MB

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. Understand management process and functions
2. Comprehend decision making and negotiations
3. Learn psychological contract
4. Study the models of organization behaviour
5. Managing stress and counseling

Outcomes:

Student will be able to
1. Explain various facets of management
2. Elaborate on ways of making decision
3. Elucidate different motivation content theories
4. Describe approaches to leadership
5. Suggest methods for stress management and counseling

UNIT – I
Management Process and Functions, Scientific and Modern Management, 3D Model of Managerial Behavior - MBO - MBWA - Line and Staff - The Peter's Principle - Parkinson's Law - Approaches to Organization Structure-Management - Classical, Human Relations, Systems and Contingency Approaches, Hawthorne's Experiments - Human Engineering.
UNIT – II
Decision Making and Negotiations: Approaches to Decision making - Rational, Behavioral, Practical, and Personal Approaches - Open and Closed Models of Decision Making, Types and steps in planning, Authority, Responsibility, Centralization, Decentralization and Recentralization, Bureaucracy.
UNIT – III
Psychological contract - Personality Traits, Big 5 personality traits, MBTI inventory, the Process of Perception - Perceptual distortions and errors, Kelly's personal construct Theory, Motivation-Content Theories: Maslow, Alderfer, Herzberg, McCleland. Process Theories: Vroom, Potter and Lawler, Equity Theory - Goal Theory - Attribution Theory.
UNIT – IV
Models of Organization Behavior - Autocratic, Custodial, Supportive, Collegial and System Models, Transactional Analysis, Johari Window. Group Dynamics: Typology of Groups - Conflicts in groups - The nature, of conflict - Reactions to conflict - A model of conflict. Trait and Behavioral Approaches to Leadership, Managerial Grid, Path-Goal

Theory, Vroom's Decision Tree Approach to Leadership - Hersey and Blanchard Model.
UNIT – V
Organization Design, Organization culture and organization climate, Stress Management and Counseling, Management of change and organization development. Communication - Emerging aspects of OB.

Suggested Readings:

1. Harold Koontz and Heinz Weihrich, *Essentials of Management*, 9th Edition, McGraw Hill Education, 2015.
2. Curtis W. Cook and Phillip L. Hunsaker, *Management and Organizational Behavior,* 3rd Edition, McGraw-Hill,2010.

CYBER LAW AND ETHICS

OE 601 LW

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To familiarize various Cyber laws and IT Acts
2. To give cyber security regulations and forensics
3. To study the risk managements and code of ethics

Outcomes:

Student will be able to
1. Understand the various Cyber laws and IT Acts
2. Learn the cyber security regulations and forensics

3. Analyse the risks and assessment of implications and code of ethics

UNIT – I

Cyber laws and rights in today's digital age: IT Act, Intellectual Property Issues connected with use and management of Digital Data The similar Acts of other countries

Information Warfare*:* Nature of information warfare, including computer crime and information terrorism; Threats to information resources, including military and economic espionage, communications eavesdropping, computer break-ins, denial-of-service, destruction and modification of data, distortion and fabrication of information, forgery, control and disruption of information How, electronic bombs, and sops and perception management.

UNIT – II

Cyberspace and the Law & Cyber Forensics*:* Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy. Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics, Special Techniques for Forensics Auditing

UNIT – III

Legal, Ethical, and Professional Issues in Information Security Ethical Component in Information System, Codes of Ethics, Certification Security Analysis: Risk Management, Identifying and assessing risk, and Controlling Risk.

UNIT – IV

Cyber Security: Organizational Implications: Introduction, cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing.

UNIT – V

Security risks and perils for organizations, social computing and the associated challenges for organizations. Cybercrime and Cyber terrorism: Introduction, intellectual property in the cyberspace, the ethical dimension of cybercrimes the psychology, mindset and skills of hackers and other cyber criminals.

Suggested Readings:

1. Nina GodboleandSunitBelpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley 2017
2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, 2018.

OPERATING SYSTEMS

OE 601 CS

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To understand CPU, Memory, File andDevicemanagement
2. To learn about concurrency control, protectionandsecurity
3. To gain knowledge of Linux and Windows NTinternals

Outcomes:

Student will be able to

1. Explain the components and functions ofoperatingsystems
2. Analyze various Schedulingalgorithms
3. Apply the principles ofconcurrency
4. Compare and contrast various memorymanagementschemes
5. Perform administrative tasks on Linux WindowsSystems

UNIT-I
Introduction to Operating Systems: OS structure and strategies, Process concepts, Threads, Inter process communication. CPU scheduling algorithms, Process synchronization, Critical section problem, Semaphores, Monitors.
UNIT-II
Memory management, Swapping, Contiguous allocation, Paging, Static and Dynamic partitions, Demand paging, Page replacement algorithms, Thrashing, Segmentation, Segmentation with paging. File system interface: File concepts, Access methods and protection. File system implementation: File system structure, Allocation methods, Directory implementation.
UNIT-III
Deadlocks: Necessary conditions, Resource allocation graph, Methods for handling deadlocks, Prevention, Avoidance, Detection and Recovery. Protection: Goals, Domain of protection, Access matrix. Security: Authentication, Threat monitoring,Encryption.
UNIT-IV
Device Management: Disk scheduling methods, Disk management, Device drivers and interfaces, CPU-Device interactions, I/O optimization.
UNIT-V
Case Studies:The Linux System–Design principles, Kernel modules, Process management, Scheduling, Memory management, File systems, Input and Output, Inter process communication Windows NT – General Architecture, The NT kernel, The NT executive.

Suggested Reading:

1.	Abraham Silberschatz, Peter B Galvin, Operating System Concepts, Addison Wesley,2006
2.	William Stallings, Operating Systems-Internals and Design Principles, 5th edition, PHI, 2005
3.	Andrew S Tanenbaum, Modern Operating Systems, 4th edition, Pearson,2016

OOP USING JAVA

OE 602 CS

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To introduce fundamental object oriented concepts of Java programming Language

such as classes, inheritance, packages andinterfaces
2. To introduce concepts of exception handling and multi-threading
3. To use various classes and interfaces in java collection framework and utility classes To understand the concepts of GUI programming using AWT controls
4. To introduce Java I/O streams and serialization

Outcomes:

Student will be able to
1. develop java applications using OO concepts and packages write multi threaded programs with synchronization
2. implement real world applications using java collection frame work and I/O classes
3. write Event driven GUI programs usingAWT/Swing

UNIT – I
Object Oriented System Development*:* understanding object oriented development, understanding object oriented concepts, benefits of object oriented development. ***Java Programming Fundamentals****:* Introduction, overview of Java, data types, variables and arrays, operators, control statements.
UNIT – II
Java Programming OO concepts*:* classes, methods, inheritance, packages and interfaces. Exceptional Handling, Multithreaded Programming
UNIT – III
I/O Basics, Reading Console Input and Output, Reading and Writing Files, Print Writer Class, String Handling Exploring Java.Lang, Collections Overview, Collection Interfaces, Collection Classes, Iterators, Random Access Interface, Maps, Comparators, Arrays, Legacy Classes and Interfaces, String Tokenizer
UNIT – IV
Introducing AWT working With Graphics*:* AWT Classes, Working with Graphics. ***Event Handling****:* Two Event Handling Mechanisms, The Delegation Event Model, Event Classes, Source of Events, Event Listener Interfaces **AWT Controls**: Control Fundamentals, Labels, Using Buttons, Applying Check Boxes, CheckboxGroup, Choice Controls, Using Lists, Managing Scroll Bars, Using TextField, Using TextArea, Understanding Layout Managers, Menu bars and Menus, Dialog Boxes, FileDialog,Handling events by Extending AWT Components, Exploring the controls, Menus and Layout Managers.
UNIT – V
Java I/O Classes and Interfaces, Files, Stream and Byte Classes, Character Streams, Serialization.

Suggested Readings:

1. Herbert Schildt, The Complete Reference JAVA, Tata McGraw Hill, 7thEdition,2005
2. James M Slack, Programming and Problem Solving with JAVA, Thomson learning, 2002
3. C.Thomas Wu, An Introduction to Object-Oriented Programming with Java, Tata McGraw Hill, 5thEdition,2005**.**

DATABASE SYSTEMS

OE 601 IT

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To understand the basic concept of DBMS
2. To learn to design, develop and query the database
3. To learn database administration and transaction processing

Outcomes:

Student will be able to
1. Apply the basic concept of DBMS
2. Design, develop and query the database
3. Develop database administration and transaction processing methods

UNIT – I
Data and Data Management: Role of Data and Databases ***Database and Database Management System:*** Key Database concepts-Basic Database Models-Database Components ***Data Modeling***: Database Design-Relational Database Models- Relationships-Comparing Data Models
UNIT – II
SQL language: SQL features- command basics-SELECT Fundamentals-Operators and Functions-DDL Commands-DML Commands.

Data Access and Manipulation: SELECT statement Advanced Syntax-Joins and Sub Queries. ***SQL Procedures:*** SQL procedures and Functions-Triggers
UNIT – III
Designing a Database: Designing Relational Tables-Comparing Relational Designs-Normalizing Data. ***Implementing a Database:*** Physical Design and Implementation- Adjusting Design to the Real World-Implementing Database Objects.
UNIT – IV
Improving Data Access: Performance Rollbacks-Using Indexes and Views-Using Programmable objects. ***Database Administration:***Need for Administration-Administration Responsibilities-Management Task.
UNIT – V
Transactions and Locking: Transaction Basics-Managing Concurrency control-SQL server transaction management. ***Database Access and Security:*** Database Connections-Managing Access Control-Protecting data.

Suggested Readings:

1. Mark L. Gillenson, Paulraj Ponniah., "*Introduction to Database Management*", John Wiley & Sons Ltd, 2008.
2. Lee Chao, *"Database Development and Management"*, Auerbach Publications, 2006.
3. Rob Coronel, *"Database Systems: Design, Implementation & Management"* Thomson Course Technology, 2000.

DATA STRUCTURES

OE 602IT

Instruction: 3 periods per week *Duration of SEE: 3 hours*
*CIE: 30 *marks* *SEE: 70 marks*
Credits: 3

Objectives:

1. To develop proficiency in the specification, representation, and implementation of abstract data types and data structures.
2. To discuss the linear and non-linear data structures and their applications.
3. To introduce the creation, insertion and deletion operations on binary search trees and balanced binary search trees.
4. To introduce various internal sorting, searching techniques and their time complexities

Outcomes:

Student will be able to
1. Implement linear, non-linear data structures and balanced binary trees
2. Understand the basic data structures arrays and linked lists.
3. Analyse time complexity of both iterative and recursive functions.
4. Define ADT necessary for solving problems based on Stacks and Queues.
5. Develop solutions using binary trees, advanced search trees, tries and graphs.
6. Use hash functions and handle collisions.

UNIT – I
Performance and Complexity Analysis: Space complexity, Time complexity, Asymptotic notation (big-Oh), complexity analysis examples. ***Linear list-array representation:*** vector representation, multiple lists single array. ***Linear list-linked representation:*** singly linked lists, circular lists, doubly linked lists, Applications (polynomial arithmetic). ***Arrays and matrices:*** row and column major representations, special matrices, sparse matrices.
UNIT – II
Stacks: Array representation, linked representation, applications (recursive calls, infix to postfix, postfix evaluation). ***Queues:*** Array representation, linked representation. ***Skip lists and Hashing:*** skip lists representation, hash table representation, application- text compression.
UNIT – III
Trees: Definitions and properties, representation of binary trees, operations, binary tree traversal. ***Binary Search Trees:*** Definitions, and Operations on binary search trees. ***Balanced Search Trees:*** AVL trees, and B-trees.
UNIT – IV
Graphs: Definitions and properties, representation, graph search methods (Depth First Search and Breadth First Search) ***Application of Graphs:*** shortest path algorithm (Dijkstra), minimum spanning tree(Prim's and Kruskal's algorithms).
UNIT – V
Sorting and Complexity Analysis: Selection sort, Insertion sort, Quick sort, Merge sort, Closest pair of points, and Heap sort.

Suggested Readings:

1. Sartaj Sahni, "*Data Structures--Algorithms and Applications in C++*" 2nd Edition, Universities Press (India) Pvt. Ltd., 2005.
2. Mark Allen Weiss, "*Data Structures and Problem Solving using C++*" Pearson Education International, 2003.
3. Michael T. Goodrich, Roberto Tamassia, David M. Mount "*Data Structures and Algorithms in C++*", John Wiley & Sons, 2010.

For the academic years 2020-2024

DISASTER MITIGATION

OE 601 CE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	To impart knowledge of the basic principles of disaster management.
2.	To give knowledge of the various types of disasters.
3.	To understand the disaster management cycle and framework.
4.	To become aware of the disaster management systems in India.
5.	To become aware of the applications of the latest technologies in disaster management

Outcomes:

	After completing this course, the student will be able to
1.	Define and explain the terms and concepts related to disaster management.
2.	Describe the various categories of disasters and their specific characteristics.
3.	Explain the pre-disaster, during disaster and post-disaster measures and framework
4.	Describe the disaster management acts and frameworks specific to India
5.	List and explain the various technological applications to aid disaster management.

UNIT-I

Introduction: Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, and Capacity – Disaster and Development, and disaster management.

UNIT-II

Disasters:Geological Disasters (earthquakes, landslides, tsunami, mining); Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves) Biological Disasters (epidemics, pest attacks, forest fire); Technological Disasters (chemical, industrial, radiological, nuclear) and Manmade Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters) Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters.

UNIT-III

Disaster Management Cycle and Framework:Disaster Management Cycle – Paradigm Shift in Disaster Management Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Microzonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness.

During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation.

Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure –

Early Recovery – Reconstruction and Redevelopment; IDNDR.
UNIT-IV
Disaster Management in India:Disaster Profile of India – Mega Disasters of India and Lessons Learnt Disaster Management Act 2005 – Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national),Non-Government and Inter Governmental Agencies.
UNIT-V
Applications of Science and Technology for Disaster Management**:** Geo-informatics in Disaster Management (RS, GIS, GPS and RS) Disaster Communication System (Early Warning and Its Dissemination) Land Use Planning and Development Regulations Disaster Safe Designs and Constructions Structural and Non-Structural Mitigation of Disasters S&T Institutions for Disaster Management in India.

Suggested Reading:

1.	Rajib, S and Krishna Murthy, R. R, *Disaster Management Global Challenges and Local Solutions"* CRC Press, 2009.
2.	Navele, P & Raja, C. K, *Earth and Atmospheric Disasters Management, Natural and Manmade. B. S. Publications.2009*
3.	Battacharya, T., *Disaster Science and Management*. Tata McGraw hill Company, 2017
4.	Manual on natural disaster management in India, M C Gupta, NIDM, New Delhi
5.	*An overview on natural & man-made disasters and their reduction*, R K Bhandani, CSIR, New Delhi
6.	Encyclopedia of disaster management, Vol I, II and IIIL Disaster management policy and administration, S L Goyal, Deep & Deep, New Delhi, 2006
7.	Disasters in India Studies of grim reality, Anu Kapur& others, 2005, 283 pages, Rawat Publishers, Jaipur
8.	*Disaster Management Act 2005*, Publisher by Govt. of India
9.	*Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management*
10.	National Disaster Management Policy, 2009, Govt. of India
11.	Jagbirsingh, Disaster management–Future challenges and opportunities,

	I.K. International publishing house, 1st edition, 2007.
12.	Coppala P Damon, Introduction to International Disaster management, Butterworth-Heinemann, 2015.

SCHEME OF INSTRUCTION & EXAMINATION
AICTE Model Curriculum
B. E. VII – Semester (MECHANICAL ENGINEERING)
(Proposed for the Academic year 2020-2021)

S. No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in Hours	
Theory Course										
1	HS104ME	Operations Research	3	-	-	3	30	70	3	3
2	PC416ME	Automation in Manufacturing	3	-	-	3	30	70	3	3
3	PE54ME	Professional Elective-IV	3	-	-	3	30	70	3	3
4	PE55ME	Professional Elective-V	3	-	-	3	30	70	3	3
5	OE62	Open Elective-II	3	-	-	3	30	70	3	3
Practical / Laboratory Course										
6	PW702ME	Project –I	-	-	6	6	50			3
Total										**18**

Professional Elective-IV			**Professional Elective-V**		
S. No.	**Course Code**	**Course Title**	**S. No.**	**Course Code**	**Course Title**
1	PE541ME	3D Printing Technology	1	PE551ME	Non- Destructive Testing
2	PE542ME	Robotics Engineering	2	PE552ME	Mechanical Vibrations
3	PE543ME	Refrigeration & Air Conditioning	3	PE553ME	Total Quality Management
4	PE544ME	Tool Design			

Open Elective-II		
S. No.	**Course Code**	**Course Title**
1	OE621ME	Entrepreneurship (Not for Mech. Engg. students)

MC: Mandatory Course **BS**: Basic Science **ES:** Engineering Science
L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)
Note:

1. Each contact hour is a clock hour
2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

OPERATION RESEARCH

HS104ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To use variables for formulating complex mathematical models in management science, industrial engineering and transportation models.
2. To use the basic methodology for the solution of linear programming problems.
3. To understand the mathematical tools that are needed to solve optimization problems like Transportation models and Assignment models.
4. To understand the replacement models with change in money value considering with time and without time.
5. To Model a system as a queuing model and compute important performance measures.

Outcomes:

After completing this course, the student will be able to:
1. To prepare the students to have the knowledge of Linear Programming Problem in Operations Research at the end students would be able to understand the concept and develop the models for different applications.
2. To make students understand the concept Replacement models at the end students would able to explain various features and applications of replacement models in real time scenario.
3. To prepare the students to understand theory of Game in operations research at the end students would able to explain application of Game theory in decision making for a conflict.
4. To prepare the students to have the knowledge of Sequencing model at the end student would able to develop optimum model for job scheduling.
5. To prepare students to understand Queuing theory concepts and various optimization techniques at the end students would able to develop models for waiting line cases.

Unit-I
Introduction: Definition and Scope of Operations Research. ***Linear Programming:*** Introduction, Formulation of linear programming problems, graphical method of solving LP problem, simplex method, maximization and minimization, Degeneracy in LPP, Unbounded and, Infeasible solutions.
Unit-II:
Duality: Definition, Relationship between primal and dual solutions, Economic Interpretation, Post optimal of sensitivity analysis, Dual Simplex Method.
Unit-III
Transportation Models: Finding an initial feasible solution - North West corner method, least cost method, Vogel's Approximation method, Finding the optimal solution, optimal solution by stepping stone and MODI methods, Special cases in Transportation problems - Unbalanced Transportation problem. ***Assignment Problems:*** Hungarian method of Assignment problem, Maximization in Assignment problem, unbalanced problem, problems with restrictions, travelling salesman problems.
Unit-IV
Replacement Models: Introduction, replacement of items that deteriorate ignoring change in money value, replacement of items that deteriorate considering change in money value with time, replacement of items that fail suddenly - Individual replacement policy, Group replacement

policy.

Game Theory: Introduction, 2 person zero sum games, Maximin - Minimax principle, Principle of Dominance, Solution for mixed strategy problems, Graphical method for 2 x n and m x 2 games.

Unit-V

Sequencing Models: Introduction, General assumptions, processing n jobs through 2 machines, processing 'n' jobs through m machines, Processing 2 jobs through m machines

Queuing Theory: Introduction, single channel - Poisson arrivals - exponential service times with infinite population & finite population, Multi channel - poison arrivals - Exponential service times with infinite population.

Introduction to Optimization Techniques: Single objective & Multi objective optimization Techniques like G.A, NSGA, P.Q.O & MPSO Techniques.

Suggested Reading:

1. Hamdy, A. Taha, "*Operations Research-An Introduction*", Sixth Edition, Prentice Hall of India Pvt. Ltd., 1997.
2. S.D. Sharma, "*Operations Research*", Kedarnath, Ramnath & Co., Meerut, 2009.
3. Hrvey M. Wagner, "*Principles of Operations Research*", Second Edition, Prentice Hall of India Ltd., 1980.
4. V.K. Kapoor, "*Operations Research*", S. Chand Publishers, New Delhi, 2004.
5. R. Paneer Selvam, "*Operations Research*", Second Edition, PHI Learning Pvt. Ltd., New Delhi, 2008.
6. Data Reconciliation by Prof. Shanker Narasimha.

AUTOMATION IN MANUFACTURING

PC416ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. To understand the importance of Automation in the field of machine tool based manufacturing.
2. To get the knowledge of various elements of manufacturing automation- like CAD, CAM, NC, CNC, AM, hydraulic & pneumatic controls & FMS.
3. To understand the concepts of product design and role of manufacturing automation.

Outcomes:

1. Understand the importance of automation in the field of machine tool based manufacturing.
2. Understand the various concepts of CAD and Numerical control machines.
3. Understand the concepts of CAM and CNC machining.
4. Understand the concepts of Additive Manufacturing Technologies.
5. To study the concepts of pneumatics & hydraulics systems and controls, and various elements of Flexible Manufacturing System.

Unit-I
Introduction to Automation: Why automation, Current trends, Rigid automation: Part handling, Machine tools, CAD, CAM, CIM: Basic Concepts of CIM: Elements of CIM, Benefits of CIM. Automation principles and strategies. Basic elements of an automated system, levels of automation. Hardware components for automation and process control, PLC: Programmable logic Controllers.
Unit-II:
Computer Aided Design: Fundamentals of CAD - Geometric modeling for downstream applications and analysis methods. Solid Modeling Techniques: Boundary Representation (B-rep) & Constructive Solid Geometry (CSG). Numerical Control of Machine tools, Features and elements of NC, NC Part Programming. Manual and Computer Aided Part Programming for simple components.
Unit-III
Computer Aided Manufacturing: Flexible automation - Computer control of Machine Tools and Machining Centers, CNC technology, Micro-controllers, CNC-Adaptive Control, Direct Numerical Control, Feedback devices and control system.Automated material handling, assembly and Flexible fixturing.
Unit-IV
Introduction to Additive Manufacturing: Need for time compression in product development, Fundamentals of additive manufacturing, AM process chain, Classification of AM processes, advantages, limitations and applications. Distinction between Additive Manufacturing and Conventional Machining processes.
Unit-V
Low cost automation & FMS: Mechanical & Electro mechanical systems, Pneumatics and Hydraulics, Illustrative Examples and case studies.Cellular Manufacturing, Flexible

Manufacturing Systems: What is an FMS, FMS Components, FMS Applications & Benefits, and FMS Planning &Implementation issues.

Suggested Reading:

1. Mikell P. Groover, Automation, Production Systems and Computer-Integrated Manufacturing, Prentice Hall.
2. Serope Kalpakjian and Steven R. Schmid, Manufacturing- Engineering and Technology, 7th Edition, Pearson.
3. CAD CAM principles, practice and Manufacturing Management / Chris Mc Mohan, Jimmie Browne / Pearson edu. (LPE).
4. Chee Kai Chua and Kah Fai Leong , 3D Printing and Additive Manufacturing Principles and Applications, Fifth Edition of Rapid Prototyping, 5th Edition, World Scientific press, 2017.
5. Ibrahim Zeid, CAD/CAM, Theory and Practice, Mc Graw Hill, 1998.

3D PRINTING TECHNOLOGY

PE541ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To understand the fundamental concepts of 3D Printing, its advantages and limitations.
2. To know the working principle, advantages, disadvantages and applications of liquid, solid and Powder based 3D Printing Technologies.
3. To know the various types of STL file errors and other data formats used in 3D Printing Technology.
4. To know the features of various 3D printing software's.
5. To know diversified applications of 3D Printing Technologies.

Outcomes:

On successful completion of this course, the student will be able to
1. Interpret the features of 3D Printing and compare it with conventional methods.
2. Illustrate the working principle of liquid, solid and powder based 3D Printing Technologies.
3. Identify various types of errors in STL file and other data formats used in 3D Printing Technology.
4. Select suitable software used in 3D Printing Technology.
5. Apply the knowledge of various 3D Printing technologies for developing Innovative applications.

Unit-I
Introduction: Prototyping fundamentals: Need for time compression in product development, Historical development, Fundamentals of 3D Printing, 3D Printing Process Chain, Advantages and Limitations of 3D Printing, 3D Printing wheel, Commonly used Terms, Classification of 3D printing processes, Fundamental Automated Processes: Distinction between 3D Printing and Conventional Machining Processes.
Unit-II:
Liquid-based Systems: Stereo Lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Polyjet: Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies ***Solid-based System:*** Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.
Unit-III
Powder Based Systems: Working principle, Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following 3D Printing Technologies like Selective laser sintering (SLS), Selective Laser Melting (SLM) and Direct Metal Laser Sintering (DMLS), Laser Engineered Net Shaping (LENS), Electron Beam Melting (EBM).
Unit-IV
Data Formats & Software: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs, Newly Proposed Formats. Software's Features: Magics, Mimics, Solid View, View Expert, 3 D Rhino, 3 D doctor, Flash Print, Object Studio, Cura, ITK Snap, 3-matic, Simplant, 3-matic, Simplant, MeshLab, Ansys for Additive Manufacturing

Unit-V
Applications of 3D Printing : Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Electronic Industry, Jewellery Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules. Biopolymers, Packaging, Disaster Management, Entertainment and Sports industry.

Suggested Reading:

1. Chee Kai Chua and Kah Fai Leong, "*3D Printing and Additive Manufacturing Principles and Applications*" Fifth Edition, World scientific
2. Ian Gibson, David W Rosen, Brent Stucker, "*Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing*" Springer, Second Edition, 2010.
3. "*Rapid Prototyping & Engineering Applications*"- Frank W.Liou, CRC Press, Taylor & Francis Group, 2011.
4. RafiqNoorani, "*Rapid Prototyping: Principles and Applications in Manufacturing*", John Wiley & Sons, 2006.
5. NPTEL Course on Rapid Manufacturing. https://nptel.ac.in/courses/112/104/112104265/

ROBOTIC ENGINEERING

PE542ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

Students will understand
1. The configuration, work envelop and motion controls and applications
2. Familiarities with the kinematics of robots.
3. Robot end effectors and their design.
4. Familiarities with the dynamics of robots.
5. Robot Programming methods & Languages of robot.
6. Various Sensors and drives and their applications in robots

Outcomes:

At the end of the course, the students will be able to
1. Identify and classify various robot configurations with their workspaces, recognize and find suitable robot for a particular Industrial application considering their Degrees of freedom, type of end effector and other Specifications.
2. Able to use rotation matrices and perform forward kinematic operations. Find Jacobean in velocity domain.
3. Able to perform inverse kinematics and convert a world space problem to joint space problem. Develop dynamical equations for control of robots.
4. Perform trajectory planning and implement independent joint control. Identify suitability of various control methods.
5. Interface various hardware and software components to develop robotic systems for industry& Evaluate their performance

Unit-I
Brief History, Types of robots, Overview of robot subsystems, Robot Joints and its Links, Degrees of freedom of robots, Work space of Robots, accuracy, precision, resolution and repeatability, Robot classification: Based on kinematic configurations, control methods, workspace. Different types of Wrists used in industrial robots. Different types of Robot Drives. End effectors and Grippers, Mechanical, Electrical, vacuum and other methods of gripping. Robots used in various Industrial operations like Material handling, Assembly, Inspection, Welding and Painting. Description and Specifications in each case.
Unit-II:
Rotation matrices, Representation of location and orientation. Euler angle and RPY representation, Homogeneous transformation matrices Denavit-Hartenberg notation, representation of Translation and rotation in terms of joint parameters, Forward kinematics. Velocity Kinematics and Jacobian in Velocity domain.
Unit-III
Inverse Kinematis, inverse location, inverse orientation,inverse velocity, Singular Configuration of robots , Static force analysis of RP type and RR type planar robots, Dynamic analysis using Lagrangian and Newton-Euler formulations of RR and RP type planar robots.

Unit-IV
Trajectory Planning: Joint interpolation,task space interpolation, executing user specified tasks, Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, Computed torque control, force control, hybrid control, neural network based control of manipulator, fuzzy control of manipulator, CNN based control of manipulator.
Unit-V
Sensors: types of sensors, tactile & non tactile sensors, sensors to measure Position, velocity & acceleration , Optical encoders. Range and Proximity sensing, acoustic, pneumatic, Hall effect sensor, Eddy current sensors, Force and Torque sensors. Vision: Image acquisition, types & components of vision system, Image representation, digitisation, binary, gray scale, RGB representation, Image processing, Image segementation, image smoothening, object descriptors, object recognition.

Suggested Reading:

1.	Spong and Vidyasagar, "Robot Dynamics & Control", John Wiley and Sons, Ed.,1990
2.	Mittal and Nagrath, "Industrial Robotics", Tata McGraw Hill Publications, 2004.
3.	Saha&Subirkumar saha, ‘Robotics’, TMH, India.
4.	Asada and Sllotine , ‘Robot analysis and intelligence’ BS Publications , India.
5.	Fu. K.S., GonZalez R.C., Lee C.S.G. "Robotics, Control-sensing vision and Intelligence", McGraw Hill, Int. Ed., 1987.
6.	Groover M.P.,"Industrial Robotics", McGraw Hill Publications, 1999.
7.	Robotics toolbox in MAT LAB.

For the academic years 2020-2024

REFRIGERATION & AIR CONDITIONING

PE543ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. To understand the basic concepts of refrigeration and air conditioning systems.
2. To study the methods of refrigeration for commercial and industrial applications.
3. To study the lower temperature applications: cryogenics by using cascade systems.
4. Solving the problems related to cooling and heating system (HVAC).

Outcomes:

1. Identify various natural and artificial methods of refrigeration. State the importance of refrigerant selection and the environmental issues related to the use of CFCs
2. Formulate equations for different types of refrigerants used in vapour compression refrigeration system. Justify the selection of single or multi stage system based on operating temperature range
3. Explain the working principles of vapour absorption, thermoelectric and steam-jet refrigeration systems. Select a suitable refrigerant absorbent mixture for Vapour absorption refrigeration system
4. Define Psychrometry and its properties. Analyze various problems on psychrometric processes, know the construction and application of Psychrometric chart
5. Able to design an air condoning system based on given inside and outside conditions. Evaluate cooling and heating loads in an air-conditioning system
6. List typical conditions required for various food product processes and List applications of refrigeration and air conditioning

Unit-I
Introduction to Refrigeration: Definition of Refrigeration and Air-conditioning, Necessity of Refrigeration, Methods of Refrigeration, Unit of Refrigeration and C.O.P. Reversed Carnot cycle. Properties of Refrigerants: Survey, Designation, Desirable properties of refrigerants, Thermodynamic, Chemical and Physical properties, Classification of Refrigerants, Ozone depletion & Global warming, Green House Effect and Future of Refrigerants. Air Refrigeration Systems: Analysis of Bell-Coleman Cycle, Open and Dense air system, Application to aircraft refrigeration, Simple cooling system and Bootstrap refrigeration system, Regenerative cooling system and Reduced ambient cooling system.
Unit-II:
Vapour compression system: Working principle and essential components of Simple vapor compression Refrigeration cycle, Compressor, condenser, evaporator, and expansion devices, Analysis of cycle, C.O.P, Representation of the cycle on T-S, P-H and H-S charts. Performance improvement of simple vapour compression refrigeration cycle by means of flash chamber and accumulator Dry and wet compression, Effect of operating conditions like evaporating pressure, condenser pressure, Liquid sub-cooling and Vapor super heating, Performance of the system. Low temperature refrigeration system (with single load system), Compound compression with water inter cooler and Flash intercooler, Cascade refrigeration system-Analysis and advantages
Unit-III
Vapour Absorption Refrigeration System: Simple absorption systems, COP, Practical ammonia absorption refrigeration system, Lithium bromide absorption system, Electrolux refrigerator, Common refrigerants and absorbents properties, Comparison with vapor compression refrigeration system Steam Jet Refrigeration: Principle of working, Analysis of the system, Advantages, limitations and

applications. Non-Conventional Refrigeration Systems: Principle and operation of Thermoelectric Refrigeration Systems, Seebeck effect - Peltier effect - Thomson effect, Analysis, Pulse tube refrigeration system.
Unit-IV
Psychrometry: Psychrometric properties, Psychrometric chart, construction, Representation of Psychrometric processes on the chart. Introduction to Air Conditioning: Requirements of comfort air conditioning, Thermodynamics of human body, Body temperature, Metabolism, Body defense and Human tolerance, Effect of heat on performance, ASHRE comfort chart and Effective temperature.
Unit-V
Cooling Load Calculations in Air Conditioning: Concept of bypass factor, Sensible heat factor, Apparatus Dew Point, Room Sensible Heat Factor (RSHF), Gross Sensible Heat Factor (GSHF), Different heating and cooling loads, Problems. Design of air conditioning systems: All fresh air, Re-circulated air with bypassed air, Design of Summer, winter and Year round air conditioning systems, Energy conservation in air conditioned building, Case study of one building with all load calculations. Air Conditioning Systems: Types, Components of air conditioner equipments, Humidifier, Dehumidifier, Filter, Grills, Fans and Blowers, Duct material, Function of Dampers, Diffusers. Applications of Refrigeration and Air conditioning Food Preservation, Transport air conditioning, and Industrial applications.

Suggested Reading:

1. Arora C.P., "Refrigeration and Air conditioning", Tata McGraw Hill, New Delhi, 2009.
2. Arora, S.C. and Domkundwar, S., "A Course in Refrigeration and Air conditioning", Dhanpat Rai & Sons, New Delhi, 2010.
3. Jain, V.K., "Refrigeration and Air Conditioning", S Chand & Company, New Delhi, 2010.
4. Stocker, W.S., "Refrigeration and Air conditioning ", McGraw Hill, New Delhi, 2009.
5. RK Rajput.,"Refrigeration & Air conditioning", SK Kataria & Sons New Delhi, Third Edition 2015.

TOOL DESIGN

PE544ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

Students will understand
1. Various forces involved in the machining operations
2. heat generation in machining & coolant operation
3. tools, jigs and fixture, suitable for a particular machining operation

Outcomes:

At the end of the course, the students will be able to
1. Calculate the values of various forces involved in the machining operations
2. Design various single and multipoint cutting tools
3. Analyse heat generation in machining & coolant operation
4. Illustrate the properties of various cutting tool materials and hence select an appropriate tool material for particular machining application
5. Identify appropriate combination of tools, jigs and fixture, suitable for a particular machining operation
6. Design assembly of jigs and fixtures on simple work-piece

Unit-I
Metal Cutting : Classification of metal cutting operations, mechanics of metal cutting, tool signature, built up edge formation, mechanism of chip formation, types of chips, oblique and orthogonal cutting - Merchant's force diagram, two component tool dynamometer, Merchant's theory of metal cutting, Lee and Schaffler's theory of metal cutting.
Unit-II:
Tool Wear and Tool Life : Sources of heat in metal cutting, heat dissipation and distribution to chip, tool and work piece, methods of evaluating temperature at tool-chip interface. Machinability, factors affecting machinability, Taylor's tool life equation, crater wear and flank wear, mechanics of tool wear and various types of tool failure. Effects of tool geometry, feed, depth of cut, cutting speed on tool wear.
Unit-III
Cutting Tool Materials: Essential requirements of a tool material, tool materials - HCS, HSS, Cast alloys, Carbides, Ceramic tools, Diamond tool bits. Essential requirements of a good cutting fluid, types of cutting fluids and their relative applications. Economics of machining - introduction, economic tool life, optimal cutting speed to maximum production and maximum profit
Unit-IV
Press Tools : Press tool design - press operations, press working terminology, working of cutting die press operations - strip layout, punching, blanking-center of pressure, drawing and deep drawing, bending dies and forging - forging die design.

Unit-V
Jigs and Fixtures: Design of jigs and fixtures. Locating devices, clamping devices, principles of design of jigs and fixtures, some examples Design of Cutting Tools: Broach design, elements of twist drill, HSS twist drill design, design of rotary milling cutter. Design of single point cutting tool.

Suggested Reading:

1. Donaldson [2001], Tool Design, TMH Publishers, New Delhi.
2. Roy A. Lindberg [2002], Processes and Materials of Manufacture, PHI Publishers, New Delhi.
3. G. R. Nagpal [2004], Tool Engineering & Design, Khanna Publishers, New Delhi.
4. ASTME [1987], Fundamentals of Tool Design, PHI Publishers, New Delhi.
5. Amitha Ghose and Mallik [2004], Manufacturing Science, EWP Publishers, New Delhi.

NON-DESTRUCTIVE TESTING

PE551ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

Student has to understand the
1. Need, basic concepts and technologies of Non-Destructive Testing (NDT)
2. Security precautions from Radiography, protection from radiation and measurement of radiation received by personnel.
3. Technology of acoustic emission (AE), the associated instrumentation and applications
4. Technologies like neutron radiography; laser induced ultrasonics, surface analysis and thermography
5. Merits and demerits of the different NDT Technologies
6. Latest research and developments in NDT

Outcomes:

1. The knowledge of different NDT techniques.
2. Clear understanding of liquid penetrat inspection and magnetic particle inspection.
3. The basics of Eddy Current Testing.
4. View and interpret radiographs, utilize the various principles of radiography for different components of different shapes
5. The knowledge of acoustic emission for NDT and the instrumentation used for NDT
6. The knowledge of latest research, developments and trends in NDT

Unit-I
Liquid Penetrate inspection: Principle of penetrate inspection, characteristics of a penetrate, water washable system, post emulsification system, solvent removable system, surface preparation and cleaning, penetrate application, development, advantages, limitations, and applications. ***Magnetic Particle Inspection:*** Principle, magnetization methods, continuous and residual methods, sensitivities, demagnetization, Advantages, Limitations, and Applications.
Unit-II:
Eddy Current Testing: Principle, lift-off factor, and edge effect, skin effect, inspection frequency, coil arrangements, inspection probes, types of circuits, reference pieces, phase analysis, display methods and applications
Unit-III
Ultrasonic Testing: Generation of ultra sound, Characteristics of an ultrasonic beam, sound wavesat interfaces, sound attenuation, display systems, probe construction, type of display, inspection techniques, identification of defects, immersion testing, sensitivity and calibration. Reference standards, surface conditions, applications
Unit-IV
Radiography: Principle and uses of radiography, limitation principle, radiation sources, production of X-rays, X-ray spectra, attenuation of radiation, shadow formation enlargement and distortion, radiographic film and paper, inspection of simple and complex

shapes, radiation hazard, protection against radiation.
Unit-V
Acoustic Emission: physical principles, sources of emission, instrumentation and applications. ***Other NDT Techniques:*** Neuron radiography, laser induced ultrasonics, surface analysis, and thermography.

Suggested Reading:

1. Barry Hull & Vernon John, '*Non-Destructive Testing'* , 1988.
2. Non-Destructive examination and quality control, ASM International, Vol.17, 9th edition 1989
3. J. Prasad and C.G.K. Nair, Non-Destructive Test and evaluation of materials, Tata McGraw-Hill Education, 2nd edition 2011
4. B. Raj, T. Jayakumar and M. Thavasimuth, Practical Non-Destructive Testing, Alpha Science International Limited, 3rd edition 2002
5. T. Rangachari, J. Prasad and B.N.S. Murthy, Treatise on Non-Destructive Testing and Evaluation, Navbharath enterprises, Vol.3, 1983.

MECHANICAL VIBRATIONS

PE552ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

Student has to understand the
1. Explain the concept of vibrations, with single degree of freedom systems
2. Discuss the numerical methods involved in vibrations
3. Demonstrate the concept of Transient vibrations

Outcomes:

At the end of the course, the students will be able to
1. Find the Natural frequencies of SDoF Systems.
2. Draw the mode shapes.
3. Solve the MDoF Systems
4. Do the Model analysis.
5. Apply the numerical methods to vibration Problems.

Unit-I
Free Vibration of Single Degree of Freedom Systems: Introduction, causes and effects of vibration. Free Vibration of an Undamped Translational System, Equation of Motion using Newton's second law of motion, Equation of motion using other methods, Equation of motion of a spring, mass system in vertical position, solution, Harmonic Motion Free Vibration of an Undamped Torsional System- Equation of motion. Free Vibration with Viscous Damping- Equation of motion.
Unit-II:
Forced Vibration of Single Degree of Freedom Systems: Introduction, Beating Phenomenon. Response of a Damped system under the Harmonic Motion of the base, Force Transmitted, Relative Motion.
Unit-III
Two Degree of Freedom Systems: Introduction, Equations of Motion for forced Vibration, Free Vibration Analysis of and undamped system, Torsional system, Coordinate Coupling and Principal Coordinates, forced Vibration Analysis, Semi definite Systems.
Unit-IV
Multi-degree of Freedom Systems: Introduction Modeling of Continuous systems as Multi-degree of Freedom systems. Equations of motion, Influence Coefficients. Potential and kinetic energy expressions in matrix form, Generalized coordinates and generalized forces, Using Lagrange's equations to derive equations of motion, Equations of motion of undamped systems in matrix form, Eigen value problem, solution of the Eigen value problems – solution of the characteristic equation, orthogonality of normal modes.
Unit-V
Determination of Natural Frequencies and Mode Shapes: Introduction, Dunkerley's formula, Rayleigh's Method- Properties of Rayleigh's Quotient, Computation of the Fundamental Natural Frequency, Fundamental Frequency of Beams and Shafts. Holzer's Method-Torsional systems, Spring Mass Systems. Jacobi method, Standard Eigen value Problems.

Suggested Reading:

1. W T Thomson., "Theory of Vibrations with Applications", CBS Publishers
2. S S Rao, "Mechanical Vibrations", Addison-Wesley Publishing Co.
3. Leonard Meirovitch, "Fundamentals of Vibration", McGraw Hill International Edison.
4. J P Den Hartog, "Mechanical Vibrations", McGraw Hill.
5. Srinivasan, "Mechanical Vibration Analysis", McGraw Hill.
6. Nuno Manuel Mendes Maia et al," Theoretical and Experimental Modal Analysis", Wiley John & sons, 1999

For the academic years 2020-2024

TOTAL QUALITY MANAGEMENT

PE553ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. The essence of total quality management in design and manufacturing a product	
2. The a variety of principles and concepts of total quality management	
3. Over view of total quality management	
4. The various technical tools of quality like control charts ,QFD POKA ,YOKA etc---	
5. To be aware of international/national Quality awards and Quality systems organizing.	

Outcomes:

1. Student gain the knowledge and importance of TQM, types leaderships theories and best practices in TQM and know the Quality environment of the organization , Apply TQM techniques in engineering applications	
2. An over view of Implementation of different types of quality management philosophies and quality circle concept, impact of Taguchi methods in TQM.	
3. Use statistical techniques in TQM.	
4. Application of tools and methods for quality management in TQM.	
5. Concept s of TQM Systems implementation and IS/ISO 90004:2000 discussed .	

Unit-I
Introduction to quality management: Definition and framework of TQM, benefits, awareness and obstacles. Quality statements – vision, mission and policy statements. Customer perception of quality, Translating needs into requirements, Customer retention, cost of quality.
Unit-II:
Quality management philosophies: Overview of the contributions of Deming, Juran Crosby, Masaaki Imai, Feigenbaum, Ishikawa, Taguchi techniques – introduction, loss function, parameter and tolerance design, signal to noise ratio. Concepts of Quality circle.
Unit-III
Statistical process control, capability and Reliability: Meaning and significance of statistical process control (SPC) – construction of control charts for variables and attributes. Process capability – meaning, significance. Reliability– definitions, reliability in series and parallel systems, product life characteristics curve.
Unit-IV
Tools and methods for quality management: Quality functions development (QFD) –House of quality (HOQ), building a HOQ, QFD process. POKA YOKE, Management tools for quality improvement, Juran's improvement programme, Tools for process improvement.
Unit-V
Quality systems organizing and implementation: Introduction to IS/ISO 9004:2000 – quality management systems – guidelines for performance improvements. Quality Audits. TQM culture, Leadership – quality council, employee involvement, motivation, empowerment, recognition and reward.

Suggested Reading:

1. Shridhara Bhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, First Edition 2002.
2. Dale H.Besterfield et al, Total Quality Management, Third edition, Pearson Education (First Indian Reprints 2004).
3. L.Suganthi etal, Total Quality Management, PHI Learning Pvt. Ltd., New Delhi,2012
4. P.N.Mukharjee, Total Quality Management, PHI Learning Pvt. Ltd., New Delhi,2010
5. Sunil Sharma, Total Engineering Quality Management, MacMillan India Ltd, New Delhi, 2003

ENTREPRENEURSHIP

OE621ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. To motivate students to take up entrepreneurship in future
2. To learn nuances of starting an enterprise & project management
3. To understand the design principles of solar energy systems, their utilization and performance evaluation
4. To understand the behavioural aspects of entrepreneurs and time management

Outcomes:

Course Outcomes
At the end of the course, the students will be able to
1. Understand Indian Industrial Environment, Entrepreneurship and Economic growth, Small and Large Scale Industries, Types and forms of enterprises.
2. Identify the characteristics of entrepreneurs, Emergence of first generation entrepreneurs, Conception and evaluation of ideas and their sources.
3. Practice the principles of project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis.
4. Apply the concepts of Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques
5. Understand the Behavioural aspects of entrepreneurs, Time Management, Various approaches oftime management, their strengths and weakness. The urgency addiction and time management matrix.

Unit-I
Indian Industrial Environment-competence, Opportunities and Challenges. Entrepreneurship and Economic growth. Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries. Types of enterprises.
Unit-II:
Identification and characteristics of entrepreneurs. Emergence of First generation entrepreneurs, environmental influence and women entrepreneurs. Conception and evaluation of ideas and their sources. Choice of Technology - Collaborative interaction for Technology development.
Unit-III
Project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis, project financing in India.
Unit-IV
Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques. Human aspects of project management. Assessment of tax burden.
Unit-V

Behavioural aspects of entrepreneurs: Personality - determinants, attributes and models. Leadership concepts and models. Values and attitudes. Motivation aspects. Change behaviour. Time Management: Various approaches of time management, their strengths and weaknesses. The urgency addiction and time management matrix.

Suggested Reading:

1. Vasant Desai, *"Dynamics of Entrepreneurial Development and Management",* Himalaya Publishing House, 1997
2. Prasanna Chandra, *"Project-Planning, Analysis, Selection, Implementation and Review",* Tata McGraw-Hill Publishing Company Ltd. 1995.
3. Stephen R. Covey and A. Roger Merrill, *"First Things First",* Simon and Schuster Publication, 1994.
4. G.S. Sudha, *"Organizational Behaviour",* 1996.
5. Robert D. Hisrich, Michael P. Peters, *"Entrepreneurship",* Tata Me Graw Hill Publishing Company Ltd., 5^{lh} Ed., 2005.

PROJECT-I

PW703ME

Instruction: 6 periods per week *Duration of SEE: -*
CIE: 50 marks *SEE: -*
Credits : 3

Objectives:

1.	To enhance practical and professional skills.
2.	To familiarize tools and techniques of systematic literature survey and documentation
3.	To expose the students to industry practices and team work.
4.	To encourage students to work with innovative and entrepreneurial ideas

Outcomes:

1.	Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to the real-world problems.
2.	Evaluate different solutions based on economic and technical feasibility
3.	Effectively plan a project and confidently perform all aspects of project management
4.	Demonstrate effective written and oral communication skills

The department can initiate the project allotment procedure at the end of VI semester and finalize it in the first two weeks of VII semester.

The department will appoint a project coordinator who will coordinate the following:

- Collection of project topics/ descriptions from faculty members (Problems can also be invited from the industries)
- Grouping of students (max 3 in a group)
- Allotment of project guides

The aim of project work is to develop solutions to realistic problems applying the knowledge and skills obtained in different courses, new technologies and current industry practices. This requires students to understand current problems in their domain and methodologies to solve these problems. To get awareness on current problems and solution techniques, the first 4 weeks of VII semester will be spent on special lectures by faculty members, research scholars, post graduate students of the department and invited lectures by engineers from industries and R&D institutions. After completion of these seminars each group has to formalize the project proposal based on their own ideas or as suggested by the project guide.

Seminar schedule will be prepared by the coordinator for all the students from the 5th week to the last week of the semester which should be strictly adhered to.

Each group will be required to:

1. Submit a one-page synopsis before the seminar for display on notice board.
2. Give a 30 minutes' presentation followed by 10 minutes' discussion.
3. Submit a technical write-up on the talk.

At least two teachers will be associated with the Project Seminar to evaluate students for the award of sessional marks which will be on the basis of performance in all the 3 items stated above.

The seminar presentation should include the following components of the project:

- Problem definition and specification
- Literature survey
- Broad knowledge of available techniques to solve a particular problem.
- Planning of the work, preparation of bar (activity) charts
- Presentation- oral and written.

Open Elective – II		
1	OE603 EE	Non-Conventional Energy Sources (Not for EEE & EIE Students)
2	OE604 EE	Transducers and Sensors (Not for EEE & EIE Students)
3	OE621 AE	Automotive Safety and Ergonomics (Not for Mech./Prod./Automobile Engg. students)
4	OE621 ME	Entrepreneurship (Not for Mech./Prod./Automobile Engg. students)
5	OE602 CE	Green Building Technologies (Not for Civil Engg. Students)
6	OE602 CS	Data Science Using R (Not for CSE Students)
7	OE 603 IT	Cyber Security (Not for IT Students)

NON-CONVENTIONAL ENERGY SOURCES

OE 603 EE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
*CIE: 30 *marks* *SEE: 70 marks*
Credits: 3

Objectives:

1. Toimparttheknowledge ofbasicsofdifferentnon-conventionaltypesofpowergeneration&powerplants
2. To helptheminunderstandingtheneedandroleofNon-Conventional Energysources particularlywhentheconventionalsourcesarescarcein nature

Outcomes:

Student will be able to
1. Understandthedifferentnonconventionalsourcesandthepowergenerationtechniquesto generate electricalpower.
2. UnderstandtheSolarenergypowerdevelopmentanddifferentapplications.
3. Understanddifferentwindenergypowergenerationtechniquesandapplications.
4. Designa prescribedengineeringsub-system.
5. Recognizetheneedandabilityto engagein lifelonglearningforfurtherdevelopmentsin thisfield.

UNIT – I
ReviewofConventionalandNon-Conventionalenergysources -Needfornon-conventionalenergysources. Typesof Non-conventionalenergysources-Fuel Cells-Principleof operationwithspecial referenceto H_2O_2Cell-ClassificationandBlockdiagram offuelcellsystems -Ionexchangemembranecell-Molten carbonatecells-

Solidoxideelectrolytecells-Regenerativesystem-Regenerative FuelCell-Advantages anddisadvantagesofFuelCells-Polarization-ConversionefficiencyandApplicationsofFuelCells.
UNIT – II
Solarenergy-Solarradiationand itsmeasurements-SolarEnergycollectors-SolarEnergystoragesystems-SolarPond-ApplicationofSolarPond-Applicationsofsolarenergy.
UNIT – III
Windenergy-Principlesofwindenergyconversion systems-Natureofwind-PowerintheWind-Basic components ofWECS-ClassificationofWECS-Siteselectionconsiderations -Advantagesand disadvantages ofWECS-Windenergycollectors-Windelectricgeneratingandcontrolsystems-ApplicationsofWindenergy-Environmentalaspects.
UNIT – IV
EnergyfromtheOceans-OceanThermalElectricConversion (OTEC)methods-Principlesoftidalpower generation-Advantages andlimitationsoftidalpowergeneration-Oceanwaves-Waveenergyconversion devices-Advantagesanddisadvantages ofwaveenergy-Geo-ThermalEnergy-TypesofGeo-Thermal EnergySystems-ApplicationsofGeo-ThermalEnergy.
UNIT – V
EnergyfromBiomass-Biomassconversiontechnologies/processes-Photosynthesis -Photosynthetic efficiency-Biogas generation-SelectionofsiteforBiogasplant-Classification ofBiogas plants-Details ofcommonlyusedBiogasplantsinIndia-Advantagesanddisadvantages ofBiogasgeneration-Thermal gasificationofbiomass-Biomassgasifiers.

Suggested Readings:

1. RaiG.D,*Non-ConventionalSourcesofEnergy*,KhandalaPublishers,NewDelhi,1999.
2. M.M.El-Wakil,Power*PlantTechnology*.McGrawHill,1984.

TRANSDUCERS AND SENSORS

OE 604 EE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
*CIE: 30 *marks* *SEE: 70 marks*
Credits: 3

Objectives:

1. To expose the students to various sensors and transducers for measuring mechanical quantities.
2. To understand the specifications of sensors and transducers.
3. To learn the basic conditioning circuits for various sensors and transducers.
4. To introduce advances in sensor technology.

Outcomes:

Student will be able to
1. Familiar with the basics of measurement system and its input, output configuration of measurement system.
2. Familiar with both static and dynamic characteristics of measurement system.
3. Familiar with the principle and working of various sensors and transducers.

UNIT – I
Introduction to measurement system (MS) static characteristics of MS:linearity,

Hysteresis, Threshold, Repeatability, Reliability and maintainability, Span, Calibration. ***Sensor Fundamentals***: Basic sensor technology and sensor system Sensor characteristics, system characteristics, instrument selection, data acquisition and readout, and installation.
UNIT – II
Resistive Transducer: Classification of transducers, Basic requirements of transducers, Variable resistance transducers; Potentiometers, Strain gauge (SG), types of Strain Guage.
UNIT – III
Variable capacitive transducers:Capacitance, Principles, Capacitance displacement transducers, Capacitive hygrometer, and capacitive proximity transducers. ***Variable inductive transducers****:* Linear variable differential transformer, Rotary variable differential transformer.
UNIT – IV
Measurement of temperature*:* Standards for calibration of temp. Temperature measuring devices, types of filled in system thermometers — liquid in glass, vapour pressure, bimetallic on solid rod thermometer Resistance temperature detectors, thermostat thermocouple.
UNIT – V
Advance Sensors:Piezoelectric transducers and their signal conditioning, Seismic transducer and its dynamic response, photoelectric transducers, Hall effect sensors, Digital displacement sensors, Fibre optic sensor, Semiconductor sensor and Smart sensors.

Suggested Readings:

1. C.S.Rangan, G R Sarma& V S N Mani, *Instrumentation Devices and Systems*-TMH, 2nd Edition2004.
2. B.Nakra&Chowdhari, *Instrumentation Measurement and Analysis*, TMH, 2nd Edition 2003.
3. D.V.S.Murthy, *Transducers and Instrumentation*, PHI, 1995 4. John P. Bentley, Principles of Measurement Systems, 3rd Edition, Pearson Education,2000.
4. Doebelin E.O, *Measurement Systems - Application and Design*, 4th Edition, McGraw-Hill, New Delhi.
5. PatranabisD, *Principles of Industrial Instrumentation*, 2nd Edition, Tata McGraw Hill, New Delhi,1997.
6. Jon Wilson *Sensor Technology Handbook*, Newness PublicationElsevier.

AUTOMOTIVE SAFETY AND ERGONOMICS

OE 621AE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
*CIE: 30 *marks* *SEE: 70 marks*
Credits: 3

Objectives:

1. To impart knowledge of automotive safety and ergonomics
2. To understand the basics of vehicle collision and its effects.
3. To understand the various safety concepts used in passenger cars
4. To Gain knowledge about various safeties and its equipment.
5. To understand the concepts of vehicle ergonomics.

Outcomes:

Student will be able to
1. Explain the types and importance of vehicle safety.

2. Describe the various safety equipments used in automobiles.
3. Demonstrate the modern tools used for vehicle safety.
4. Explain the role of automotive ergonomics in automobiles.
5. Demonstrate the best comfort and convenience system in vehicle.

UNIT – I

Introduction:Design of the Body for safety, Energy equations, Engine location, Effects of Deceleration inside passenger compartment, Deceleration on impact with stationary and movable obstacle, Concept of Crumble zone and Safety sandwich construction, Active and passive safety, Characteristics of vehicle structures, Optimization of vehicle structures for crash worthiness, Types of crash / roll over tests, Regulatory requirements for crash testing, instrumentation, High speed photography, image analysis.

UNIT – II

Safety Concepts:Active safety- driving safety, Conditional safety, Perceptibility safety and Operating safety, Passive safety: Exterior safety, Interior safety, Deformation behaviour of vehicle body, Speed and acceleration characteristics of passenger compartment on impact, pedestrian safety, human impact tolerance, determination of injury thresholds, severity index, study of comparative tolerance, Study of crash dummies.

UNIT – III

Safety equipments:Seat belt, automatic seat belt fastening system, Collapsible steering column, tilt-able steering wheel, Air bags, electronic systems for activating air bags, Frontal design for safety, collision warning system, Causes of rear end collision, frontal object detection, rear vehicle object detection system, Object detection system with braking system interactions. Anti-lock braking system ESP and EBD systems

UNIT – IV

Vehicle Ergonomics:Introduction to human body - anthropometrics and its application to vehicle ergonomics, Cockpit design, Driver comfort – seating, visibility, Man-machine system- psychological factors – stress, attention, Passenger comfort - ingress and egress, spaciousness, Ventilation, temperature control, Dust and fume prevention and vibration, Interior features and conveniences, Use of modern technology for the same

UNIT – V

Comfort and Convenience System: Cabin comfort - in-car air conditioning – overall energy efficiency, Air management, central and Unitary systems, air flow circuits, air cleaning, ventilation, air space diffusion, Compact heat exchanger design, controls and instrumentation, Steering and mirror adjustment, central locking system, Garage door opening system, tire pressure control system, rain sensor system, environment information system, Automotive lamps, types, design, construction, performance, Light signalling devices- stop lamp, Rear position lamp, Direction indicator, Reverse lamp, reflex reflector, position lamp, gas discharge lamp, LED, Adoptive front lighting system (AFLS) and Daylight running lamps(DRL).

Suggested Readings:

1. Prasad, Priya and BelwafaJamel, "*Vehicles Crashworthiness and Occupant Protection*", American Iron and Steel Institute,USA.
2. JullianHappian-Smith "*An Introduction to Modern Vehicle Design"* SAE,2002
3. Bosch - "*Automotive Handbook*" - 5th edition - SAE publication -2000.
4. *"Recent development in Automotive Safety Technology*", SAE International Publication. Editor: Daniel J Helt,2013.
5. Keitz H.A.E. "*Light Calculations and Measurements*", Macmillan1971.

ENTREPRENEURSHIP

OE621ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To motivate students to take up entrepreneurship infuture
2. To learn nuances of starting an enterprise & projectmanagement
3. To understand the design principles of solar energy systems, their utilization and performance evaluation
4. To understand the behavioural aspects of entrepreneurs and timemanagement

Outcomes:

At the end of the course, the students will be able to
1. Understand Indian Industrial Environment, Entrepreneurship and Economic growth, Small and Large Scale Industries, Types and forms ofenterprises.
2. Identify the characteristics of entrepreneurs, Emergence of first generation entrepreneurs, Conception and evaluation of ideas and theirsources.
3. Practice the principles of project formulation, Analysis of market demand, Financial and profitability analysis and Technicalanalysis.
4. Apply the concepts of Project Management during construction phase, project organization, project planning and control using CPM, PERTtechniques
5. UnderstandtheBehaviouralaspectsofentrepreneurs,TimeManagement,Variousapproachesofti me management, their strengths and weakness. The urgency addiction and time management matrix.

Unit-I
Indian Industrial Environment-competence, Opportunities and Challenges. Entrepreneurship and Economic growth. Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries. Types of enterprises.
Unit-II:
Identification and characteristics of entrepreneurs. Emergence of First generation entrepreneurs, environmental influence and women entrepreneurs. Conception and evaluation of ideas and their sources. Choice of Technology - Collaborative interaction for Technology development.
Unit-III
Project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis, project financing in India.
Unit-IV
Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques. Human aspects of project management. Assessment of tax burden.
Unit-V
Behavioural aspects of entrepreneurs: Personality - determinants, attributes and models. Leadership concepts and models. Values and attitudes. Motivation aspects. Change behaviour. Time Management: Various approaches of time management, their strengths and weaknesses. The urgency addiction and time managementmatrix.

Suggested Reading:

1. Vasant Desai, *"Dynamics of Entrepreneurial Development and Management",* Himalaya Publishing House,1997
2. Prasanna Chandra, *"Project-Planning, Analysis, Selection, Implementation and Review",*

Tata McGraw-Hill Publishing Company Ltd. 1995.
3. Stephen R. Covey and A. Roger Merrill, *"First Things First",* Simon and Schuster Publication, 1994.
4. G.S. Sudha, *"Organizational Behaviour",*1996.
5. Robert D. Hisrich, Michael P. Peters, *"Entrepreneurship",* Tata Me Graw Hill Publishing Company Ltd., 5^{lh} Ed.,2005.

GREEN BUILDING TECHNOLOGIES

OE 602 CE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
*CIE: 30 *marks* *SEE: 70 marks*
Credits: 3

Objectives:

1. To impart knowledge of the principles behind the green building technologies

2. To know the importance of sustainable use of natural resources and energy.
3. To understand the principles of effective energy and resources management in buildings
4. To bring awareness of the basic criteria in the green building rating systems
5. To understand the methodologies to reduce, recycle and reuse towards sustainability.

Outcomes:

Student will be able to
1. Define a green building, along with its features, benefits and rating systems.
2. Describe the criteria used for site selection and water efficiency methods.
3. Explain the energy efficiency terms and methods used in green building practices.
4. Select materials for sustainable built environment & adopt waste management methods.
5. Describe the methods used to maintain indoor environmental quality.

UNIT – I
***Introduction to Green Buildings*:** Definition of green buildings and sustainable development, typical features of green buildings, benefits of green buildings towards sustainable development. Green building rating systems – GRIHA, IGBC and LEED, overview of the criteria as per these rating systems.
UNIT – II
***Site selection and planning*:** Criteria for site selection, preservation of landscape, soil erosion control, minimizing urban heat island effect, maximize comfort by proper orientation of building facades, day lighting, ventilation, etc.
UNIT – III
Water conservation and efficiency:Rainwater harvesting methods for roof & non-roof, reducing landscape water demand by proper irrigation systems, water efficient plumbing systems, water metering, waste water treatment, recycle and reuse systems. ***Energy Efficiency:*** Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy. ***Methods to reduce operational energy:*** Energy efficient building envelopes, efficient lighting technologies, energy efficient appliances for heating and air-conditioning systems in buildings, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of net zero buildings.
UNIT – IV
Building materials: Methods to reduce embodied energy in building materials: (a) Use of local building materials (b) Use of natural and renewable materials like bamboo, timber, rammed earth, stabilized mud blocks, (c) use of materials with recycled content such as blended cements, pozzolona cements, fly ash bricks, vitrified tiles, materials from agro and industrial waste. (d) reuse of waste and salvaged materials
UNIT – V
Indoor Environmental Quality for Occupant Comfort and Wellbeing: Daylighting, air ventilation, exhaust systems, low VOC paints, materials & adhesives, building

acoustics. Codes related to green buildings: NBC, ECBC, ASHRAE, UPC etc.

Suggested Readings:

1. *IGBC Green Homes Rating System, Version 2.0.*, Abridged reference guide, 2013, Indian Green Building Council Publishers
2. GRIHA version 2015, GRIHA rating system, *Green Rating for Integrated Habitat Assessment*
3. '*Alternative building materials and technologies*' by K.S. Jagadish, B.V. Venkatarama Reddy and K.S. Nanjunda Rao.
4. '*Non-Conventional Energy Resources*' by G. D. Rai, Khanna Publishers.
5. *Sustainable Building Design Manual, Vol.1 and 2*, TERI, New Delhi 2004

DATA SCIENCE USING R

OE 602CS

For the academic years 2020-2024

Instruction: 3 periods per week *Duration of SEE: 3 hours*
*CIE: 30 *marks* *SEE: 70 marks*
Credits: 3

Objectives:

1. To learn basics of R Programming environment: R language, R- studio and R packages.
2. To learn various statistical concepts like linear and logistic regression, cluster analysis, time series forecasting.
3. To learn Decision tree induction, association rule mining and text mining.

Outcomes:

Student will be able to
6. Use various data structures and packages in R for data visualization and summarization.
7. Use linear, non-linear regression models, and classification techniques for data analysis.
8. Use clustering methods including K-means and CURE algorithm

UNIT – I
Introduction To R: Introduction, Downloading and Installing R, IDE and Text Editors, Handling Packages in R. **Getting Started With R:** Introduction, Working with Directory, Data Types In R, Few Commands for Data Exploration. **Loading and Handling Data In R:** Introduction, Challenges of Analytical Data Processing, Expression, Variables, Functions, Missing Values Treatment In R, Using _As' Operator To Change The Structure Of The Data, Victors, Matrices, Factors, List, Few Common Analytical Tasks, Aggregation And Group Processing Of A Variable, Simple Analysis Using R, Methods For Reading Data, Comparison Of R GUI's For Data Input, Using R With Databases And Business Intelligence Systems.
UNIT – II
Exploring Data In R: Introduction, Data Frames, R Functions for Understanding Data in Data Frames, Load Data Frames, Exploring Data, Data Summary, Finding the Missing Values, Invalid Values And Outliers, Descriptive Statistics, Spotting Problems In Data with Visualization.
UNIT – III
Linear Regression Using R: Introduction, Model Fitting, Linear Regression, Assumptions of Linear Regression, Validating Linear Assumption. **Logistic Regression:** Introduction, What Is Regression?, Introduction To Generalized Linear Model, Logistic Regression, Binary Logistic Regression, Diagnosing Logistic Regression, Multinomial Logistic Regression Model.
UNIT – IV
Decision Tree: Introduction, What Is A Decision Tree?, Decision Tree Representation In R, Appropriate Problems For Decision Tree Learning, Basic Decision Tree Learning Algorithm, Measuring Features, Hypothesis Space Search In Decision Tree Learning,

Inductive Bias In Decision Tree Learning, Why Prefer Short Hypotheses, Issues In Decision Tree Learning.

Time Series In R: Introduction, What Is Time Series Data, Reading Time Series Data, Decomposing Time Series Data, Forecasts Using Exponential Smoothing, ARIMA Models.

UNIT – V

Clustering: Introduction, What Is Clustering, Basic Concepts in Clustering, Hierarchical Clustering, K-Means Algorithm, CURE Algorithm, Clustering in Non-Euclidean Space, Clustering for Streams and Parallelism.

Association Rules: Introduction, Frequent Itemset, Data Structure Overview, Mining Algorithm Interfaces, Auxiliary Functions, Sampling from Transaction, Generating Synthetic Transaction Data, Additional Measures of Interestingness, Distance Based Clustering Transaction and Association.

Text Mining: Introduction, Definition of Text Mining, A Few Challenges in Text Mining, Text Mining Verses Data Mining, Text Mining In R, General Architectures of Text Mining Systems, Pre-Processing of Documents In R, Core Text Mining Operations, Using Background Knowledge for Text Mining, Text Mining Query Languages.

Mining Frequent Patterns, Associations and Correlations: Basic Concepts and Methods.

Frequent Itemset, Closed Itemset And Association Rules.

Frequent Itemset: Mining Methods, Pattern Evaluation Methods, Sentiment Analysis**.**

Suggested Readings:

1. Data Analytics using R by Seema Acharya. McGraw Hill education.
2. Practical Data Science with R, Nina Zumel and John Mount, Manning Shelter Island.
3. 'The R book, Crawley, Michael J. John Wiley & Sons, Ltd

CYBER SECURITY

OE 603 IT

Instruction: 3 periods per week *Duration of SEE: 3 hours*
*CIE: 30 *marks* *SEE: 70 marks*
Credits: 3

Objectives:

1. To familiarize various types of cyber-attacks and cyber-crimes
2. To give an overview of the cyber laws
3. To study the defensive techniques against these attacks

Outcomes:

Student will be able to
4. Understand different types of cyber-attacks
5. Understand the types of cybercrimes and cyber laws
6. To protect them self and ultimately the entire Internet community from such attacks

UNIT – I
Introduction to Cyber Security: Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance –Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defense, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., Comprehensive Cyber Security Policy.
UNIT – II
Basic Data Privacy Concepts: Fundamental Concepts, Data Privacy Attacks, Data linking and profiling, privacy policies and their specifications, privacy policy languages, privacy in different domains-medical, financial.
UNIT – III
Logical Design: Blue print for security. Security Policy, standards and Practices, Design of Security Architecture.

Physical Design: Security Technology, Physical Design of Security SDLC Firewalls, Dialup Protection, Intrusion Detection Systems, Scanning and analysis tools, and Content filters.
UNIT – IV
Cryptography: The basic elements of cryptography: symmetric (Symmetric Key-DES, IDEA, and AES), and public key cryptography (Public Key Encryptions-RSA).
UNIT – V
Message digest (MD-5, SHA), and digital signatures. ***SSL and SET:*** SSL and SET protocols, Internet transactions using both SSL and SET.

Suggested Readings:

1. Michael E. Whitman and Herbert J. Mattord, "*Principles of Information Security*", Thomson, 2003.
2. William Stallings, "*Cryptography and Network Security*", Pearson Education, 2000.
3. Nina Godbole, "*Information System Security*", John Wiley & Sons, 2008.

For the academic years 2020-2024

SCHEME OF INSTRUCTION & EXAMINATION
AICTE Model Curriculum
B. E. VIII – Semester (MECHANICAL ENGINEERING)
(Proposed for the Academic year 2020-2021)

S. No	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in Hours	
Theory Course										
1	PE56ME	Professional Elective-VI	3	-	-	3	30	70	3	3
2	OE63	Open Elective-III	3	-	-	3	30	70	3	3
Practical / Laboratory Course										
3	PW703ME	Project-II	-	-	16	16	50	150		8
Total										**14**

Professional Elective-VI		
S. No.	**Course Code**	**Course Title**
1	PE561ME	Energy Conversation & Management
2	PE562ME	Entrepreneurship Development
3	PE563ME	Control Systems Theory
4	PE564ME	Cryogenics

Open Elective-III		
S. No.	**Course Code**	**Course Title**
1.	OE631ME	Mechatronics (Not for Mech Engg students)

MC: Mandatory Course **BS**: Basic Science **ES:** Engineering Science
L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:

1. Each contact hour is a clock hour
2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

ENERGY CONSERVATION AND MANAGEMENT

PE561ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To learn about energy conservation.
2. To understand sources of loss of power in energy conversion.
3. To understand Procedure for Comprehensive Energy Conservation Planning.
4. To understand Industrial energy conservation methods.

Outcomes:

On successful completion of this course, the student will be able to
1. Understand different forms of energy.
2. Calculate the amount of heat energy available.
3. Understand the industry energy conservation modeling.
4. Understand methodology for forecasting industrial energy supply and demand.

Unit-I
Definition, Principles of Energy Conservation - Maximum Thermodynamic efficiency. Maximum Cost - effectiveness in energy use. Various forms of energy - Heat Mechanical. Electrical energy and Chemical energy. Identification of potential sources of energy losses - Transportation, operation and conversion from one from to another.
Unit-II:
Heat energy and storage - Media of transport of heat energy - steam, oil and flue gases. Calculation of steam quality. Calculation of amount of heat energy available. Recuperators. Constructional details, Selection of materials to store heat energy. Concept of power. Modes of mechanical energy transport - Gears, pulleys, belts, shafts etc., Calculation of power. Sources of loss of power in energy conversion into electricity, potential energy (i.e., pumps).
Unit-III
Chemical energy - combustion of fuels - petrol, diesel and coal. Loss due to quality of fuel, conversion into other form of energy - boilers, I.C. engines. Calculation related to losses. Electrical energy - Working principle of motors and generators. Calculation of efficiency of generators. Losses during transmission and energy conversion - into mechanical energy, thermal energy. Calculation of effecting parameters.
Unit-IV
Procedure for Comprehensive Energy Conservation Planning (CECP) -Specifying targets, identifying energy in-efficient facilities. Synthesize evaluation and optimization of alternative conservation measures in view of organization costs. Flow chart of organization's functions. Collection of accountable data. Application of CECP method. An example.
Unit-V
Industrial energy conservation modeling - Methodology - Definition of production system - A primary copper production system, Model construction - Mathematical Programming. Market penetration, Structure of energy conservation model. Data preparation - coefficients needed in a model, Unit production cost and unit energy requirements. Model exercise, verification and

validation. Methodology for forecasting Industrial Energy Supply and Demand.

Suggested Reading:

1. Gottschalk C.M., "*Industrial Energy Conservation*", John Wiley & Sons, 1996.
2. Chaturvedi P., and Joshi S., "*Strategy for Energy Conservation in India*", Concept PublishingCo., New Delhi, 1997.
3. Sharna and Venkata Sebhaiah, "Energy *management and conservation*".
4. Dr. Sanjeevsingh, Umesh Rathore, "*Energy management*", Edition 2019.
5. Mrs. P Nagaveni, Dr. A Amudha, Dr. M.Sivaramkumar and Mr. N. Prasanna, "*Energy management and Energy conservation*".

ENTREPRENEURSHIP DEVELOPMENT

PE562ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To motivate students to take up entrepreneurship in future.
2. To learn nuances of starting an enterprise & project management.
3. To understand the design principles of solar energy systems, their utilization and performance evaluation.
4. To understand the behavioral aspects of entrepreneurs and time management.

Outcomes:

1. Understand Indian Industrial Environment, Entrepreneurship and Economic growth, Small and Large Scale Industries, Types and forms of enterprises.
2. Identify the characteristics of entrepreneurs, Emergence of first generation entrepreneurs, Conception and evaluation of ideas and their sources.
3. Practice the principles of project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis.
4. Apply the concepts of Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques.
5. Understand the Behavioural aspects of entrepreneurs, Time Management, Various approaches of time management, their strengths and weakness. The urgency addiction and time management matrix.

Unit-I
Indian Industrial Environment-competence, Opportunities and Challenges. Entrepreneurship and Economic growth. Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries. Types of enterprises.
Unit-II:
Identification and characteristics of entrepreneurs. Emergence of First generation entrepreneurs, environmental influence and women entrepreneurs. Conception and evaluation of ideas and their sources. Choice of Technology - Collaborative interaction for Technology development.
Unit-III
Project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis, project financing in India.
Unit-IV
Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques. Human aspects of project management. Assessment of tax burden.
Unit-V
Behavioural aspects of entrepreneurs: Personality - determinants, attributes and models. Leadership concepts and models. Values and attitudes. Motivation aspects. Change behaviour. Time Management: Various approaches of time management, their strengths and weaknesses. The urgency addiction and time management matrix.

Suggested Reading:

1. Vasant Desai, "*Dynamics of Entrepreneurial Development and Management*", Himalaya Publishing House, 1997.
2. Prasanna Chandra, "*Project-Planning, Analysis, Selection, Implementation and Review*", Tata McGraw-Hill Publishing Company Ltd. 1995.
3. Stephen R. Covey and A. Roger Merrill, "*First Things First*", Simon and Schuster Publication, 1994.
4. G.S. Sudha, "*Organizational Behaviour*", 1996.
5. Robert D. Hisrich, Michael P. Peters, "*Entrepreneurship*", Tata Me Graw Hill Publishing Company Ltd., 5lh Ed., 2005.

CONTROL SYSTEMS THEORY

PE563ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

1. To know the development of input-output relations using block diagrams, signal flow graphs of mechanical, electromechanical systems etc and methods of obtaining time and frequency response.
2. To understand the stability and margins for stability from characteristics equation, root-locus method or frequency methods.
3. To know the development of the alternative state space models of dynamic systems, and their importance in predicting time response of multiple variables of the system.

Outcomes:

1. Derive the transfer function of mechanical, electrical, hydraulic and thermal systems.
2. Evaluate the time response of I and II order systems for various input signals.
3. Sketch the Bode, Polar and Root locus plots to check the stability of the system.
4. Sketch the Nyquist plot and design the Lead & Lag compensators to meet the requirements.
5. Develop the State space model of a system, check for its Controllability & Observability.

Unit-I
Control Systems Classification: Open Loop & Closed Loop Systems. Mathematical models and Transfer functions from governing equations of mechanical, electrical, hydraulic, pneumatic, thermal systems AC, DC servomotors & Electromechanical servo systems
Unit-II:
Block Diagrams-Block diagram reduction. Signal flow graphs, Mason's gain formula. Transient response Time domain specifications of 1st and 2nd order systems Steady state error, Error coefficients, and sensitivity Performance indices Routh criteria
Unit-III
Routh criteria- Root Locus method Frequency Response: Bode, Polar plots. Correlation between transient and frequency response, Bandwidth, Experimental determination of transfer functions
Unit-IV
Nyquist criteria - Gain and phase margins, Lead. Lag and Lead-lag compensator design, PID controller, linearization of Non linear systems.
Unit-V
State - Space Representation of Linear Control Systems: State transition matrix. Solution of state equations: Zero input response and Zero state response. Concept of controllability and observability

Suggested Reading:

1. Dorf, R.C., *Modern Control Systems, Addison*-Wesley 1989.
2. M. Gopal, *Con tori Systems*, Tata McGraw Hill, 2004.
3. Ogata, K., *Modern Control Engineering,* Prentice Hall, 2004.
4. Norman S. Nise, *Control Systems Engineering*, John Wiley & Sons, Inc., 2001.

CRYOGENICS

PE564ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. Learning the mechanical properties, methods to protect the cryogenic fluids.
2. To describe liquefaction system for Neon, Hydrogen and Helium.
3. To explain the cryogenic gas separation and purification system.
4. To explain the cryogenic refrigeration systems.
5. To embark on a research career in Cryogenic Engineering.

Outcomes:

1. List the applications of cryogenic systems.
2. Understand the principles of cryogenics engineering.
3. Analyse the performance of cryogenics gas liquefaction system.
4. Analyse performance of cryogenics gas separation and purification system.
5. Evaluate material properties at cryogenic temperature.
6. Design the cryogenic storage system & cryo coolers.

Unit-I
Introduction to Cryogenic Systems: Mechanical Properties at low temperatures. Properties of Cryogenic Fluids. Gas Liquefaction: Minimum work for liquefaction. Methods to protect low temperature. Liquefaction systems for gages other than Neon. Hydrogen and Helium.
Unit-II:
Liquefaction Systems for Neon, Hydrogen and Helium: Components of Liquefaction systems. Heat exchangers. Compressors and expanders. Expansion valve, Losses in real machines.
Unit-III
Gas Separation and Purification Systems: Properties of mixtures, Principles of mixtures, Principles of gas separation, Air separation systems.
Unit-IV
Cryogenic Refrigeration Systems: Working Medium, Solids, Liquids, Gases, Cryogenic fluid storage & transfer, Cryogenic storage systems, Insulation, Fluid transfer mechanisms, Cryostat, Cryo Coolers.
Unit-V
Applications: Space technology, In-Flight air separation and collection of LOX, Gas industry, Biology, Medicine, Electronics.

Suggested Reading:

1. Cryogenic Systems/ R.F. Barren/ Oxford University Press.
2. Cryogenic Engineering- Thomas Flynn- CRC Press-2nd Edition.
3. Cryogenic Research and Applications: Marshal Sitting/ Von Nostrand/ Inc. New Jersey.
4. Cryogenic Heat Transfer/ R.F.Baron.

5. Cryogenic Engineering Edit / B.A. Hands/ Academic Press, 1986.
6. Cryogenic Engineering/ R.B. Scottm Vin Nostrand/ Inc. New Jersey, 1959.

MECHATRONICS

OE631ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Objectives:

Student has to understand the
1. How to identify, formulate, and solve engineering problems
2. The design a system, component, or process to meet desired needs within realistic constraints
3. The how to use the techniques, skills, and modern engineering tools necessary for engineering practice
4. The use of drive mechanisms and fluid power systems
5. The use of industrial electronic devices
6. The demonstrate the design of modern CNC machines, and Mechatronics elements

Outcomes:

At the end of the course, the students will be able to
1. Model and analyse electrical and mechanical systems and their interconnection
2. Integrate mechanical, electronics, control and computer engineering in the design of Mechatronics systems
3. Do the complete design, building, interfacing and actuation of a Mechatronics system for a set of specifications
4. Be proficient in the use of fluid power systems in various Mechatronics applications
5. Demonstrate the use of industrial electronic devices
6. Demonstrate the design of modern CNC machines, and Mechatronics elements

Unit-I
Introduction to mechanization & automation: Need of interface of electrical & electronic devices with mechanical elements, the concept of Mechatronics, Flow chart of Mechatronics system, elements of Mechatronics system, drive mechanisms, actuators, feedback devices and control system, application in industries and systems development
Unit-II:
Drive mechanisms: Feeding and indexing, orientation, escapement and sorting devices, conveyor systems Introduction to electrical actuators: A.C. servomotors, D.C. servomotors, stepper motors
Unit-III
Introduction to fluid power systems: Industrial Pneumatics and hydraulics, merits of fluid power, pneumatic & hydraulic elements symbols, study of hydraulic control valves, pumps & accessories, hydraulic circuits & mechanical servo control circuits, Electro-hydraulic and Hydro pneumatic circuits
Unit-IV
Introduction to industrial electronic devices: Diodes, Transistors, Silicon Controlled

Rectifiers (SCR), Integrated Circuits (IC), Digital Circuits, Measurement systems & Data acquisition systems: sensors, digital to analog and analog-to-digital conversion, signal processing using operational amplifiers, introduction to microprocessor & micro controller, Temperature measurement interface and LVDT interface, Systems response
Unit-V
Design of modern CNC machines and Mechatronics elements: machine structures, guide ways, spindles, tool monitoring systems, adaptive control systems, Flexible manufacturing systems, Multipurpose control machines, PLC programming

Suggested Reading:

1. William Bolton, Mechatronics: Electronic control systems in mechanical and electrical engineering, 6th edition, Pearson Education
2. HMT Ltd, Mechatronics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998
3. Michaels Histand & David G, Alciatore, Introduction to Mechatronics and Measurement Systems, Tata McGraw-Hill International Edition
4. Devdas Shetty, Richard A. Kolk, Mechatronics System Design, Cengage Learning
5. S.R. Majumdar, Oil Hydraulic Systems – Principles & Maintenance, McGraw-Hill Publishing Company Limited, New Delhi
6. Godfrey Onwubolu, Mechatronics: Principles and Applications, Butterworth-Heinemann

PROJECT WORK-II

PW704ME

Instruction: 16 periods per week *Duration of SEE: 3 hours*
CIE: 50 marks *SEE: 150marks*
Credits : 8

Objectives:

1. To enhance practical and professional skills.
2. To familiarize tools and techniques of systematic literature survey and documentation
3. To expose the students to industry practices and team work.
4. To encourage students to work with innovative and entrepreneurial ideas

Outcomes:

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to the real-world problems.
2. Evaluate different solutions based on economic and technical feasibility
3. Effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills

The aim of Project work –II is to implement and evaluate the proposal made as part of Project Work - I. Students can also be encouraged to do full time internship as part of project work-II based on the common guidelines for all the departments. The students placed in internships need to write the new proposal in consultation with industry coordinator and project guide within two weeks from the commencement of instruction.

The department will appoint a project coordinator who will coordinate the following:

1. Re-grouping of students - deletion of internship candidates from groups made as part of project Work-I
2. Re-Allotment of internship students to project guides
3. Project monitoring at regular intervals

All re-grouping/re-allotment has to be completed by the 1st week of VIII semester so that students get sufficient time for completion of the project.

All projects (internship and departmental) will be monitored at least twice in a semester through student presentation for the award of sessional marks. Sessional marks are awarded by a monitoring committee comprising of faculty members as well as by the supervisor. The first review of projects for25 marks can be conducted after completion of five weeks. The second review for another 25 marks can be conducted after 12 weeks of instruction.

Common norms will be established for the final documentation of the project report by the respective departments. The students are required to submit draft copies of their project report within one week after completion of instruction.

Note: Three periods of contact load will be assigned to each project guide.

Open Elective – III		
1	OE605 EE	Smart Building Systems (Not for EEE & EIE Students)
2	OE606 EE	Programmable Logic Controllers (Not for EEE & EIE Students)
3	OE631 AE	Automotive Maintenance (Not for Mech./Prod./Automobile Engg. students)
4	OE631 ME	Mechatronics (Not for Mech./Prod./Automobile Engg. students)
5	OE603 CE	Road Safety Engineering (Not for Civil Engg. Students)
6	OE604 IT	Software Engineering (Not for IT Students)

SMART BUILDING SYSTEMS

OE605EE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
*CIE: 30 *marks* *SEE: 70 marks*
Credits: 3

Objectives:

1. To understand the basic blocks of Building Management System.
2. To design various sub systems (or modular system) of building automation
3. To integrate all the sub systems

Outcomes:

Student will be able to
1. Describe the basic blocks and systems for building automation
2. Use different subsystems for building automation and integrate them
3. Understand basic blocks and systems for building automation
4. Design different systems for building automation and integrate those systems

UNIT – I
Introduction: Concept and application of Building Management System (BMS) and Automation, requirements and design considerations and its effect on functional efficiency of building automation system, architecture and components of BMS.
UNIT – II
Fire Alarm (FA) System: concept of fire, Fire modes, History, Components, and Principles of Operation. Different fire sensors, smoke detectors and their types, Fire control panels, design considerations for the FA system. Field Components, Panel Components, Applications. Types of FAS Architectures, Examples. Classification of FAS loops, Examples. FAS Design procedure in brief, NFPA 72A, BS 5839, IS, Concept of IP enabled fire & alarm system, design aspects and components of PA system.
UNIT – III
Access Control System: Access Components, Access control system Design. **CCTV:** Camera Operation & types, Camera Selection Criteria, Camera Applications, DVR Based system, DVM, Network design, Storage design. Components of CCTV system like cameras, types of lenses, typical types of cables, controlling system. CCTV Applications.
UNIT – IV
Security Systems Fundamentals: Introduction to Security Systems, Concepts. **Perimeter Intrusion:** Concept, Components, Technology, Advanced Applications. Security system design for verticals. concept of automation in access control system for safety, Physical security system with components, RFID enabled access control with components, Computer system access control –DAC, MAC, RBAC. **EPBX System & BMS subsystem integration:** Design consideration of EPBX system

and its components, integration of all the above systems to design BMS.
UNIT – V
Energy Management: Energy Savings concept & methods, Lighting control, Building Efficiency improvement, Green Building (LEED) Concept & Examples. **Building Management System:** IBMS (HVAC, Fire &Securi-ty) project cycle, Project steps BMS, Advantages & Applications of BMS, IBMS Architecture, Normal & Emergency operation, Advantages of BMS.

Suggested Readings:

1. Jim Sinopoli, *Smart Buildings,* Butterworth-Heinemann imprint of Elsevier,2nd ed., 2010.
2. Reinhold A. Carlson, Robert A. Di Giandomenico, *Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life Safety, Security, Access Control, Lighting, Building Management Programs),* R.S. Means Company Publishing, 1991.
3. Albert Ting-Pat So, WaiLok Chan, Kluwer, *Intelligent Building Systems*, Academic publisher,3rd ed., 2012.
4. Robert Gagnon, *Design of Special Hazards and Fire Alarm Systems*, Thomson Delmar Learning; 2nd edition, 2007.
5. Levenhagen, John I.Spethmann, Donald H, *HVAC Controls and Systems*, McGraw-Hill Pub.
6. Hordeski, Michael F, *HVAC Control in the New Millennium*, Fairmont press, 2001.
7. Bela G. Liptak, *Process Control-Instrument Engineers Handbook*, Chilton book co.

For the academic years 2020-2024

PROGRAMMABLE LOGIC CONTROLLERS

OE606EE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
*CIE: 30 *marks* *SEE: 70 marks*
Credits: 3

Objectives:

1. To be able to understand basics of Programmable logic controllers, basic programming of PLC.
2. To make the students to understand the Functions and applications of PLC

Outcomes:

Student will be able to
1. Develop PLC programs for industrial applications.
2. Acquire the knowledge of PLC counter functions and PLC Arithmetic functions and data handling functions.

UNIT – I
PLC Basics: Definition and History of PLC - PLC advantages and disadvantages - Over all PLC Systems - CPUs and Programmer Monitors - PLC input and output models - Printing PLC Information- Programming Procedures - Programming Equipment - Programming Formats- Proper Construction of PLC Diagrams - Devices to which PLC input and output modules are connected - Input on/off switching devices - Input analog devices - Output analog on/off devices and output analog devices.
UNIT – II
Basic PLC Programming: Programming on/off inputs to produce on/off outputs - PLC input instructions - Outputs - Operational procedures - Contact and coil input/output programming examples - Relation of digital gate logic contact / coil logic - PLC programming and conversion examples - Creating ladder diagrams from process control descriptions - Sequence listings - Large process ladder diagram constructions.
UNIT – III
Basic PLC Functions: General Characteristics of Registers - Module addressing - Holding registers - Input registers - output registers - PLC timer functions - examples of timer functions. Industrial applications - PLC counter functions.
UNIT – IV
Intermediate Functions: PLC Arithmetic functions - PLC additions and subtractions - The PLC repetitive clock - PLC Multiplications, Division and Square Root - PLC trigonometric and log functions - Other PLC arithmetic functions - PLC number comparison functions. PLC basic comparison functions and applications - Numbering systems and number conversion functions - PLC conversion between decimal and BCD-Hexadecimals numbering systems.
UNIT – V
Data Handling Functions: The PLC skip and master control relay functions - Jump functions - Jump with non return - Jump with return. PLC data move Systems - The PLC functions and applications. PLC functions working with bits - PLC digital bit functions and applications - PLC sequence functions - PLC matrix functions.

Suggested Readings:

1. John W. Weff, Ronald A. Reis, Programmable Logic Controllers, Prentice Hall of India Private Limited, Fifth edition, 2003.
2. Frank D. Petruzella, *Programmable Logic Controllers*, 5th Edition, Mc-Graw Hill, 2019.

For the academic years 2020-2024

AUTOMOTIVE MAINTENANCE

OE 631AE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
*CIE: 30 *marks* *SEE: 70 marks*
Credits: 3

Objectives:

1. To study basic types of vehicle maintenance along with its importance
2. To understand the trouble diagnosis procedure for electrical and electronic systems in automobiles
3. To acquaint with various Trouble shooting, fault tracing practices available in automobile industry
4. To understand the maintenance procedure for air-conditioning in automobiles.

Outcomes:

Student will be able to
1. Demonstrate the maintenance procedure for automotive Engine.
2. Illustrate the trouble diagnosis procedure for electrical systems like Battery, Starting Systems
3. Identify the trouble diagnosis procedure for steering and suspension system
4. Illustrate trouble diagnosis procedure for lubrication and fuel delivery system etc.
5. Explain trouble diagnosis procedure for heating system of automobile.

UNIT – I

Maintenance, Workshop Practices, Safety and Tools: Maintenance – Need, importance, primary and secondary functions, policies - classification of maintenance work - vehicle insurance - basic problem diagnosis.

vehicles, fire safety - First aid. Basic tools –Scheduled maintenance services – service intervals - Towing and recovering.

UNIT – II

Engine and Engine Subsystem Maintenance: introduction engine IC Engine General Engine service- cooling and lubricating system, fuel system, Intake and Exhaust system, electrical system - Electronic fuel injection and engine management. **S**ervice - fault diagnosis- servicing emission controls.

UNIT – III

Transmission and Driveline Maintenance: Clutch- general checks, adjustment and service- road testing, Rear axle service points- removing axle shaft and bearings- servicing differential assemblies- fault diagnosis.

UNIT – IV

Steering, Brake, Suspension and Wheel Maintenance: *Inspection*, Maintenance and Service of Hydraulic brake, Drum brake, Disc brake, Parking brake. Bleeding of brakes. Inspection, Maintenance and Service of Mc person strut, coil spring, leaf spring, shock absorbers. Wheel alignment and balance, removing and fitting of tyres, tyre wear and tyre rotation. Inspection, Maintenance and Service of steering linkage.

UNIT – V
***Auto Electrical and Air Conditioning Maintenance*:** Maintenance of batteries, starting system, charging system and body electrical -Fault diagnosis using Scan tools. Maintenance of air conditioning parts like compressor, condenser, expansion valve, evaporator - Vehicle body repair like panel beating, tinkering, soldering, polishing, painting.

Suggested Readings:

1. Ed May, "*Automotive Mechanics Volume One*", McGraw Hill Publications, 2003.
2. Ed May, "*Automotive Mechanics Volume Two*", McGraw Hill Publications, 2003
3. *Vehicle Service Manuals of reputed manufacturers*
4. *Bosch Automotive Handbook*, Sixth Edition, 2004

MECHATRONICS

OE 631ME

Instruction: 3 periods per week *Duration of SEE: 3 hours*
*CIE: 30 *marks* *SEE: 70 marks*
Credits: 3

Objectives:

Student has to understand the
1. How to identify, formulate, and solve engineeringproblems
2. The design a system, component, or process to meet desired needs within realisticconstraints
3. The how to use the techniques, skills, and modern engineering tools necessary for engineering practice
4. The use of drive mechanisms and fluid powersystems
5. The use of industrial electronicdevices
6. The demonstrate the design of modern CNC machines, and Mechatronicselements

Outcomes:

At the end of the course, the students will be able to
1. Model and analyse electrical and mechanical systems and theirinterconnection
2. Integrate mechanical, electronics, control and computer engineering in the design of Mechatronics systems
3. Do the complete design, building, interfacing and actuation of a Mechatronics system for a set of specifications
4. Be proficient in the use of fluid power systems in various Mechatronicsapplications
5. Demonstrate the use of industrial electronicdevices
6. Demonstrate the design of modern CNC machines, and Mechatronicselements

Unit-I
Introduction to mechanization & automation: Need of interface of electrical & electronic devices with mechanical elements, the concept of Mechatronics, Flow chart of Mechatronics system, elements of Mechatronics system, drive mechanisms, actuators, feedback devices and control system, application in industries and systems development
Unit-II:
Drive mechanisms: Feeding and indexing, orientation, escapement and sorting devices, conveyor systems Introduction to electrical actuators: A.C. servomotors, D.C. servomotors, stepper motors
Unit-III
Introduction to fluid power systems: Industrial Pneumatics and hydraulics, merits of fluid power, pneumatic & hydraulic elements symbols, study of hydraulic control valves, pumps & accessories, hydraulic circuits & mechanical servo control circuits, Electro-hydraulic and Hydro pneumatic circuits
Unit-IV
Introduction to industrial electronic devices: Diodes, Transistors, Silicon Controlled Rectifiers (SCR), Integrated Circuits (IC), Digital Circuits, Measurement systems & Data acquisition systems: sensors, digital to analog and analog-to-digital conversion, signal processing using operational amplifiers, introduction to microprocessor & micro controller, Temperature measurement interface and LVDT interface, Systems response
Unit-V
Design of modern CNC machines and Mechatronics elements: machine structures, guide ways, spindles, tool monitoring systems, adaptive control systems, Flexible manufacturing systems, Multipurpose control machines, PLCprogramming

Suggested Reading:

1. William Bolton, Mechatronics: Electronic control systems in mechanical and electrical

	engineering, 6th edition, PearsonEducation
2.	HMT Ltd, Mechatronics, Tata McGraw-Hill Publishing Company Limited, New Delhi,1998
3.	Michaels Histand& David G, Alciatore, Introduction to Mechatronics and Measurement Systems, Tata McGraw-Hill InternationalEdition
4.	Devdas Shetty, Richard A. Kolk, Mechatronics System Design, CengageLearning
5.	S.R. Majumdar, Oil Hydraulic Systems – Principles & Maintenance, McGraw-Hill Publishing Company Limited, NewDelhi
6.	Godfrey Onwubolu, Mechatronics: Principles and Applications,Butterworth-Heinemann

For the academic years 2020-2024

ROAD SAFETY ENGINEERING

OE 603 CE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
*CIE: 30 *marks* *SEE: 70 marks*
Credits: 3

Objectives:

1. Introduction to various factors considered for road safety and management
2. Explain the road safety appurtenances and design elements
3. Discuss the various traffic management techniques

Outcomes:

Student will be able to
1. Understand the fundamentals of traffic safety analysis
2. Analyze Accident data
3. Remember the concepts of road safety in urban transport
4. Apply crash reduction techniques
5. Design of urban Infrastructure considering safety aspects.

UNIT – I
Introduction: Road Safety scenario in India and World, Road Accident Characteristics. ***Traffic Safety Analysis:*** Fundamentals of Traffic Engineering - Basic Characteristics of Motor-Vehicle Traffic, Highway Capacity, Applications of Traffic Control Devices, Design of Parking Facilities, Traffic Engineering Studies; Statistical Methods in Traffic Safety Analysis – Regression Methods, Poisson Distribution, Chi- Squared Distribution, Statistical Comparisons.
UNIT – II
Accident Analysis: Accident Investigations and Risk Management, Collection and Analysis of Accident Data, Condition and Collision Diagram, Causes and Remedies, Traffic Management Measures and Their Influence on Accident Prevention, Assessment of Road Safety, Methods to Identify and Prioritize Hazardous Locations and Elements, Determine Possible Causes of Crashes, Crash Reduction Capabilities and Countermeasures, Effectiveness of Safety Design Features, Accident Reconstruction. Application of computer analysis of accident data.
UNIT – III
Road Safety in planning and Geometric Design: Vehicle And Human Characteristics, Road Design and Road Equipment's, Redesigning Junctions, Cross Section Improvements, Reconstruction and Rehabilitation of Roads, Road Maintenance, Traffic Control, Vehicle Design and Protective Devices, Post Accident Care.
UNIT – IV
***Traffic Signals & Road signs*:** Traffic Signals, Factors affecting signal design, street lighting, Provisions for NMT Vehicles in India, Safety Provisions for Pedestrians & Cyclists, Road Signs and Pavement Markings. **Safety at Construction Site:** Safety provisions for workers at construction site, Construction Zone markings, signs.
UNIT – V
Traffic Management safety audit: Traffic Management Systems for Safety, Road Safety Audits and Tools for Safety Management Systems, Road Safety Audit Process, Approach to Safety, Road Safety

Improvement Strategies, ITS and Safety.

Suggested Readings:

1. KadiyaliL.R,.*Traffic Engineering and Transport planning*, 9th Edition, Khanna Tech Publishers, 2013.
2. C.E.G. Justo, A. Veeraragavanand S. K. Khanna, *Highway Engineering*, 10th Edition, Nem Chand Publishers, 2017.
3. Donald Drew, *Traffic Flow Theory Chapter 14 in Differential Equation Models*, Springer, 1983
4. C. Jotinkhisty and B. Kent Lall, *Transportation Engineering – An Introduction, 3rd Edition, Pearson publications, 2017*
5. Rune Elvik, Alena Hoye, TrulsVaa, Michael Sorenson, *Handbook of Road Safety measures, second Edition, Emerald Publishing, 2009.*
6. Highway Research Programme (NCHRP) Synthesis 336.*A synthesis of Highway Research Board, Washington D.C, 2016*.

SOFTWARE ENGINEERING

OE 604 IT

Instruction: 3 periods per week *Duration of SEE: 3 hours*
*CIE: 30 *marks* *SEE: 70 marks*
Credits: 3

Objectives:

6. To introduce the basic concepts of software development processes from defining a product to shipping and maintaining
7. To impart knowledge on various phases, methodologies and practices of software development
8. To understand the importance of testing in software development, study various testing strategies along with its relationship with software quality and metrics

Outcomes:

Student will be able to
5. Acquired working knowledge of alternative approaches and techniques for each phase of software development
6. Judge an appropriate process model(s) assessing software project attributes and analyze necessary requirements for project development eventually composing SRS.
7. Creation of visual models to describe (non-) algorithmic solutions for projects using various design principles.
8. Acquire skills necessary as an independent or as part of a team for architecting a complete software project by identifying solutions for recurring problems exerting knowledge on patterns.

UNIT – I

Introduction to Software Engineering:

A generic view of Process: Software Engineering, Process Framework, CMM Process Patterns, Process Assessment.

Process Models: Prescriptive Models, Waterfall Model, Incremental Process Models, Evolutionary Process Models, Specialized Process Models, The Unified Models, Personal and Team Process Models, Process Technology, Product and Process.

An Agile view of Process: Introduction to Agility and Agile Process, Agile Process Models

UNIT – II

Software Engineering Principles: SE Principles, Communication Principles, Planning Principles, Modeling Principles, Construction Principles, Deployment.

System Engineering:Computer-based Systems, The System Engineering Hierarchy, Business Process Engineering, Product Engineering, System Modeling.

Requirements Engineering: A Bridge to Design and Construction, Requirements Engineering Tasks, Initiating Requirements Engineering Process, Eliciting Requirements, Developing Use-Cases, Building the Analysis Model, Negotiating Requirements, Validating Requirements.

UNIT – III

Building the Analysis Model:Requirements Analysis Modeling Approaches, Data Modeling Concepts, Object-Oriented Analysis, Scenario-based Modeling, Flow-oriented Modeling, Class-based Modeling, Creating a Behavioral Model.

Design Engineering:Design within the context of SE, Design Process and Design Quality, Design Concepts, The Design Model, Pattern-based Software Design.

UNIT – IV

Creating an Architectural Design: Software Architecture, Data Design, Architectural Styles and Patterns, Architectural Design.

Modeling Component-Level Design:Definition of Component, Designing Class-based Components, Conducting Component-level Design, Object Constraint Language, Designing Conventional Components.

Performing User Interface Design:The Golden Rules, User Interface Analysis and Design, Interface Analysis, Interface Design Steps, Design Evaluation.

UNIT – V

Testing: Strategies:A Strategic Approach to Conventional Software Testing, Test Strategies for O-O Software.

Tactics:Software Testing Fundamentals, Black-box and White-box Testing, Basis Path Testing, Control Structure Testing, O-O Testing Methods.

Debugging:Debugging Techniques, The Art of Debugging.

Product Metrics: A Framework for Product Metrics, Metrics for each phase of software development.

Software Quality:Definition, ***Quality Assurance:***Basic Elements, Formal Approaches, Statistical Software Quality Assurance, Software Reliability, ISO9000 Quality Standards, SQA Plan.

Suggested Readings:

1. Roger S. Pressman, *Software Engineering: A Practitioner's Approach*, 7th Edition, McGraw Hill, 2009
2. Ali Behforooz and Frederick J. Hudson, *Software Engineering Fundamentals*, Oxford University Press, 1996
3. Pankaj Jalote, *An Integrated Approach to Software Engineering*, 3rd Edition, Narosa Publishing House, 2008