With Effect from the Academic Year 2019 – 2020

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

AICTE MODEL CURRICULUM

B.E. (PRODUCTION ENGINEERING)

SEMESTER – V to SEMESTER - VI

With effect from academic year 2020-2021

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

AICTE MODEL CURRICULUM

B.E. (PRODUCTION ENGINEERING)

SEMESTER – V

S. No.	Course Code	Title of the Course	Scheme of instruction			Scheme of examination			Credits
			Hours per week			Duration in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	18ME C12	Dynamics of Machines	3	--	--	3	30	70	3
2	18ME C13	Applied Thermodynamics and Heat Transfer	3	--	--	3	30	70	3
3	18ME C14	Design of Machine Elements	3	--	--	3	30	70	3
4	18PE C05	Metal Forming Technology	3	--	--	3	30	70	3
5		Core Elective – I	3	--	--	3	30	70	3
6		Core Elective – II	3	--	--	3	30	70	3
PRACTICALS									
7	18ME C15	Dynamics and Vibrations Lab	--	--	2	2	15	35	1
8	18ME C16	Applied Thermodynamics and Heat Transfer Lab	--	--	2	2	15	35	1
9	18PE C06	Metal Forming Technology Lab	--	--	2	2	15	35	1
		TOTAL	**18**	--	**06**	--	**225**	**525**	**21**

L: Lecture T: Tutorial D: Drawing P: Practical
CIE - Continuous Internal Evaluation SEE – Semester End Examination

Core Elective – I (3/3)			**Core Elective – II (3/3)**		
SNO	**Subj. Code**	**Name of the Subject**	**SNO**	**Subj. Code**	**Name of the Subject**
1	18ME E01	Refrigeration and Air Conditioning	1	18ME E04	Automobile Engineering
2	18ME E02	Values, Ethics and Society	2	18ME E05	Nano Science and Technology
3	18PE E01	Plastics, Ceramics and Composite Materials	3	18ME E06	Rights, Duties and Legislation
4	18PE E02	Product Design and Process Planning	4	18PE E04	Non Destructive Testing and Evaluation
5	18PE E03	Powder Processing	5	18PE E05	Surface Engineering

With Effect from the Academic Year 2020 – 2021

18ME C12

DYNAMICS OF MACHINES

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Objectives:

1. To understand static and dynamic forces on planar mechanisms and turning moment Diagrams for Flywheels
2. To understand the Gyroscopic effect and the performances of Governors
3. To know the Balancing of rotating and reciprocating masses
4. To determine natural frequencies of undamped, damped and forced vibrating systems of single degree freedom systems.
5. To understand the modes of vibrations, Two degree of Freedom and Torsion Vibrations

Outcomes: At the end of the course, the students are able to

1. Determine the fluctuation of energy and decide the cross section of flywheel. (BL-3)
2. Understand the gyroscopic effects in ships, aero planes and road vehicles. (BL-2)
3. Analyze the characteristics of various centrifugal governors. (BL-4)
4. Analyze balancing problems in rotating and reciprocating machinery. (BL-4)
5. Understand free and forced vibrations of single degree freedom systems and two-degree freedom linear systems. (BL-2)

UNIT- I

Force analysis: Dynamic force analysis of single slider crank mechanism, concept of dynamically equivalent link.

Flywheels: Working principle of flywheel, turning moment on the crank shaft, turning moment diagrams, maximum fluctuation of energy and its determination, coefficient of fluctuation of speed, design of flywheels, rim type flywheel versus solid type flywheel**.**

Gyroscope: Principle of gyroscope, roll, yaw and pitch motions, gyroscopic effect in a two-wheeler, car, ship and aeroplane, practical problems.

UNIT- II

Governors: Necessity of governor, different types of governors, working principle of centrifugal governors, characteristics of Watt governor, Porter governor, Proell governor, Hartnell governor, Hartung governor, hunting of governors, concept of control force, control force diagram, definition of stability of governor, condition for stability, concept of isochronism, sensitivity of governor, energy of governor.

UNIT- III

Balancing of Rotating masses: Balancing and its types, rotor balancing, single plane and two plane balancing, unbalanced forces and couples, static and dynamic balancing, balancing of rotors by analytical and graphical methods.

Balancing of reciprocating machines: Primary and secondary unbalanced forces, balancing of in line and radial engines.

UNIT - IV

Vibrations: Vibrations of single degree freedom system (axial, transverse and torsional), equivalent system of combination of springs, stepped shaft, whirling speed of shafts.

Damped Vibrations: Types of damping, vibrations with viscous damping,

Forced Vibrations: Vibrations with harmonically applied force with viscous damping, dynamic magnifier, resonance, vibration isolation and transmissibility.

UNIT –V

Two and three degree freedom systems: Natural frequencies of two degree freedom linear systems. Nodes in two and three rotor systems, modes of vibration, determining natural frequencies by Holzer's method for multi-rotor systems. Dunkerley's and Rayleigh's approximate methods.

Text Books:

1. S.S. Rattan, “Theory of Machines”, Fourth edition ,Tata-Mc Graw Hill, ,2014
2. John.J.Vicker, Gordon R. Pennock, Joseph E. Shigley, “Theory of Machines & Mechanisms”, Oxford University press, 2003. .
3. William T.Thomson “Theory of Vibration with Application”, 5th edition, Pearson education 2008

Suggested Reading:

1. A. Ghosh and Mallick, “Theory of mechanisms and machines”, Affiliated to E-W Press, 1988.
2. J.S. Rao and Gupta, “Theory and Practice of Mechanical Vibrations”, PHI, 1984

With Effect from the Academic Year 2020 – 2021

18ME C13

APPLIED THERMODYNAMICS AND HEAT TRANSFER

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Objectives:

Student will understand

1. the working principles of reciprocating air compressor and its applications in engineering
2. the working principle of diesel and petrol engine, their combustion phenomena and problems pertaining to abnormal combustion
3. Student will understand the features of IC engine like ignition system and injection system
4. the basic modes of heat transfer
5. the classification of heat exchanger, concepts of radiation heat transfer and phase heat transfer

Outcomes: At the end of the course, the students are able to

1. Estimate the power required for reciprocating air compressor using the basic principles of thermodynamics for many engineering applications. (BL-4)
2. Evaluate the performance of C.I. and S.I. engines with appropriate consideration for public health and safety. (BL-5)
3. Understand the functioning of components of I.C. engines and the concept of abnormal combustion with remedial measures. (BL-2)
4. Derive the expressions for the heat transfer in conduction and convection with the basic principles of thermodynamics. (BL-3)
5. Understand the basic principles of heat exchangers, boiling and condensation. (BL-2)

UNIT – I

Reciprocating Air Compressors: Classification of compressors, advantages of reciprocating compressors over rotary compressors, applications of compressed air, working principle of reciprocating compressors - single stage and multi stage compressors with and without clearance, concept of optimum pressure ratio, minimum work input, various efficiencies of multi stage compressors, simple problems on reciprocating compressors.

UNIT - II

Internal Combustion Engines: Classification, working principles of 2 stroke, 4 stroke SI and CI engines, valve and port timing diagrams, performance of IC engines, Morse test, various methods of determining frictional power, various efficiencies, heat balance sheet.

UNIT - III

Combustion Phenomena: Stages of combustion in SI and CI engines, octane and cetane number, factors affecting, normal and abnormal combustion phenomenon in SI and CI engines, methods to control the abnormal combustion, types of combustion chambers, cooling systems, lubrication systems, battery and magneto ignition systems of IC engines, working principle of simple carburetor and fuel injector.

UNIT - IV

Modes of Heat Transfer: General 3-D conduction equation in cartesian and cylindrical coordinates, one dimensional steady state conduction through slabs, hollow cylinders without heat generation, critical radius of insulation for cylinders.

Convection: Free and forced convection, dimensionless numbers and their physical significance.

UNIT - V

Radiation: Various laws of radiation, concept of black-body.

Heat Exchangers: Classification, concept of LMTD and simple problems.

Condensation and boiling: Types of condensation, heat transfer coefficient for laminar parallel flow condensation, pool boiling curve, simple problems on condensation and boiling.

Text Books:

1. Mahesh M. Rathore, “Thermal Engineering”, TMH, New Delhi, 2010
2. V. Ganeshan, “Internal Combustion Engines”, Tata Mcgraw Hill Publishing, New Delhi,2015
3. J.P. Holman, “Heat Transfer”, McGraw Hill Publication, New Delhi,

Suggested Reading:

1 R.K. Rajput., “Thermal Engineering”, Laxmi Publishers, New Delhi, 2014

2 D.S. Kumar, “Heat Transfer”, S K Kataria Publishers, 2015

18ME C14

DESIGN OF MACHINE ELEMENTS

(Use of data book is permitted)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. To understand the principles of machine design and design considerations, types of loads, failure criteria.
2. To design machine members for static, fluctuating loads and impact loads
3. Learn the design principles of shafts, keys, couplings, belt drives and pulleys.
4. Understand the principles of design of permanent joints such as riveted and welded joints.
5. Understand the principles of design of bolted joints, power screws and gasket joints.

Outcomes: At the end of the course, the students are able to

1. Understand the standards, codes, various design considerations and failure criteria of members (BL-2)
2. Analyze and evaluate machine members subjected to static and dynamic loads (BL-4)
3. Recommend suitable shafts, couplings and belt drives for a given application (BL-5)
4. Design permanent joints for a given application (BL-6)
5. Design bolted joints, power screws and screw jack (BL-6)

UNIT – I

Introduction: Materials used in machine design and their specifications to Indian standards, codes and standards used in design. Reliability, principles of Ergonomics and Manufacturing considerations. Preferred numbers, analysis of stress and strain: Types of loading and stresses. Cotter and knuckle joints. Theories of elastic failure, stress concentration factor, factor of safety, Design of components for static loads.

UNIT – II

Design for Fatigue and Impact loads: Importance of fatigue in design, fluctuating stresses, fatigue strength and endurance limit. Factors affecting fatigue strength, S-N Diagram, Soderberg and Modified Goodman's diagrams for fatigue design. Cumulative fatigue, Miner's rule, Design of components for fatigue. Design of components for impact loading.

UNIT – III

Design of shafts, Keys & Couplings: Solid, hollow and splined shafts under torsion and bending loads, types & design of Keys, muff , split muff , flange, marine type and flexible type of couplings.
Design of Belt Drive Systems: selection of belts and design of pulleys.

UNIT – IV

Design of Permanent Joints: Types of Riveted joints, efficiency of the joint. Design of riveted joints subjected to direct and eccentric loads. Types and design of welded joints subjected to direct and eccentric loading.

UNIT – V

Design of Bolted Joints, Power Screws: Design of bolts and nuts, locking devices, bolt of uniform strength, design of gasket joints, design of power screws and screw jack.

Text Books:

1. V.B. Bhandari, "Design Machine Elements", Mc Graw Hill Publication, 2017.
2. J.E. Shigley, C.R. Mischne, "Mechanical Engineering Design", Tata Mc Graw Hill Publications, 2015.
3. R.S.Khurmi and J.K.Gupta, "Machine design", 34/e, S Chand publications, 2018.

Suggested Reading:

1. P. Kannaiah, "Machine Design", Sci-Tech Publications, 2010
2. M.F. Spotts, "Design of Machine Elements", Prentice Hall of India, 2013.

Machine Design Data Books:

1. K. Mahadevan, K. Balaveera Reddy., "Design Data Hand book for Mechanical Engineers", 3/e, CBS Publisher, 2018
2. PSG College, "Design Data book", 2012

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18PE C05

METAL FORMING TECHNOLOGY

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Objectives:

1. To introduce students to metal forming technology while understanding the fundamentals of theory of plastic deformation and stress strain relations.
2. To explain the working principle of various operations like sheet metal operations, extrusion, drawing, rolling, forging etc with their applications, merits and demerits.
3. To explain different deformation mechanisms and effect of the process variables on different process and product quality.
4. To enable the students to determine loading and energy required for metal forming tools and machines.
5. To enable the students to understand different defects that occurring forming operations with remedial measures.

Outcomes:

At the end of the course, student will be able to

1. Apply theory of plasticity to analyze metal forming processes.
2. Understand the basic principles and practical aspects of metal forming operations.
3. Understand various process parameters that affect product quality in various processes under different conditions.
4. Determine load, energy and power required for various processes and machines.
5. Propose suitable metal forming processes for making different products.

UNIT - I

Theory of Plasticity: Plastic deformation, work hardening, cold, warm and hot working with their advantages and disadvantages, true stress and true strain, flow curve, effect of strain-rate and temperature on flow stress. yield criterion: von-Mises and Tresca

UNIT - II

Forging: Open and closed die forging, Drop, Press and Machine forging operations, types of hammers and presses, their principles of operation and applications, Forging load calculation with slab method and empirical methods, forge ability , forging defects, Methods of heating and types of furnaces, Isothermal forging Hot Isostatic Pressing.

UNIT - III

Extrusion and Drawing: Types of extrusion, Tube extrusion Rod/wire/tube drawing ,load calculation of extrusion and drawing using uniform deformation energy method and slab method. maximum reduction in drawing, effect of friction, die angles, deformation speeds on extrusion/drawing forces, die materials and lubrication in these operations, extrusion and drawing defects.

UNIT - IV

Rolling: Principles of Metal rolling, roll load, torque and mill power calculation for homogenous deformation, classification and description of rolling mills, their applications, rolling defects, shape rolling, ring rolling thread rolling, roll bending and powder rolling.

UNIT - V

Sheet Metal Working: Sheet Metal working operations-shearing, blanking, piercing, bending, drawing and squeezing operations, estimation of loads and energy required for these operations, Formability, FLD, types of presses, specifications and their applications, comparison of simple, compound, progressive and combination dies. Other sheet metal forming operations like Embossing, Stretch forming, Spinning and Flow forming.

Text Books:

1. Serope Kalpakjian, “Manufacturing Engineering and Technology”, 4/e, Pearson education INC., 2015.
2. George.E. Dieter, “Mechanical Metallurgy”, SI Metric Edition, McGraw –Hill, 1988.
3. P.N. Rao, “Manufacturing Technology”, 4/e, TMH, 2015.

Suggested Reading:

1. R.K. Jain, S.C. Gupta, “Production Technology”, 17/e, Khanna Publications, 2012.
2. Roy A lindberg, “Materials and Process of manufacturing”, 4/e, PHI, 2004.
3. John A Schey, “Introduction To Manufacturing Processes”, 3/e, McGraw Hill education, 2012.

18ME E01

REFIGRERATION AND AIR CONDITIONING

(Core Elective-I)
(Use of data book is permitted)

Instruction	3	Hours per
week		
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. Acquire the basic knowledge about the importance of refrigeration, its applications in aircraft refrigeration.
2. Demonstrate basic knowledge of vapor compression refrigeration system, cascade and compound refrigeration.
3. Understand various types of absorption refrigeration systems like ammonia, Electrolux and lithium bromide refrigeration systems.
4. Acquire the basic knowledge on various psychrometric processes and comfort air conditioning.
5. Acquire knowledge in estimating air conditioning loads.

Outcomes: At the end of the course, the students are able to

1. Evaluate COP of various air craft refrigeration systems using principles of thermodynamics along with necessity of eco-friendly refrigerants for public health and safety. (BL-4)
2. Analyze COP of vapor compression refrigeration system with the appropriate concern for environment. (BL-4)
3. Understand the Vapour absorption, steam jet refrigeration and non-conventional refrigeration in order to provide valid conclusions over simple vapor compression refrigeration system. (BL-2)
4. Understand the working principle of air conditioning system including human comfort and its importance over environment, society with balance of ecological system. (BL-2)
5. Apply the principles of engineering which are complex in nature, having lifelong learning to design air conditioning system for various environments. (BL-3)

UNIT – I

Introduction to Refrigeration: Application of Refrigeration, Definition of COP, Tonne of Refrigeration,Designation, Carnot cycle, Eco-friendly Refrigerants, Properties of Refrigerants.

Air Refrigeration Systems: Analysis of Bell-Coleman Cycle, Application to aircraft refrigeration, Simplecooling system, Bootstrap simple evaporating system, Regenerative cooling system and Reduced ambient cooling system.

UNIT - II

Vapour Compression System: Working principle and analysis of Simple vapor compression Refrigerationcycle. 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 absorptionrefrigeration 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 andapplications.

Thermoelectric refrigeration systems: Seebeck effect, Peltier effect and Thompson effect, Analysis of the thermoelectric refrigeration systems using Peltier effect, Expression for COP, Vortex tube refrigeration – principle and working.

UNIT - IV

Psychrometry: Psychrometric properties, Psychrometric chart, construction, Representation of variousPsychrometric processes on the chart.

Introduction to Air Conditioning: Requirements of comfort air conditioning, Thermodynamics of humanbody, ASHRE comfort chart, Effective temperature.

UNIT - V

Cooling Load Calculations in Air Conditioning: Concept of bypass factor, Sensible heat factor, ApparatusDew Point, Various Heat Loads.

Design of air conditioning systems: Simple Problems on summer, winter and year Round Air conditioningsystems Energy conservation in air conditioned building.

Air Conditioning Systems: Components of air conditioner equipments, Humidifier, Dehumidifier, Filter.

Text Books:

1. C.P. Arora, "Refrigeration and Air conditioning", Tata McGraw Hill, New Delhi, 2017.
2. Stoecker, W.F., and Jones, J.W., Refrigeration and Air-Conditioning, Mc.Graw Hill, New Delhi, 2014.
3. R.K. Rajput, "Refrigeration and Air Conditioning", Laxmi Publications, New Delhi, 2013.

Suggested Reading:

1. V.K. Jain, "Refrigeration and Air Conditioning", S Chand & Company, New Delhi, 2019.
2. Manohar Prasad, "Refrigeration and Air Conditioning", New Age International, Allahabad, 2015.

Refrigeration and air conditioning data books:

1. Manohar Prasad, "Refrigeration and Airconditioning Data Book", New Age International Publishers, 2010.

18ME E02

VALUES, ETHICS AND SOCIETY

(Core Elective - I)

Instruction week	3	Hours per
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. Develop the critical ability among students to distinguish between what is of value and what is superficial in life
2. Understand the values, the need for value adoption and prepare them meet the challenges
3. Develop the potential to adopt values, develop a good character and personality and lead a happy life
4. Practice the values in life and contribute for the society around them and for the development of the institutions/organization.
5. Understand the professional ethics and their applications to engineering profession

Outcomes: At the end of the course, the students are able to

1. State basic values and the need for value education. (BL-2)
2. Differentiatebetween values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual. (BL-2)
3. Demonstrate the knowledge of ethics at their work place and apply different theoretical approaches to solve ethical dilemmas. (BL-3)
4. Apply risk and safety measures in the engineering practice. (BL-3)
5. Understand the role of a human being in ensuring harmony in society and nature. (BL-2)

UNIT- I

Concepts and Classification of Values –Need and Challenges for Value Adoption: Definition of Values**,** Concept of Values, Classification of Values, Hierarchy of Values, Types of Values, Espoused and Applied Values, Value judgement based on Culture, Value judgement based on Tradition, Interdependence of Values, Need for value education, Findings of Commissions and Committees, Corruption and illegal practices, Science and Technology without values, Exploitation of nature, Increasing use of violence and intoxicants, Lack of education in values, Implications of education in values, Vision for a better India, Challenges for Value adoption, Cultural, Social, Religious, Intellectual and Personal challenges.

UNIT -II

Process for Value Education: Right Understanding, Relationship and Physical Facilities,basicrequirements for fulfillment of aspirations of every human being with their correct priority, Understanding Happiness and prosperity correctly, a critical appraisal of the current scenario, Method to fulfill the above human aspirations; understanding and living in harmony at various levels.

UNIT-III

Basic Concepts of Professional Ethics: Ethics, Morals and Human life , Types of Ethics, Personal Ethics,Professional ethics, Ethical dilemmas, Indian and Global thoughts on ethics, Profession, Professional and Professionalism, Ethical role of a professional Basic ethical principles, Some basic ethical theories, use of ethical theories, Science, Religion Ethics, Genders and ethics, Media and ethics, Computer Ethics, Case Studies on Professional Ethics, Exemplary life sketches of prominent Indian personalities.

UNIT- IV

Ethics in Engineering Profession: Engineering profession-Technology and Society-Engineering as SocialExperimentation-Engineering ethics-Ethical obligations of Engineering Professionals, Role of Engineers-Engineers as Managers, Professional responsibilities of Engineers, Engineers Responsibility for Safety, A few Case Studies on Risk management, Conflicts of Interest, Occupational Crimes- Plagiarism-Self plagiarism-Ethics Audit-Consideration for ethics audit-Ethics Standards and Bench Marking.

UNIT - V

Understanding Harmony in the Family and Society: Understanding harmony in the family, the basic unit ofhuman interaction, Understanding values in human relationship; meaning of Nyaya and Program for its fulfillment to ensure Ubhay-tripti, Trust (Vishwas) and Respect (Samman) as the foundational values of relationship.

Text Books:

1. Subramanian R., “Professional Ethics”, Oxford University Press , 2017

2. Dinesh Babu S., “Professional Ethics and Human Values”, Laxmi Publications , 2016
3. Nagarajan R.S., “A Text Book on Human Values and Professional Ethics”, New Age Publications, 2007

Suggested Reading:

1. Santosh Ajmera and Nanda Kishore Reddy, “Ethics, Integrity and Aptitude”, Mc Graw Hill Education Private Limited , 2014
2. Govinda Rajan M., Natarajan S., Senthil Kumar V.S., “Professional Ethics and Human Values”, Prentice Hall India Private Limited, 2013.

18PE E01

PLASTICS, CERAMICS AND COMPOSITE MATERIALS

(Core Elective-I)

Instruction week	3	Hours per
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. Understand various types of plastics, their properties and uses.
2. Understand various methods of manufacturing plastic components.
3. Understand types of ceramics, refractoriness, and their uses.
4. Understand the manufacturing processes of ceramics.
5. Understand composites and their uses.

Outcomes: At the end of the course, the students are able to

1. Recall the types of plastics, properties and applications. (BL-1)
2. Select the suitable method of manufacturing a plastic component. (BL-5)
3. Describe refractories, their manufacturing methods and applications. (BL-2)
4. Describe the properties, uses and Manufacturing methods of white wares, ceramic coatings and glass. (BL-2)
5. Understand the concept of composites, properties in engineering applications. (BL-2)

UNIT - I

Introduction to Polymers: Plastics and elastomers, polymerization, degree of polymerization, thermoplasticsand thermosetting plastics, properties and applications of various thermoplastic and thermosetting plastics, mechanical properties of plastics and their influencing parameters.

UNIT - II

Processing of Plastics and Elastomers: Constructional features, working principles, advantages, disadvantages and applications of Injection moulding, Extrusion, calendaring, thermoforming, Blowmoulding, compaction moulding, transfer moulding.

UNIT - III

Introduction to Ceramics, Classification of Ceramic Materials, Conventional and Advanced, Refractories:Classification of Refractories, Modern trends and developments, Basic raw materials, Elementary idea of manufacturing process technology, Flow diagram of steps necessary for manufacture, basic properties and areas of application.

UNIT - IV

White Wares: Classification and type of White wares, Elementary idea of manufacturing process technologyincluding body preparation, basic properties and application area.

Ceramic Coatings: Types of glazes and enamels, Elementary ideas on compositions, Process of enameling &glazing and their properties.

Glass: Definition of glass, Basic concepts of glass structure, glass manufacturing processes, Different types of glasses, Application of glasses.

UNIT - V

Fundamentals of Composites: Need for composites–enhancement of properties–classification of composites

– Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Reinforcement–particle reinforced composites, Fiber reinforced composites, Applications of various types of composites, Production techniques for glass fiber, carbon fiber and ceramic fiber, manufacturing methods of composites.

Text Books:

1. Mikell P. Groover, “Fundamentals of Modern Manufacturing: Materials, Processes, and Systems”, Wiley publications, 6th edition 2015.
2. Kalpakjian, “Manufacturing Engineering and Technology”, Pearson publications, 7th edition 2013.
3. P.N. Rao, “Manufacturing Technology”, Vol.-1, McGraw Hills Publication, 4th Edition 2016.

Suggested Reading:

1 R.K.Rajput, “A text book of Manufacturing Technology”, Vol-I, Laxmi Pub., 2007.
2 P.C. Sharma, “A Text book of Production Technology”, 8/e, S. Chand & Co., Pvt. Ltd., 2014.

18PE E02

PRODUCT DESIGN AND PROCESS PLANNING

(Core Elective-I)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

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

Outcomes: At the end of the course, the students are able to

1. Define the needs of the customer while designing a new product or modifying existing product in the competitive environment. (BL-1)
2. Understand c**r**eativity, brainstorming and ergonomic concepts. (BL-2)
3. Apply the concept of design for manufacture, assembly, maintenance, reliability and product life cycle in developing a product. (BL-3)
4. Implement the Intellectual Property Rights to a new product or a process. (BL-3)
5. Evaluate and recommend an effective Process Plan and principles of value engineering to new product development. (BL-5)

UNIT - I

Product Design and Process Design: Functions, Essential factors of product design, Selection of right product,Systematic procedure of product innovation, function of design, value of appearance, colors and laws of appearance.

UNIT - II

Product Selection and Evaluation: Need for creativity and innovation. Techniques of innovation like brainstorming and Delphi techniques, collection of ideas. Selection criteria - screening ideas for new products using evaluation techniques. Principles of ergonomics, Anthropometry, Design with Human Machine Interaction (HMI).

UNIT - III

New Product Planning and Development: Interaction between the functions of design, manufacture, andmarketing, design and material selection, Steps for introducing new products after evaluation, Product life cycle, Research and new product development.

UNIT - IV

Intellectual Property Rights (IPR): Patents, definitions, Types of Patent, Patent search, Patent laws,International code for patents, Trademark, Trade Secret and Copy Rights.

Process Planning: Need and significance of process planning, Process capability studies, Process sheets, Benefits and Types of Computer Aided process planning.

UNIT - V

Process Selection and Planning: Selection of manufacturing process, estimation of machining time in various cutting operations, Estimation of costs for manufacture, value engineering in product design, Group technology, and concepts of concurrent engineering.

Text Books:

1. B.W. Niebel & A.B.Draper, “Production Design & Process Engg”, McGraw Hill, 1974.
2. K. G. Swift & J. D. Booker, “Process Selection: From Design to Manufacture”, Butterworth-Heinemann Ltd; Revised 2/e, 2003.
3. BhaskaranGopalakrishnan, “Product Design and Process Planning in CE (Design & Manufacturing”, Chapman and Hall publishers, 1994.

Suggested Reading:

1. A.K. Chitale& R.C. Gupta, “Product Design & Manufacturing”, PHI, 1997.
2. Karl T. Ulrich, Stephen Eppinger, “Product Design and Development”, McGrawHill Publication, 2012.

18PE E03

POWDER PROCESSING (Core Elective-I)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Objectives:

To make the students to understand the different

1. Powder properties & characteristics.
2. Powder mixing & compaction methods.
3. Powder Sintering methods.
4. Post Sintering processes.
5. Testing's of sintered parts.

Outcomes:

At the end of the course, the students are able to

1. Characterize the Powders in different techniques.
2. Suggest appropriate compaction technique for a particular powder.
3. Suggest appropriate sintering technique for a particular powder.
4. Choose correct post sintering processes.
5. Have ability to choose the appropriate testing for sintered parts.

UNIT - I

Introduction: Importance and advantages of powder processing.

Powder Manufacture: Comminution, solid state reduction, electrolysis, thermal decomposition, and Atomization (water atomization, oil atomization, gas atomization, centrifugal atomization).

UNIT - II

Powder Properties, Characterization and Mixing: Chemical composition, particle shape, powder density, particle size, size distribution compressibility, green strength. Blending and mixing. Compaction: Compact size, tool materials, design of sintered part, Olivetti process hot pressing, injection moulding, cold iso-static pressing, and hot iso-static pressing.

UNIT - III

Sintering: Theory of sintering, Sintering practice – furnace design, furnace atmospheres, vacuum sintering, control of shrinkage, liquid phase sintering, activated sintering, and loose powder sintering.

UNIT - IV

Post-Sintering Operations: Re-press and re-enter, hot re-press, hot forge in a closed die, sizing, coining, HIP, steam treatment, infiltration, and impregnation. Heat treatment, hardening, and tempering, surface hardening, electro-plating, and other coatings. Deburring, machining and joining. Sinter forging.

UNIT - V

Testing of Sintered Parts and Applications: Porous bearings, filters Magnetic Materials, super alloys, High speed steels, Stainless steels, ODS materials, Production of Near-net shapes, rapidly solidified powders, and spray forming. Manufacturing of Cutting tools, forming dies using powder metallurgy.

Text Books:

1. J. S. Hirsch horn: "Introduction to Powder Metallurgy", American Powder Metallurgy Institute, Princeton, NJ, 1976.
2. P. C. Angelo and R. Subramanian: "Powder Metallurgy- Science, Technology and Applications", PHI, New Delhi, 2008.

Suggested Reading:

1. G.S.Upadhya, "Powder Metallurgy Technology", Cambridge international Science publishing,1997.
2. B.K Dutta, "Powder Metallurgy: An advanced technique and processing of engineering materials", PHI Publications , 2011.
3. Clark Frances Hurd, "Advanced Techniques in Powder Metallurgy", Literary Licensing,2017.

18ME E04

AUTOMOBILE ENGINEERING

(Core Elective-II)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. The anatomy of the automobile in general.
2. The functioning of the engine and its accessories, gear box, clutch, brakes, steering, axles and wheels.
3. Suspension, frame, springs and other connections.
4. Ignition, controls, electrical systems and ventilation.
5. Emissions, pollution regulations, EURO and BHARATH stages

.**Outcomes:** At the end of the course, the students are able to

1. Understand the basic layout of automobiles. (BL-2)
2. Understand the various systems in an automobile like engine cooling, lubrication, ignition, electrical and air conditioning systems with the principles of thermodynamics. (BL-2)
3. Describe the principles of suspension and steering system using modern tool usage. (BL-2)
4. Explore therecent systems in Braking and Transmission. (BL-3)
5. Evaluate the effect of automobile pollution on environment and necessity of pollution norms along with trouble shooting (BL-5)

UNIT - I

Types of Automobiles: Normal, Hybrid and Hydrogen Fuel vehicles.

Engine: Engine location and its components, chassis layout - parts of the automobile body, terminology, automobile frames ; crank shaft, firing order, piston and piston rings, cylinder liners, valves and operation mechanism, inlet and exhaust manifolds, carburetion – Zenith carburettor, Fuel injection system, Mechanical Fuel Injection system- MPFI, Electronic Fuel Injection system.

UNIT - II

Lubricating Systems: Wet sump, dry sump and petroil systems

Cooling systems: Water pumps, radiators, thermostat control, anti-freezing compounds

Ignition Systems: Types of Ignition Systems, Modern Ignition systems, Types of Batteries and charging systems- Batteries used in Electric and Hybrid Vehicles, starting motors,

Electrical Systems : Main electrical circuits, generating & starting circuit, lighting system, indicating devices, warning lights, speedometer, automobile air-conditioning.

UNIT - III

Steering Systems: Linkage arrangements and its components, steering gear box types,recent trends, Davis Steering , Modified Ackerman linkage, Steering geometry: caster, camber, King Pin Inclination, Toe in, toe out.

Wheel and tyres: Tyre construction, specification. Tyre wear and causes, wheel balancing, wheel alignment

Suspension systems: Types of Suspension systems, 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

Brakes Systems: Disc and drum types, leading and trailing shoe layout, Description and operation of hydraulic brake, hand brake linkage, Pneumatic, air and vacuum brakes

UNIT – V

Maintenance: Trouble shooting and servicing procedure overhauling, engine tune up, tools and equipment for repair and overhaul testing equipment

Pollution control: Pollution control techniques used for petrol and diesel engines, PCVS, EGR, SCRT, Thermal Reactors, Catalytic converters; Euro norms and Bharat Norms.

Text Books:

1. Crouse & Anglin, “Automotive Mechanics”, 10/e, TMH. Publishing Co. Ltd., New Delhi, 2006.
2. Kirpalsingh., “Automobile Engineering”, Vol. I & II Standard Publishers, Delhi, 2017.
3. Joseph Heitner, “Automotive Mechanics”, 2/e, Affiliated East West Pvt. Ltd. 2013.

Suggested Reading:

1. R.K. Rajput, “A Textbook of Automobile Engineering”, Laxmi Publications, New Delhi, 2012.
2. D S Kumar, “Automobile engineering”, S K Kataria Publications, New Delhi, 2015.

18ME E05

NANO SCIENCE AND TECHNOLOGY

(Core Elective –II)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. Nanotechnology approach and challenges
2. Materials and characterization procedures
3. Zero and One dimensional Nano structures
4. Various Fabrication Techniques
5. Special nano materials and Nano biomaterials

Outcomes: At the end of the course, the students are able to

1. Understand the basic concepts, developments and challenges in Nano technology. (BL-2)
2. Describe the methods of evaluating magnetic and electronic properties, microstructure by SPM, atomic force microscopy, friction force microscopy. (BL-2)
3. Apply homogenous & heterogeneous methods and characterization techniques of Zero & One dimensional Nano structures. (BL-3)
4. Evaluate various Nano Material Fabrication Techniques. (BL-5)
5. Analyze Nano materials and Nano bio materials for obtaining solutions to societal problems. (BL-4)

UNIT - I

Introduction: Nanoscale, Properties at Nanoscale, advantages and disadvantages, importance ofNanotechnology, Bottom-up and Top-down approaches, challenges in nanotechnology, proximal probe technologies.

UNIT - II

Materials of Nanotechnology: Introduction, Si-based materials, Ge-based materials, Ferroelectric materials, Polymer materials, GaAs&InP (HI-V) group materials, Nanotribology and materials, characterization using Scanning Probe Microscope, AFM and Friction force microscopy.

UNIT - III

Nano Structures: Zero dimensional Nanostructure, synthesis procedure by heterogeneous method,characterization techniques, properties and applications particles

One dimensional Nanostructures: Nanowires, Nanotubes and its Synthesis procedure, characterization procedure and principles involved, properties and applications of Nano Wires

UNIT - IV

Nano Fabrication: Introduction, Basic fabrication techniques by Lithography, thin film deposition and doping,MEMS fabrication techniques, Nano fabrication techniques by E-beam, Nano-imprint fabrication, Epitaxy and strain engineering

UNIT - V

Special Nano Materials: Introduction, Synthesis procedure by metal-polymer, metal ceramic and polymerceramic, Characterization procedures, applications

Nano Biomaterials: Introduction, Biocompatibility, anti-bacterial activity, applications

Text Books:

1. Dieter Vollath, “Nanomaterials: An introduction to Synthesis, properties and applications”, Wiley, 2013
2. Guozhong Cao, “Nanostructures and Nano Materials, Synthesis properties and applications”, Imperial College Press, 2004
3. Carl C Koch, “Nano materials Synthesis, Properties and applications”, Jaico Publishing House, 2008

Suggested Reading:

1. Willia Tllsey Atkinson, “Nano Technology”, Jaico Publishing House, 2009
2. George W. Hanson, “Fundamentals of Nanoelectronics”, Pearson Education, 2009

18ME E06

RIGHTS, DUTIES AND LEGISLATION

(Core Elective - II)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. Understand the value of human rights
2. Understand the Lawful rights available to him and others
3. Create understanding the rights of under privileged and respect them
4. Understand role of an individual in the Civil Society
5. Understand the safety aspects while using technology and to understand the role of NGO's in protecting human rights and environment.

Outcomes: At the end of the course, the students are able to

1. Recall the human rights in the global and national context. (BL-1)
2. Understand the overall view on working of Indian constitution. (BL-2)
3. Analyse the societal problems in the context of human rights. (BL-4)
4. Evaluate implementation of right to development and right to information. (BL-5)
5. Application of human rights for human safety and clean environment. (BL-3)

UNIT-I

Conceptual Background Of Human Rights And Duties: Rights, inherent, inalienable,universal, indivisible, Values, Dignity, liberty, equality, justice, unity in diversity, Need for balance between Rights and Duties, Freedom and Responsibility, Theories of human rights, History of human rights civilization, Human rights movements, Universal declaration of human rights 1948, classification and three generations of human rights and sarvodaya.

UNIT-II

Human Rights And Duties In India: Evolution, Independence movement, making of theConstitution, Indian Constitution, Fundamental Rights, Directive Principles, Fundamental duties, Their Interrelationship, Enforcement and protection mechanism of human rights in India, Judiciary, Article 32 and 226 of Indian Constitution, National Human Rights Commission and other Commissions and Committees, Non-governmental organizations, Information Media, Education.

UNIT-III

Societal Problems: Core Problems, Poverty, underdevelopment and illiteracy, Women, children andthe disadvantaged groups, National and state commissions of Women/children/minority/SC/ST.

UNIT-IV

Right to Development: Socio-Economic and Cultural Effects of Globalization, Right to Education,Transparency in Governance and Right to Information, Consumer Protection act.

UNIT-V

Environment Rights Such as Right to Clean Environment and Public Safety: Issues of Industrial Pollution,Prevention, and Rehabilitation, Safety aspects of New Technologies such as Chemical and Nuclear Technologies, Issues of Waste Disposal, Protection of Environment.

Text Books:

1. Mr. Ishay, "The history of Human rights", Orient Longman, New Delhi, 2004.
2. S.N. Chaudhary, "Human Rights and Poverty in India: Theoretical Issues", Delhi: Concepts, 2005.
3. Anuradha Kumar, "Encyclopedia of Human Rights Development of under Privilege", New Delhi: Sarup, 2002.

Suggested Readings:

1. K.P. Saksena, "Human Rights and the Constitution: Vision and the Reality", New Delhi: Gyan Pub., 2003.
2. Dr.J.N.Pandey, "Constitutional Law of India", Central Law Agency; Central Law Agency; 37th Edition, 2001.

18PE E04

NON DESTRUCTIVE TESTING AND EVALUATION

(Core Elective-II)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

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. Technologies like neutron radiography; laser induced ultrasonics, surface analysis and thermography.
4. Merits and demerits of the different NDT Technologies.
5. Latest research and developments in NDT.

Outcomes: At the end of the course, the students are able to

1. Understand Non Destructive Testing techniques of Dye penetrant inspection andMagnetic particle inspection. (BL-2)
2. Compareeddy current testing with other NDT methods. (BL-2)
3. Identify different types of defects using ultra sonic testing. (BL-2)
4. Analyze the radiograph to detect the defects by using principles of radiography. (BL-4)
5. Interpretlatest techniques of NDT with other methods. (BL-3)

UNIT - I

Dye Penetrant Inspection: Principles of penetrate inspection, characteristics of a penetrate, water washablesystem, 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, magnetic particles, applications, advantages and limitations.

UNIT - II

Eddy Current Testing: Principle, lift-off factor, and edge effect, skin effect, inspection frequency, coilarrangements, inspection probes, types of circuit, reference pieces, phase analysis, display methods and applications.

UNIT - III

Ultrasonic Testing: Generation of ultra sound, characteristics of an ultrasonic beam, sound waves at interfaces,sound attenuation, display systems, probe construction, type of display, inspection techniques, identification of defects, Immersion testing , sensitivity and calibration, reference standards, surface condition, applications.

UNIT - IV

Radiography: Principle and uses of radiography, limitation principle, radiation sources, production of X-Rays,x-ray spectra, attenuation of radiation, radiographic equivalence, shadow formation enlargement and distortion, radio graphic film and paper, Xeroradiography, fluoroscopy, exposure factors, radiographic screens, identification markers and image quality indicators, inspection of simple shapes, inspection of complex shapes, viewing and interpretation of radiographs, radiation hazard, protection against radiation, measurement of radiation received by personnel.

UNIT - V

Acoustic Emission: Physical Principles, Sources of emission, instrumentation and applications, Other NDT Techniques: Neuron radiography, Laser induced ultrasonic, surface analysis, and thermography.

Text Books:

1. Barry Hull & Vernon John, “Non Destructive Testing”, 1988
2. H J Frissell (Editorial Coordinator), “Non-Destructive Evaluation and quality control”, ASM handbook-International Publication USA, 1989.
3. Don.E. Bray, Roderic K. Stanley: Nondestructive Evaluation- A Tool in Design, Manufacturing, and Service, Revised Ed, CRC Press, 1997.

Suggested Reading:

1. Paul E. Mix, “Introduction to Nondestructive Testing- A Training Guide”, John Wiley & Sons, 2005.

2. J. Prasad and C. G. K. Nair, “Non-Destructive Test and Evaluation of Materials”, Tata McGraw-Hill Education, 2nd edition, 2011.

With Effect from the Academic Year 2021 - 2022

18PE E05

SURFACE ENGINEERING (Core Elective - II)

Instruction	3 Theory Hours per week
Duration of Semester End Examination	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Objectives:

1. To impart knowledge on surface engineering and surface modification methods that will come in handy to solve the industrial problems.
2. This will also serve as a precursor for future research in the same field.
3. Student will understand the basic principles of corrosion and know the methods to reduce the corrosion on mechanical components.
4. Student will understand the role of wear and wear measurement techniques on engineering components.
5. Student will identify the suitable surface processing method from various methods to create surface engineering solutions for specific materials, specific environments and specific applications in modern engineering practice.

Outcomes: At the end of the course, the students are able to

1. Demonstrate basic understanding of friction, and be familiar with adhesion theories and the effect of adhesion on friction.
2. Demonstrate basic understanding of wear processes, and able to describe wear mechanisms on engineering components.
3. Demonstrate basic understanding of corrosion and know the methods to reduce the corrosion on engineering components.
4. Design a tribological system for optimal performance, and Justify, critical analysis on surface engineering techniques and surface design for relevant applications.
5. Apply surface engineering principles and methods to modify and improve the properties of surfaces for structural and functional applications.

UNIT – I:

Friction: Topography of Surfaces – Surface features – Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction – Rolling Friction – Friction properties of metallic and non metallic materials – Friction in extreme conditions – Thermal considerations in sliding contact.

UNIT–II

Wear: Introduction – Abrasive wear, Erosive, Cavitation, Adhesion, Fatigue wear and Fretting Wear- Laws of wear – Theoretical wear models – Wear of metals and non metals - International standards in friction and wear measurements.

UNIT – III

Corrosion: Introduction – Principle of corrosion – Classification of corrosion – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Evaluation of corrosion – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors.

UNIT – IV

Surface Treatments: Introduction – Surface properties, Superficial layer – Changing surface metallurgy – Wear resistant coatings and Surface treatments – Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying, Applications of coatings and surface treatments in wear and friction control – Characteristics of Wear resistant coatings – New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coatings.

UNIT – V

Engineering Materials: Introduction – Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Applications – Bio Tribology, Nano Tribology.

Text Books:

1. G.W.Stachowiak & A.W. Batchelor, “Engineering Tribology”, Butterworth-Heinemann, UK, 2005.
2. E. Rabinowicz, “Friction and Wear of materials”, John Willey & Sons, UK,1995.
3. J. Halling, (Editor), “Principles of Tribology”, Macmillian – 1984.

Suggested Reading:

1. J.A. Williams, “Engineering Tribology”, Oxford Univ. Press, 1994.
2. S.K. Basu, S.N. Sengupta & B.B.Ahuja, “Fundamentals of Tribology”, Prentice –Hall of India Pvt Ltd , New Delhi, 2005.
3. G. Fontana, “Corrosion Engineering”, McGraw Hill, 1985.

18ME C15

DYNAMICS AND VIBRATIONS LAB

Instruction	2	Hours per week
Duration of SEE	2	Hours
SEE	35	Marks
CIE	15	Marks
Credits	1	

Objectives:

1. To demonstrate basic principle and exposure to evaluate CAM Follower Motion and Gyroscopic effects.
2. The importance of static and dynamic balancing.
3. The methods of controlling speeds of prime movers
4. To acquire the knowledge in evaluating the stability of vehicles
5. Frequency response of spring mass system with damping and without damping - Undamped torsional vibrations of single and double rotor systems

Outcomes: At the end of the course, the students are able to

1. Demonstrate the dynamic behavior of mechanical systems. (BL-3)
2. Analyze the cam profile for different motion characteristics. (BL-4)
3. Examine the performance of governors and the gyroscopic effect on vehicles. (BL-3)
4. Evaluate the static and dynamic balancing masses in a rotating mass system. (BL-5)
5. Determine the natural frequency of different single degree freedom vibrating systems. (BL-3)

List of the Experiments

1. To study the motion of follower with the given profile of the cam. To plot the follower displacement vs angle of rotation curves for different cam follower pairs.
2. To study the gyroscopic effect on a rotating disc.
3. Determination of the frequency of torsional vibrations.
4. Static and Dynamic balancing in a rotating mass system.
5. Study the effect of varying mass on the centre of sleeve in Porter governor.
6. Study the effect of varying the initial spring compression in Hartnell governor.
7. Undamped torsional vibrations of double rotor system.
8. To study the longitudinal vibrations of helical coiled spring.
9. To study the undamped forced vibration of spring mass system.
10. To study the force damped vibration of spring mass system.
11. Determination of critical speed of the given shaft with the given end conditions (Whirling of Shafts).
12. Frequency response of spring mass system with damping.
13. Determine the equivalent link parameters and centre of mass of connecting rod theoretically and validate the result by experiment by choosing suitable methods and devices.

NOTE: Students should complete a minimum of 10 experiments including experiment 13 which is compulsory.

Text Books:

1. S.S. Rattan, “Theory of Machines”, Fourth edition Tata-Mc Graw Hill, ,2014
2. John.J.Vicker, Gordon R. Pennock, Joseph E. Shigley, “Theory of Machines & Mechanisms”, Oxford University Press, 2003.
3. William T.Thomson “Theory of Vibration with Application”, 5th edition, Pearson education 2008

Suggested Reading:

1. Robert L. Norton, “Design of Machinery”, Tata Mc Graw Hill, 2005.
2. Benson H. Tangue, “Principles of Vibration”, 2/e, Oxford University Press, 2007

18ME C16

APPLIED THERMODYNAMICS AND HEAT TRANSFER LAB

Instruction	2	Hours per week
Duration of SEE	2	Hours
SEE	35	Marks
CIE	15	Marks
Credits	1	

Objectives:

1. To demonstrate basic knowledge and exposure to determine valve and port diagram and also to evaluate the performance of the petrol engine and diesel engine.
2. Student will determine the importance of heat balance sheet of IC engine.
3. Students will acquire knowledge in evaluating the performance of multi-stage reciprocating compressor.
4. To demonstrate knowledge in evaluating thermal conductivity and heat transfer coefficient under natural convection phenomena and forced convection phenomena.
5. Students will understand the basic concepts of radiation heat transfer.

Outcomes: At the end of the course, the students are able to

1. Evaluate the performance of petrol and diesel engines. (BL-5)
2. Evaluate the heat losses in heat balance sheet of IC engine. (BL-5)
3. Determine the performance of multi stage reciprocating air compressor and its importance over single stage air compressor. (BL-3)
4. Estimate the effect of insulation on conduction heat transfer and also estimate the value of convection heat transfer coefficients under different scenario. (BL-5)
5. Determine Stefan - Boltzmann constant, emissivity of grey plate and LMTD of heat exchanger. (BL-3)

List of the Experiments:

Applied Thermodynamics

1. Determination of Valve timing diagram and Port diagram of IC engine.
2. Determination of Performance characteristics of a multi-cylinder petrol engine.
3. To conduct Morse test on multi cylinder petrol engine.
4. To conduct performance test on a variable compression ratio petrol engine.
5. To conduct performance test on single cylinder diesel engine
6. To conduct heat balance test on single cylinder diesel engine.
7. To determine volumetric efficiency, isothermal efficiency of multi -stage reciprocating air compressor.

Heat Transfer

8. Determination of thermal conductivity of composite wall.
9. Determination of convective heat transfer coefficient under Natural and Forced convection phenomena using pin-fin apparatus.
10. Determination of Emissivity of a given plate.
11. Determination of the value of Stefan-Boltzmann constant.
12. Determination of Heat transfer coefficient in parallel and counter flow heat exchanger.
13. Evaluate the performance parameters of an alternative fuel on a vertical stroke single cylinder diesel engine.

Note: Students should complete a minimum of 10 experiments including experiment 13 which is compulsory.

Text Books:

1. Mahesh M. Rathore, “Thermal Engineering”, TMH, New Delhi, 2010
2. V. Ganeshan,“Internal Combustion Engines”, Tata Mcgraw Hill Publishing, New Delhi,2015
3. J.P. Holman, “Heat Transfer”, McGraw Hill Publication, New Delhi, 2009

Suggested Reading:

1. R.K. Rajput., “Thermal Engineering”, Laxmi Publishers, New Delhi, 2014
D.S. Kumar,” Heat Transfer”, S K Kataria Publishers, 2015With Effect from the Academic Year 2020 – 2021

18PE C06

METAL FORMING TECHNOLOGY LAB

Instruction	2 Hours per week
Duration of Semester End Examination	2 Hours
SEE	35 Marks
CIE	15 Marks
Credits	1

Objectives:

Students will learn

1. To demonstrate various operations like sheet metal operations-blanking, punching, deep drawing, extrusion etc with their applications, merits and demerits.
2. To enable the students to determine loading and energy required for metal forming tools and machines.
3. To enable the students to understand different defects that occurring forming operations with remedial measures.
4. To make the students understand working principle, types, and applications of forging process.
5. To make students understand working principle, parameters, types and applications of extrusion 1process.

Outcomes:

At the end of the course, a student will be able to

1. Understand the practical aspects of metal forming operations.
2. Understand various process parameters that affect product quality under different conditions.
3. Determine load, energy and power required for various processes and machines.
4. Propose suitable metal forming processes for making different products.
5. Design and fabricate various types of dies for sheets metal operations.

List of the Experiments

1. Evaluation of Formability of a given sheet material using Erichsen cupping test.
2. Study of Simple Die design for Blanking/ Piercing operations in sheet metal forming and manufacturing of circular blanks using a mechanical press (capacity30Tons) and measurement of forces and comparing with theoretical loads.
3. Study of Progressive die design and manufacturing of washer components using the same on a fly press (capacity6Tons) and estimation of forces.
4. Study of Compound die design and manufacturing of washer components using the same on double body fly press (capacity8 Tons) and estimation of forces.
5. Study of Combination die design and manufacturing of cylindrical cups using the same on a Hydraulic power press (capacity 50Tons) and estimation of drawing force.
6. Study of deep drawing die design and measuring forces with/without blank holder for cylindrical/square cups using 10 T load cell on a Hydraulic power Press and comparing them with theoretical values.
7. Measurement of cutting force or Blanking operation using 10T load cell on Mechanical power Press for different materials and comparing theoretical and practical values.
8. Estimation of True stress and True strain for ferrous/ non-ferrous materials encountered in metal forming operations using Universal Testing Machine.
9. Study of extrusion dies and demonstration of extruding lead material.
10. Demonstration of Simulation software for metal forming operations.

Text Books:

1. Serope Kalpakjian, “Manufacturing Engineering and Technology”, 4/e, Pearson education INC., 2015.
2. George.E. Dieter, “Mechanical Metallurgy”, SI Metric Edition, McGraw –Hill, 1988.
3. P.N. Rao, “Manufacturing Technology”, 4/e, TMH, 2015.

Suggested Reading:

1. R.K. Jain, S.C. Gupta, “Production Technology”, 17/e, Khanna Publications, 2012.
2. Roy A lindberg, “Materials and Process of manufacturing”, 4/e, PHI, 2004.
3. John A Schey, “Introduction To Manufacturing Processes”, 3/e, Mcgraw Hill education, 2012.

With effect from academic year 2020-2021

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

AICTE MODEL CURRICULUM

B.E. (PRODUCTION ENGINEERING)

SEMESTER – VI

S. No.	Course Code	Title of the Course	Scheme of instruction			Scheme of examination			Credits
			Hours per week			Duration in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	18ME C17	CAD/CAM	3	--	--	3	30	70	3
2	18ME C18	Machine Design	3	--	--	3	30	70	3
3	18PE C09	Machine Tool Engineering	3	--	--	3	30	70	3
4		Core Elective – III	3	--	--	3	30	70	3
5		Core Elective – IV	3	--	--	3	30	70	3
6		Core Elective – V	3	--	--	3	30	70	3
PRACTICALS									
7	18ME C20	CAD and CAM Lab	--	--	2	2	15	35	1
8	18PE C10	Machine Tool Engineering Lab	--	--	2	2	15	35	1
TOTAL			**18**	--	**04**	--	**210**	**490**	**20**

L: Lecture T: Tutorial D: Drawing P: Practical
CIE - Continuous Internal Evaluation SEE – Semester End Examination

Core Elective – III (3/3)			**Core Elective – IV (3/3)**		
SNO	**Subj. Code**	**Name of the Subject**	**SNO**	**Subj. Code**	**Name of the Subject**
1	18ME E08	Object Oriented Programming with C++	1	18ME E12	Computational Fluid Dynamics
2	18ME E09	Mechanics of Composite Materials	2	18ME E13	Principles of Entrepreneurship
3	18ME E10	Robotic Engineering	3	18PE E08	Modern Machining and Forming Methods
4	18PE E06	Production and Operations Management	4	18ME E15	Blockchain Technology
5	18PE E07	Principles of Industrial Engineering	5	18ME E16	Finite Element Methods

Core Elective – V (3/3)		
SNO.	**Subj. Code**	**Name of the Subject**
1	18ME E17	Renewable Energy Sources
2	18ME E18	Control Systems Theory
3	18ME E19	Artificial Intelligence
4	18ME E20	Industrial Administration and Financial Management
5	18PE E10	Total Quality Management

18ME C17

CAD/CAM

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. To teach the basic design process and the importance and types of geometric modeling techniques
2. To teach the theory for modeling of surface and solid modeling techniques
3. To impart the basic skill in writing CNC part programming
4. To teach basic configurations of robot Manipulator
5. To teach concepts of part classification coding, computer aided process planning, automated inspection methods

Outcomes: At the end of the course, the students are able to

1. Understand the applications of computer in design, manufacturing, and geometric transformation techniques (BL-2)
2. Apply Wireframe, surface, and solid modeling techniques for the generating various parts. (BL-3)
3. Distinguish various NC systems and develop the CNC program. (BL-4)
4. Demonstrate the fundamentals knowledge of robotics (BL-2)
5. Understand automated manufacturing environment. (BL-2)

UNIT-I

Introduction: Introduction to CAD, Product life cycle, Design Process, Design criteria, Alternative solutions, Hardware integration and networking, Graphic Standards and Exchange Formats (IGES, STEP, STL)

Geometric Transformations: Introduction, Translation, Rotation, Scaling, Reflection Transformations, Homogenous Representation, Concatenated Transformation, Transformations about fixed point

UNIT-II

Wire frame Modeling: Wire frame entities and their definition, interpolation and approximation curves. concept of parametric and non-parametric representation of circle and helix curves, properties of splines, synthetic curves: parametric representation of cubic spline, Bezier and B-spline curves, continuity, properties and characteristics, Introduction to non-uniform rational B-splines.

Surface Modeling: Surface representation Analytic surfaces: definition of Plane surface, Ruled surface, Surface of revolution, Tabulated cylinder, Synthetic Surfaces- Hermite cubic and Bezier surfaces.

Solid Modeling: Solid entities, Boolean operations, B – rep and CSG approaches, feature based modeling, assembly modeling and mating conditions

UNIT-III

Numerical Control of Machine Tools: Features and elements of NC, Types of NC systems: PTP, straight Cut and Contouring. definition of axes, definition of interpolation, post-processor, preparatory and miscellaneous functions, canned cycles, tool length and cutter radius compensation. Manual part programming and computer aided part programming for simple components (APT).

UNIT-IV

CNC: Introduction to CNC, Typical configurations, Machining centers, Introduction to FANUC, SINUMERIC controllers

DNC: Typical configurations, CNC vs DNC.

Adaptive Control Systems: ACO and ACC.

Industrial Robots: Robot anatomy, configurations, control systems, drivers, accuracy and repeatability, end effectors, sensors in robotics, programming methods.Robot industrial applications: material handling, processing and assembly and inspection.

UNIT-V

GT: Part families, layout, part classification and coding system- OPITZ, MICLASS.

CAPP: Variant and Generative process planning.

FMS and CIM: FMS equipment, FMS layouts, benefits of FMS, Elements of CIM.

Computer Aided Inspection and QC: Automated inspection- Off-line, On-line, Contact (Co-ordinate measuring machine), Non-contact inspection (Machine Vision, Scanning LASER Beam, Photogrammetry).

Text Books:

1. Ibrahim Zeid, “CAD/ CAM Theory and Practice”, McGraw Hill Inc, New York, 2011.
2. Mikell P.Groover, “Automation, Production Systems and Computer-Integrated Manufacturing”, Pearson Publication, 4/e, 2016.
3. P.N. Rao, “CAD/CAM - Principles and Applications”, 2/e, Tata McGraw Hill, New Delhi, 2004.

Suggested Reading:

1. Yoram koren, “Computer Control of Manufacturing Systems”, McGraw Hill Int, New York, 1994.
2. C. Elanchezhian, T. Sunder Selwyn, G. Shanmuga Sunder, “Computer Aided manufacturing”, 2/e, Laxmi Publications (P) Ltd, New Delhi 2007.

18ME C18

MACHINE DESIGN

(Use of data book is permitted)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. Design principles of helical coiled and leaf springs. types of materials used for springs
2. The design principles of gears
3. The design principles of sliding contact bearings
4. The Selection of rolling contact bearings and roller chains
5. Design principles of IC engine piston, connecting rod, crank shaft, C-clamp and crane hooks

Outcomes: At the end of the course, the students are able to

1. Understand the stresses in helical, leaf springs under static and fluctuating loads. (BL-2)
2. Design the spur, helical and bevel gears. (BL-6)
3. Demonstrate the ability in designing sliding contact bearings. (BL-3)
4. Selection of rolling contact bearings and roller chains. (BL-4)
5. Design of IC engine piston, connecting rod, crank shaft, C-clamp and crane hooks. (BL-6)

UNIT-I

Mechanical Springs: Introduction, types of springs, Materials used for springs.

Helical Springs: Wahl's factor, calculation of stresses, deflection and energy stored in spring. Design for staticand fluctuating loads.

Leaf Springs: Stresses and deflection, nipping of Leaf springs. Design for static loads.

UNIT-II

Gears: Introduction to gear drives, types of gears, materials used for gears, Standards and specification of gears,Design of Spur, Helical and Bevel gears. Lewis beam strength equation. Dynamic loads on gear tooth. Wear load and design for wear strength.

UNIT-III

Bearings: Introduction, classification of bearings, materials used for bearings, properties and types oflubricants.

Design of Sliding Contact Bearings: Hydrodynamic bearings: journal bearing and thrust bearings.

Selection of Rolling Contact Bearings: Types of rolling elements and their constructional details, Static anddynamic load carrying capacity, Load-life relationship, selection of bearing, for cyclic loads and speeds.

UNIT-IV

I.C. Engine Parts: Introduction, Materials used, Design of piston, connecting rod and overhang crank shaft.

UNIT-V

Design of Curved Beams: Introduction, stresses in curved beams, expression for radius of curvature of neutralaxis for rectangular, circular and trapezoidal sections, Design of C-clamp and crane Hook.

Selection of chain drives: Power rating of roller chains, Strength of roller chains.

Text Books:

1. V.B. Bhandari, "Design Machine Elements", Mc Graw Hill Publication, 2017.
2. J.E. Shigley, C.R. Mischne, "Mechanical Engineering Design", Tata Mc Graw Hill Publications, 2015.
3. R.S.Khurmi and J.K.Gupta, "Machine design", 34th edition, S Chand publications, 2018.

Suggested Reading:

1. P. Kannaiah, "Machine Design", Sci-Tech Publications, 2010
2. M.F. Spotts, "Design of Machine Elements", Prentice Hall of India, 2013.

Machine Design Data Books:

1. K.Mahadevan, K.BalaveeraReddy.,"Design Data Hand book for Mechanical Engineers", 3/e, CBS Publisher, 2018
2. PSG College, "Design Data book",2012

18PE C09

MACHINE TOOL ENGINEERING

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Objectives:

Student will learn

1. To provide the basic understanding of cutting tools, geometry in machining process.
2. The concepts of tool wear
3. Different operations performed on lathe machine.
4. To make the students to understand various machine tools, like drilling, milling and boring machines
5. To make knowledge of Thread manufacturing and gear manufacturing.

Outcomes:

Students will be able to

1. Select tool geometry for various materials.
2. Estimate the tool wear
3. Identify the machine tools for manufacturing various components.
4. Select grinding wheel and Automats.
5. Work on shaper, planner and grinding machines.

UNIT - I

Orthogonal and Oblique Cutting: Cutting forces in turning, drilling milling and grinding, Merchant's analysis, Shear angle, friction angles. Experimental methods for estimation of shear angle, cutting forces and power, types of chips. Built up edge phenomena and its effects. Chip breakers. Sources of heat, its distribution and measurement. Different types of cutting fluids.

UNIT - II

Tool Wear and Tool Life: Criteria for tool wear, flank and crater wear theories, criteria for tool life in roughing and finishing, Measurement of tool wear, Taylor's tool life equation, factors effecting tool life, Machiniability. Single point cutting tool design; Geometry, tool nomenclature, American, DIN, max. rake system. Interrelation between normal rake and orthogonal rake, tool signature, effect of basic tool angles on its performance. Selection of size and angles of S.I. Tools, from tools. Design feature of multipoint cutting tools

UNIT - III

Lathe: Types constructional features, size of lathe, various operations that can be performed on lathes types of lathes, capstan and turret lathes, bar work and chuck work and tool holding devices. Taper turning methods. Thread cutting and accessories of lathe.

Automats: Single spindle and multiple spindle automats, Swiss type of automats, constructions and features of these machines.

UNIT - IV

Drilling Machines: Types and constructional features and applications, Radial drilling machine, drilling operations.

Milling Machines: Classifications and types various operations on milling machines, Up and down milling, Types of milling cutters and bars. Dividing head, plain, compound and differential indexing.

Boring Machines: Horizontal, Vertical and Jig boring machines and constructional features.

Thread Production: Thread rolling, thread chasing , thread milling and thread grinding.

UNIT - V

Shaping, Planing & Slotting Machines: Types, Constructional features, Types of work done on it. Quick return motion, manipulation of cutting speeds and feeds, work and tool holding devices, comparison of these machines.

Gear Cutting Machines: Methods of gear cutting, types and classification of gear hobbing, gear shaping machines Bevel gear cutting.

Grinding Machines: Types, Classification Abrasives and bonds used for grinding wheel, Selection of grinding wheel, cylindrical grinding and center less grinding.

Text Books:

1. B.L. JuneJa and Shekon, Fundamentals of "Metal Cutting & Machines Tools", Wiley Eastern Ltd. 1987.

2. P.N. Rao, “Manufacturing Technology – Metal Cutting & Machine Tools”, Vol. 2, Tata McGraw Hill Education Pvt. Ltd, 2010.
3. M.C. Shaw, “Metal Cutting Principles”, Clarendon Press, Oxford 1984.

Suggested Reading:

1. Hazra Choudary, “Workshop Technology”, Vol. II, Media Pub., New Delhi.
2. Kibbe Richand R, Meyer, R.D, Neely etal, “Machine Tool Practices”, 9/e, PHI, 2014.
3. Jain & Chitale, “Text Book of Production Engineering”, 2/e, PHI, 2014.

18ME E08

OBJECT ORIENTED PROGRAMMING WITH C++

(Core Elective-III)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. To understand difference between OOP and structured programming
2. To know classes, objects, constructors and destructors.
3. How to overload operators.
4. To understand inheritance and polymorphism
5. Knowledge about templates and exception handling.

Outcomes: At the end of the course, the students are able to

1. Identify fundamental object oriented concepts of C++ programming Language. (BL-1)
2. Distinguish between object oriented program and structured programming (BL-2)
3. Use operator overloading to give comfort in the programming. (BL-3)
4. Illustrate Exception handling and templates (BL-4)
5. Solve basic mechanical engineering problems by developing programs using object oriented features (BL-5)

UNIT - I

Principles of Object Oriented Programming: Procedure Vs Object Oriented, Paradigm, Basic concepts,benefits, Applications and Object Oriented Languages.

Introduction: Program structure, Creating, Compiling and Linking of C++ program.

Token, Expression and Control Structures: Tokens, Keywords, Identifiers and Constants, Data Types,Operators, Precedence, Type Compatibility, Control Structures, New Features of C++.

Functions: Function Prototype and Parameter Passing, Inline Functions, Default, Constant Arguments,Recursion, Function Overloading

UNIT - II

Classes and Objects: Defining classes and Member functions, creating objects, objects and arrays, objects andfunctions, const with classes, friends to a class, nesting static members of a class.

Constructors and Destructors: Type of Constructors, Dynamic Initialization of Objects, Destructors.

UNIT - III

C++ Operator Overloading and Type Conversions: Fundamentals, restrictions, overloading unary / binaryoperators, overloading ++ and —, overloading special operators, overloading by member functions and friend functions, type conversions.

UNIT - IV

C++ Inheritance: Defining derived classes, Types of Inheritance, Virtual Base class Abstract Class, functionoverriding and containership.

Pointers and Polymorphism: Pointers and Generic pointer, Pointer to Objects and Derived Classes, thispointer, Virtual Functions, Virtual Destructors

UNIT - V

C++ Templates: Introduction, function templates and class templates.

C++ Exception Handling: Conventional error handling mechanism, C++ error handling mechanism, Try,throw, catch, exception handling in classes.

Text Books:

1. Rohit Khurana, “Object oriented programming with C++”, Vikas publications. 2/e, 2014.
2. Ashok Kamtani, “Object Oriented Programming with ANSI and Turbo C++”, Pearson Education, 2017.
3. Somshekara, “Object Oriented Programming with C++”, Eastern Economy Edition, 2/e, 2012.

Suggested Reading:

1. E. Balagurusamy, “Object Oriented Programming with C++”, McGraw-Hill Education (India), 6/e, 2018.
2. Robert Lafore, “Object-Oriented Programming in C++”, 4/e, Sams Publishing, 2016.

18ME E09

MECHANICS OF COMPOSITE MATERIALS

(Core Elective - III)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. Application and use of composite materials in industry.
2. Types of fibers and matrix materials used in commercial composites.
3. Prediction of the properties of UD lamina based on the constituent materials.
4. Analysis of composite laminates based on classical lamination theory.
5. Method of predicting failure in composite lamina using different theories.

Outcomes: At the end of the course, the students are able to

1. Differentiate between composite materials and conventional materials using basic concepts. (BL-2)
2. Analyze macro and micro mechanical behaviour of a lamina. (BL-4)
3. Determine role of constituent materials in defining the average properties and response of composite materials on macroscopic level. (BL-3)
4. Analyze the laminates for stresses and strains using Classical lamination theory (BL-4)
5. Summarize the various fabrication methods of composite materials and measurements of properties through tests. (BL-2)

UNIT-I

Introduction: Definition, characteristics, overview of advantages and limitations of Composite materials. classification, significance, objectives of composite materials and applications.

UNIT-II

Basic concepts and characteristics: Scale of analysis; Micromechanics, Macromechanics, Macro and micro mechanical behaviour of a lamina: Stress strain relations for anisotropic materials, Restrictions on engineering constants, transformation of stress, Strain and elastic parameters.

UNIT-III

Elastic behaviour of UD Lamina: Elastic constants of a lamina using MOM approach, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation. Tensile and compressive strength of unidirectional fibre composites, Macromechanical failure theories, applicability of various failure theories. Max stress theory, max strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria.

UNIT-IV

Elastic Behaviour of Laminate: Basic assumptions, Strain-displacement relations, classical Lamination Theory [CLT], Stress-strain relation of layer within a laminate, Force and moment resultant, classification of laminates. Analysis of different types of laminates.

UNIT-V

Manufacturing Processes& Testing: Hand lay-up, bag molding, autoclave processing, RTM, pultrusion, filament winding, gel time test for resins, curing cycle, Testing: Fiber and matrix tests, tensile test, compressive test, in-plane shear test, inter-laminar shear test, flexure test.

Text Books:

1. R. M. Jones, “Mechanics of Composite Materials”, Mc Graw Hill Co., 2006.
2. B. D. Agarwal, “Analysis and performance of fiber composites”, Wiley & Sons 3/e, 2013.
3. Ronald F Gibson, “Principles of composite material mechanics”, CRC press. 4/e, 2016.

Suggested Reading:

1. Isaac M. Daniels and Ori Ishai, “Engineering Mechaincs of Composite Materials”, Oxford University Press, 1994.
2. M.W.Hyer, “Stress Analysis of Fibre Reinforced Composite Materials”, McGraw Hill Co., 1998.

18ME E10

ROBOTIC ENGINEERING

(Core Elective–III)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. Principle of working of a robot, types and specifications,configuration, work envelop and motion controls and applications
2. Transformations, kinematics and dynamics of robots
3. Singularities, Jacobian and trajectory planning of a robot to prepare the robot for various tasks
4. Design of end effectors, drives, working of sensors and controllers for finding position and orientation.
5. Robot vision for image acquisition and processing and plan for various tasks and various Languages and Programming methods of robot.

Outcomes: At the end of the course, the students are able to

1. Understand the basic components and specifications of the Robots (BL-2)
2. Solve the problems of transformations, direct and inverse kinematics of robots (BL-3)
3. Analyze forces in links and joints of a robot and find the singularities, Jacobian and trajectory planning of a robot for various tasks (BL-4)
4. Recommend sensors and controllers for finding position and orientation to take corrective action based on feedback (BL-5)
5. Design an intelligent robot using machine vision and sensors (BL-6)

UNIT - I

Overview of Robots and Subsystems: Brief History, Types of robots, resolution, repeatability and accuracy,degrees of freedom of robots, Robot configurations, Workspace, Mechanisms and transmission, End effectors and Different types of grippers, vacuum and other methods of gripping, Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.

UNIT – II

Direct Kinematics: Rotation matrices, Euler angle and RPY representation, Homogeneous transformationmatrices, Denavit-Hartenberg notation, representation of absolute position and orientation in terms of joint parameters, direct kinematics.

UNIT - III

Inverse Kinematics: inverse orientation, inverse locations, Singularities, Jacobian, Trajectory Planning: jointinterpolation, task space interpolation, executing user specified tasks, sensor based motion planning.

UNIT - IV

Analysis of RP and RR Type Robots: Static force analysis of RP type and RR type planar robots, Dynamicanalysis using Lagrangean and Newton-Euler formulations of RR and RP type planar robots. Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, force feedback, hybrid control

UNIT - V

Sensors and Controllers: Internal and external sensors, position, velocity and acceleration sensors, proximitysensors, force sensors, laser range finder. Robot vision: image processing fundamentals for robotic applications, image acquisition and preprocessing. Object recognition by image matching and based on features

Text Books:

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw-Hill, 2003.
2. Spong and Vidyasagar, “Robot Dynamics and Control”, John Wiley and sons, 2008.
3. Mikell P. Groover “ Industrial Robotics”, McGraw-Hill, 2008.

Suggested Reading:

1. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, “Robotics, control, sensing, Vision and Intelligence”, McGraw Hill International, 1987
2. Steve LaValle, “Planning Algorithms”, Cambridge Univ. Press, New York, 2006.

18PE E06

PRODUCTION AND OPERATIONS MANAGEMENT

(Core Elective-III)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. Understand plant layout design to facilitate material flow and processing of a product in the most efficient manner
2. Gain some ability to recognize situations in a production system environment that suggests the use of certain quantitative methods to assist in decision making on operations management and strategy.
3. Understand how Materials Requirement Planning and MRPII systems are used in managing operations
4. Recognize the importance of Inventory control to ensure their availability with minimum capital lock up.
5. Evaluate the quality processes in manufacturing and service sector to improve the operational performance

Outcomes: At the end of the course, the students are able to

1. Understand the role of production system and its design in Production and Operations Management. (BL-2)
2. Apply forecasting techniques for predicting demand. (BL-3)
3. Use Aggregate Planning, Master Scheduling and Materials Requirement Planning in a production system. (BL-3)
4. Compare various inventory control techniques used in production system. (BL-4)
5. Apply the quality control tools to improve performance of production system. (BL-3)

UNIT-I

Introduction: Production systems classification and characterization

Plant Location and Layout: Factors affecting plant location, Objectives of Plant layout, different types of layouts, merits and demerits.

Work Study: Productivity, Introduction to method study and work measurement, standard time calculations, work sampling, wages and incentive plans.

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UNIT-II

Forecasting: Introduction, forecasting objectives and uses, demand patterns, qualitative models, market survey,Delphi method, quantitative models, moving average, weighted moving average, simple exponential smoothing, trend adjusted exponential smoothing, simple regression.

Forecast Errors: Mean Absolute Deviation (MAD), Mean Square Error (MSE), Mean Forecast Error (MFE),Mean Absolute Percentage Error (MAPE)

UNIT-III

Aggregate Planning and Master Scheduling: Introduction, objectives of aggregate planning, cost in aggregateplanning, strategies in aggregate planning, master production scheduling

Materials Requirement Planning (MRP): Importance of MRP, MRP system inputs and outputs, bill ofmaterials (BOM).

UNIT-IV

Inventory Control: Importance of Inventory control, Inventory control systems, Types of Inventories, Inventory costs, Deterministic Inventory models - Basic Purchase model, Purchase model with Instantaneous replenishment and with shortages, Basic Production model, Production model with shortages, Inventory model with price breaks.

UNIT-V

Quality Control: Introduction, quality gurus and their contributions, quality tools, process capability, qualitycontrol by control charts, control charts for variables and attributes, sampling plans, operating characteristic curve, introduction to total quality management (TQM).

Text Books:

1. William J. Stevenson, “Operations Management”, 8/e, Tata Mc Graw Hill Edition, 2005.
2. Joseph G. Monks, “Operations Management: Theory and Problems”, 3/e, McGraw Hill International Edition, 1987.
3. ElwoodS. Buffa, “Modern Production/Operations Management”, 5/e, John Wiley Publishers, Singapore, 2002.

Suggested Reading:

1. Everrete E. Adama & Ronald J. Ebert, “Production & Operations Management”, 5/e, Prentice Hall of India, 2005.
2. R. Panneerselvam, “Production and Operations Management,” 2/e, PHI Learning Pvt. Ltd., New Delhi, 2006.

18PE E07

PRINCIPLES OF INDUSTRIAL ENGINEERING (Core Elective-III)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Objectives: Student will learn the

1. Basic principles of industrial engineering along with work study techniques.
2. Significance of production planning & control.
3. Necessity of inventory control techniques.
4. Essence of quality engineering.
5. Productivity improvement tools and techniques.

Outcomes: At the end of the course, the students are able to

1. Conceptualize the essence of industrial engineering techniques.
2. Plan, execute and control production related issues.
3. Analyze and choose right inventory control techniques.
4. Plot control charts and apply quality control tools.
5. Apply productivity improvement techniques.

UNIT - I

Concepts of Industrial Engineering: Productivity-concepts, Principles and Techniques, Production Vs Productivity, Productivity Improvement Methods. Work Study: Method Study and Work Measurement steps involved in method study and work measurement, Recording Techniques-Flow Process Charts, multiple activity chart, two handed process chart, SIMO Chart. Various techniques of work measurement-Time Study, Work Sampling, PMTS etc, Standard time computation.

UNIT - II

Plant Location and Layout: Factors for Plant Locations, Types of production - Mass, batch, job. Types of plant layout - product, process and fixed position layouts, cellular layouts.

UNIT - III

Production Planning and Control: Elements of PPC-Planning, Routing, Scheduling, Dispatching., Materials Requirement Planning (MRP), Manufacturing Resource Planning (MRP II).JIT and KANBAN system.

UNIT - IV

Inventory Control: ABC analysis, FSN analysis, VED Analysis, P System, Q System. Economic order quantity, Lead time, Buffer Stock, ASRS, Stores management.

UNIT - V

Quality Engineering: Control Charts-X, R, P, C charts. OC Curve, Acceptance Sampling, Kaizen, ISO-9000, Quality Concepts by Deming, Juran, Philip Crosby. Taguchi ' loss function.

Text Books:

1. SK Hajra Choudhury, Nirjhar Roy, AK Hajra Choudhury, "Industrial Engineering & Management", Media Promoters & Pub. Pvt. Ltd.,
2. Banga and Sharma, "Industrial Engineering and Management", Khanna Publishers, 2008.
3. O.P. Khanna, "Industrial Engineering and Management", Dhanpat Rai Pub.,
4. M.S. Mahajan, "Industrial Organization & Management", Nirali Prakashan Pub.

Suggested Reading:

1. K.K.Ahuja, "Industrial Management", Khanna Publishers, 5/e, 1993.
2. James L. Riggs,"Production Systems - Planning Analysis And Control" Wiley Publishers, 1992.
3. Elwood S Buff Rakesh K Sarin, "Modern Production Operations Management", John Wiley & Sons (Asia) Pte Ltd. 1983.

18ME E12

COMPUTATIONAL FLUID DYNAMICS

(Core Elective - IV)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. To understand governing equations of fluid flow
2. To understand turbulence and how to model them.
3. To know how to descretize governing equations of fluid flow by FDM and their stability.
4. To learn various iterative methods to solve N-S equation.
5. To understand FVM to solve fluid flow equations.

.**Outcomes:** At the end of the course, the students are able to

1. Describe and develop mathematical models for flow phenomena. (BL-1)
2. Classify PDE for fluid flow and heat transfer applications. (BL-2)
3. Apply Finite Difference Method for fluid flow and heat transfer problems (BL-3)
4. Test the discretized equations for stability and solve the system of linear equations (BL-4)
5. Formulate numerical equations by Finite Volume Method for fluid flow and heat transfer problems (BL-6)

UNIT-I

Basic Equations: Continuity, momentum and energy equations, Navier-Stokes equations, Heat transferconduction equations for steady and unsteady flows, steady convection-diffusion equation

UNIT-II

Models: Reynolds and Favre averaged N-S equations, mixing length model, k-epsilon turbulence model. **Classifications of Partial Differential Equations:** Elliptic, parabolic and hyperbolic equations, Initial andboundary value problems.

UNIT-III

Finite Difference Method: Forward, backward and central difference.

Parabolic partial differential equations: Euler, implicit and crank Nicholson methods, ADI models, Errors,consistency, stability analysis, Vonnumen analysis, Convergence criteria

UNIT-IV

Elliptic Partial Differential Equations: Jacobi, Gauss Seidel methods, TDMA, Viscous incompressible flow,Vorticity Stream function method.

UNIT-V

Finite Volume Method: Finite volume formulation for diffusion equation, convection diffusion equation,Solution algorithm for pressure velocity coupling in steady flows, staggered grid, SIMPLE algorithm.

Text Books:

1. P.S. Ghoshdastidar, “Computational Fluid Dynamics & Heat Transfer”, Cengage Pub., 2018.
2. J.D. Anderson, Jr., “Computational Fluid Dynamics: The Basic with Applications”, McGraw Hill, Inc., 2012.
3. H. Versteeg and W. Malalasekra, “An Introduction to Computational Fluid Dynamics : The Finite Volume Method”, 3/e ,Pearson, , 2016

Suggested Reading:

1. F. John Wendt (Editor), “Computational Fluid Dynamics - An Introduction”, Springer – Verlag, Berlin, 1992.
2. Charles Hirsch, “Numerical Computation of Internal and External Flows”, Vols. I and II. John Wiley & Sons, New York, 1988.

18ME E13

PRINCIPLES OF ENTREPRENEURSHIP

(Core Elective - IV)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. Concept and procedure of idea generation
2. The nature of industry and related opportunities and challenges
3. Elements of business plan and its procedure
4. Project management and its techniques
5. Behavioral issues and Time management

.**Outcomes:** At the end of the course, the students are able to

1. Understand the concept and essence of entrepreneurship. (BL-2)
2. Identify business opportunities and nature of enterprise. (BL-3)
3. Analyze the feasibility of new business plan. (BL-4)
4. Apply project management techniques like PERT and CPM for effective planning and execution of projects. (BL-3)
5. Use behavioral, leadership and time management aspects in entrepreneurial journey. (BL-3)

UNIT-I

Entrepreneurship: Definition, functions of entrepreneurship, qualities of entrepreneurs, Entrepreneur vs intrapreneur, First generation entrepreneurs, women entrepreneurs, innovation and Intellectual property in entrepreneurial journey, conception and evaluation of ideas and their sources, need and importance of startups and incubation centers.

UNIT-II

Indian Industrial Environment: Competence, opportunities and challenges, Entrepreneurship and Economic growth, Entrepreneurship and Engineering, Small Scale Industry in India, objectives, Linkage among small, medium and large scale industries, Types of enterprises**,** corporate social responsibility.

UNIT-III

Formulation of Business Plan: Introduction, Elements of Business Plan and its salient features, Business model canvas, Technical Analysis, Profitability and Financial Analysis, Marketing Analysis, Feasibility studies, Executive Summary. Choice of Technology and Collaborative interactions, Sources of finance and Incentives for entrepreneurs.

UNIT-IV

Project Management: During construction phase, project organization, project planning, execution and control using CPM, PERT techniques, Human aspects of project management, Assessment of tax burden, environmental issues.

UNIT-V

Behavioral Aspects of Entrepreneurs: Personality, determinants, Maslow's Hierarchy of needs, Leadership concepts and models, Values and attitudes, Motivation aspects, Change behavior Time Management: Approaches of time management, their strengths and weaknesses. Time management matrix and the urgency addiction

Text Books:

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. S.S. Khanka, "Entrepreneurial Development", S. Chand & Co. Pvt. Ltd., New Delhi, 2012

Suggested Reading:

1. Robert D. Hisrich, Michael P. Peters, "Entrepreneurship", 5/e, Tata Me Graw Hill Publishing Company Ltd., 2005
2. Stephen R. Covey and A. Roger Merrill, "First Things First", Simon and Schuster Publication, 1994.

18PE E08

MODERN MACHINING AND FORMING METHODS

(Core Elective - IV)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. Various non-conventional machining processes and their process parameters.
2. The relative merits, limitations and applications of various non-conventional machining processes.
3. The knowledge regarding working media and its functions of non-conventional machining processes.
4. The concepts of non-conventional forming processes such as rubber pad forming, hydro forming, stretch forming, etc.
5. The concepts of HERF and to provide the description of HERF process

Outcomes: At the end of the course, the students are able to

1. Compare the Traditional and Non Traditional Machining process and recognize the need for Non traditional Machining process. (BL-2)
2. Illustrate constructional features, performance parameters, process characteristics, applications, advantages and limitations of Non Traditional Machining process. (BL-3)
3. Classify mechanisms of material removal of various non traditional machining processes. (BL-4)
4. Describe the principles, characteristics, advantages, limitations and applications of various unconventional methods of forming, HERF. (BL-1)
5. Compare the principles, constructional features and applications among explosive forming, EHF and EMF.

i. (BL-4)

UNIT-I

Ultrasonic Machining (USM):Introduction, Process description, abrasive slurry, Abrasive materials and theircharacteristics, Functions of liquid medium in slurry, Types of transducers, effect of process parameters, applications and limitations.

Abrasive Jet Machining (AJM): Principle of operation, process details, process variables and their effect onMRR and accuracy, advantages, disadvantages and applications

Water Jet Machining (WJM): Schematic diagram, equipment used, advantages and applications.

Abrasive Water Jet Machining (AWJM): Process, advantages, limitations and applications

UNIT-II

Electro Discharge Machining (EDM): Process description with schematic diagram, process parameters,functions and characteristics of dielectric medium, dielectric fluids, flushing, mechanism of metal removal, types of power supply circuits, mathematical analysis of metal removal rate (MRR), equations for surface finish, characteristics of spark eroded surfaces, advantages, disadvantages and applications.

Wire EDM: Process description and applications.

Laser Beam Machining (LBM): Principle of LASER beam production, materials used, process parameters,advantages, limitations and applications.

Plasma Arc Machining (PAM): Introduction, equipment used, process description and parameters, types of plasma arc: transferred arc and non transferred arc and process applications.

Electron Beam Machining (EBM): Schematic of the process, process parameters, principle of production ofelectron beam, equipment used, advantages, disadvantages and applications.

UNIT-III

Electro-chemical machining (ECM): Schematic of processparameters, function and characteristics of electrolyte, MRR for pure metal and alloys, electrode feed rate (EFR), advantages, limitations and applications.

Chemical Machining : Chemical blanking and chemical milling, advantages, limitations and applications.**ION Etching**: Process description, merits, limitations and applications.

UNIT-IV

High Energy Rate Forming Processes (HERF): Introduction, applications, advantages

Explosive Forming: Principles, explosive materials, Equipment, types of explosive forming, standoffoperation and contact operation.

Electro Hydraulic Forming (EHF): Schematic of process, description and its applications

Electro Magnetic Forming (EMF): Process description, merits, limitations and applications.

UNIT-V

Flexible Forming: Principle of the process, process details and its types, Guerin, wheelon, Mar formingand Hydro forming processes and applications

Stretch Forming: Introduction, types of stretch forming, stretch draw forming, rotary stretch forming or stretchwrapping, compression forming, radial draw forming.

Tube spinning: Introduction, methods of tube spinning, backward spinning, forward spinning.

Text Books:

1. P.C. Pandey and H.S. Shah, "Modern Machining Process", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1980.
2. J Paulo Davim, "Modern Machining Technology - A Practical Guide", 1/e, Woodhead Publishing in Mechanical Engineering, 1980.
3. Hassan Abdel-Gawad El-Hofy, "Advanced Machining Processes, Nontraditional and Hybrid Machining Processes", McGraw Hill Publishing Co. Ltd., 1984.

Suggested Reading:

1. Davies and Austin, "Developments in High Speed Metal Forming", The Machinery Publishing Co. Ltd., 1985.
2. "Production Technology", HMT, 1984.

18ME E15

BLOCKCHAIN TECHNOLOGY

(Core Elective -IV)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Course Objectives:

1. To provide Conceptual understanding of how blockchain technology can be used to improve business processes.
2. To facilitate understanding of bit coin and working with consensus in Bitcoin.
3. To impart knowledge about designing and building Permissioned blockchains.
4. To introduce supply chain management and internet enabled supplychains.
5. To familiarize with blockchain applications.

Course Outcomes: At the end of the course, the students are able to

1. Outline the concepts of blockchain technology. (BL-2)
2. Understand the bit coin, working with consensus in Bitcoin. (BL-2)
3. Develop knowledge about designing and building Permissioned block chains. (BL-3)
4. Explain the concepts of supply chain management and internet enabled supply chains. (BL-2)
5. Make use of blockchain applications involved in various sectors. (BL-3)

UNIT- I

Introduction: History, blockchain Architecture, nodes, crypto currency, tokens, cryptography- private and public keys, hash, ledgers, bitcoin, design Primitives- digital Signature, protocols, security, consensus, understanding Crypto currency.

UNIT- II

Bitcoin and block chain: creation of coins, payments and double spending, bitcoin scripts, bitcoin p2p network, transaction in bitcoin network, block mining, block propagation and block relay.

Working with consensus in bitcoin: distributed consensus in open environments, consensus in a bitcoin network, proof of work (pow) – basic introduction, hashcash pow, bitcoinpow, attacks on pow and the monopoly problem, proof of stake, proof of burn and proof of elapsed time, the life of a bitcoin miner, mining difficulty, mining pool.

UNIT- III

Permissioned Block chain: Definition, merits and demerits, differences between permissioned and permissionless blockchain, overview of Consensus models for permissioned block chain- Distributed consensus in closed environment, Paxos, RAFT, Byzantine fault tolerant (BFT) system, Lamport-Shostak-Pease BFT Algorithm.

Enterprise application of Block chain: Cross border payments, Know Your Customer (KYC), Food security, Mortgage over Blockchain, Blockchain enabled Trade.

UNIT- IV

Blockchain and the world economy: Supply chain industry-past and future, supply chain using blockchain technology, building blocks of a supply chain network, business processes in supply chains,

types of supply chains and examples, strategic, tactical, and operational decisions, supply chain performance measures. ERP and automation.
Internet-enabled supply chains: e-marketplaces, e-procurement, e-logistics, e-fulfillment, customer relationship management, web services.

UNIT -V

Applications of blockchain technology: Uses of blockchain in e-governance, land registration, property records, notary, titles, micropayments, medical information systems, next generation of industry 4.0 and additive manufacturing, government identity management, auto executing contracts, three signature escrow, triple entry.

Text Books:

1. Melanie Swan, "Block Chain: Blueprint for a New Economy", 1st Edition O'Reilly, 2015.
2. Andreas Antonopoulos, “Mastering Bitcoin: Unlocking Digital Crypto currencies”, 1st Edition, O’Relly, 2015.
3. Tiana Laurence, “Introduction to blockchain technology”, Van Haren Publishing, ’s-Hertogenbosch, 2019.

Suggested Reading:

1. Daniel Drescher, “Block Chain Basics”, 1st Edition, Apress, 2017.
2. RiteshModi, “Solidity Programming Essentials: A Beginner’s Guide to Build Smart Contracts for Ethereum and Block Chain”, Packt Publishing, 2018.

18ME E16

FINITE ELEMENT METHODS (Core Elective - IV)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
SEE	70 Marks
CIE	30 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 and beam problems
3. Enable the students to formulate 2D problems with special cases
4. Enable the students to formulate quadrilateral element, use of numerical integration, Gaussian quadrature and one dimensional dynamic problems
5. Enable the students to understand the convergence requirements, heat transfer , formulate 3D problems and perform engineering simulations using Finite Element Analysis software (ANSYS)

Outcomes: At the end of the course a student will be able to

1. Apply FE method for solving field problems using Virtual work and Potential energy formulations
2. Analyze linear problems like axial, trusses and beam problems
3. Analyze 2D structural problems using CST element and analyze plane stress, plane strain and axi-symmetric problems with triangular elements.
4. Write shape functions for 4 node quadrilateral isoparametric elements, apply numerical integration, Gaussian quadrature and to estimate natural frequencies for stepped bar
5. Check for convergence requirements, Solve linear 1D and 2D heat conduction and convection heat transfer problems, formulate 3D elements, apply finite element analysis software for engineering solutions

UNIT - I

Fundamental concepts: Introduction to finite element method, stresses and equilibrium, boundary conditions, strain – displacement and stress – strain relationship

One dimensional problems: Finite element modeling co-ordinates and shape functions, virtual work and potential energy approach, Assembly of global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, analysis of axial element and quadratic element

UNIT - II

Analysis of trusses and frames: Element stiffness matrix for a truss member, Analysis of plane truss with two degrees of freedom at each node, Analysis of beams: element stiffness matrix for two nodes (two degrees of freedom per node), Analysis of frames with two translations and rotational degrees of freedom per node

UNIT - III

2D triangular elements: plane stress, plane strain and axisymmetry, finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions, Finite element modeling of axisymmetric solids subjected to axisymmetric loading with triangular elements

UNIT - IV

Quadrilateral elements and numerical integration: Two dimensional four noded isoparametric elements, numerical integration and Gauss quadrature

Dynamic analysis: Formulation of finite element model, element mass matrices, Evaluation of Eigen values and Eigen vectors for a stepped bar

UNIT - V

Heat transfer analysis: Steady state heat transfer analysis: One dimensional analysis of a fin and two dimensional analysis of thin plate

3 D elements and FEA software: Introduction to finite element formulation of three dimensional problems in stress analysis, convergence requirements

Introduction to Finite Element analysis software: Modeling, analysis and post processing

Text Books:

1. Ramamurthy, G. "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", Practice Hall of India, 1997.
3. Daryl L. Logan, "A First Course in the Finite Element Method", Cengage Learning, 2011.

Suggested Reading:

1. Rao S S, "The Finite Element Method in Engineering", Pergamon Press, 1989.
2. Segerlind L J, "Applied Finite Element Analysis", Wiley Eastern, 1984.
3. Reddy JN, "An Introduction to Finite Element Method ", McGraw-Hill, 1984.
4. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt., "Concepts and Applications of FiniteElement Analysis", 4/e, Wiley.

18ME E17

RENEWABLE ENERGY SOURCES

(Core Elective - V)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. Need and importance of non-conventional energy resources
2. Extent of solar energy which can be utilized as energy resource
3. Concept of wind energy and its merits and demerits
4. Operating principles of geothermal energy and bio-energy
5. Merits and demerits of tidal energy, wave energy and OTEC

Outcomes: At the end of the course, the students are able to

1. Understand the need for renewable energy sources in the context of environmental issues. (BL-2)
2. Apply the principles of solar energy for domestic and industrial usages. (BL-3)
3. Understand the working principle of wind power plants along with merits and demerits. (BL-2)
4. Describe the concepts of geothermal energy sources and biomass as a source of energy. (BL-2)
5. Explain the principles and impact of wave, tidal and OTEC plants on the environment. (BL-2)

UNIT-I

Energy Sources: Energy characteristics, forms of energy, energy chain (route), energy sectors, Indian energy scenario, energy pricing in India, energy and environment, energy security, energy conservation and its importance, energy strategy for future, classification of energy sources, availability of conventional and non-conventional (renewable) energy sources, classification of RES - solar, wind, geothermal, bio-mass, ocean tidal, ocean wave and ocean thermal energy conversion (OTEC), advantages and limitations of conventional and renewable energy sources.

UNIT-II

Solar Energy: Solar radiation, solar thermal collectors, working of flat plate and concentrating (focusing) solar collectors and their limitations, comparison of flat plate and focusing collectors, applications of solar collectors - water heating, space heating, low temperature power generation, solar cookers, water pumping, SODIS, solar thermal power plant, advantages and limitations of solar energy systems, PV materials, PV cells and their manufacturing, space based solar power (SBSP), solar satellite system, advantages and disadvantages of SBSP.

UNIT-III

Wind Energy: Sources of wind, merits and demerits of wind energy, site selection for wind energy conversion system, wind turbine (wind mill), classification of wind mills, working principle horizontal axis and vertical axis windmills, horizontal vs vertical axis windmills, power extracted from the wind, effect of velocity on power generation, new developments and problems in operating large wind power generators.

UNIT-IV

Geothermal Energy: Layers in earth, resources of geothermal energy, hydrothermal, petrothermal and geopressure resources, advantages, disadvantages, applications and environmental effects of geothermal energy sources.

Biomass Energy: Resources, biogas and its composition, process of biogas generation, wet process and dry process, raw materials available for biogas fermentation, economical, social, environmental and health benefits of biogas utilization, selection of site and constructional techniques of a biogas plant, working of KVIC, Pragathi design, Janata and Deenbandu biogas plants, common operational problems, causes and remedies relating to a biogas plant.

UNIT V

Tidal power: Tidal systems, site selection for tidal power plant, schematic layout of tidal power house, principle of operation of single basin and double basin tidal plants, advantages and disadvantages of tidal

power.

Wave energy - Differences between tides and waves, advantages and disadvantages of wave power, problems associated with wave energy collection, working principle of wave energy conversion devices.

Ocean thermal energy conversion (OTEC) - OTEC power plants, location, open cycle and closed cycle OTEC plants, advantages, limitations and applications of OTEC, environmental impact of OTEC plants.

Text Books:

1. S. Hasan Saeed and D.K. Sharma, "Non Conventional Energy Resources", S.K. Kataria & Sons, New Delhi, 2017.
2. Dr. R.K. Singal, "Non Conventional Energy Resources", S.K. Kataria & Sons, New Delhi, 2005.
3. G.D. Rai, "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 2011.

Suggested Reading:

1. K. M. Mittal, "Non-Conventional Energy Systems", Wheeler Publishing Co. Ltd, New Delhi, 2003.
2. Shali Habibulla, "Non-Conventional Energy Sources", State Institute of Vocational Education, Hyderabad, 2005.

18ME E18

CONTROL SYSTEMS THEORY

(Core Elective - V)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. To provide with basic knowledge of control systems, associated terminologies, transfer function.
2. Familiar with basic electrical, mechanical & electromechanical system and their representation in Differential Equation /Transfer function form.
3. To make students familiar with system performance analysis in time & frequency domain.
4. To understand different methods of stability analysis
5. To provide basic pathway to space representation and controllability and observability

Outcomes: At the end of the course, the students are able to

1. Understand control system, modeling and transfer functions of different systems**.** (BL-3)
2. Apply the concept of block diagram and signal flow graphs to different systems. (BL-3)
3. Differentiate between time domain and frequency domain techniques. (BL-2)
4. Examine the stability of a system using different approaches. (BL-3)
5. Analyze the system in state space and to find out the controllability and observability. (BL-4)

UNIT-I

Mathematical Modeling: Introduction to control systems **,** Open loop & closed loop systems, Mathematicalmodeling & Mechanical systems, Transfer functions from Governing equations, Electrical, hydraulic systems pneumatic, thermal systems, AC,DC servomotors &Electromechanical servo systems

UNIT-II

Components of Control System: Introduction to Block diagrams & Problems, Signal flow graph & mason'sgain formula, Transient response &time domain specifications of 1^{st} order systems, 2^{nd} order systems & time domain specifications, Steady state error, error coefficients, Sensitivity Performance Indices

UNIT-III

Time Domain Analysis: Routh criteria & root locus method, Frequency response, Bode & polar plots,Correlation between Transient & frequency response, Band width, Experimental determination of transfer function

UNIT-IV

Stability Analysis: Nyquist Criteria, Phase & gain margins, Lead, lag compensator design lead-lagcompensator design, PID-controller, linearization of non linear systems

UNIT-V

State Space Representation: State space representation of linear control systems, State transition matrix, **Solution of State Space Equations**: Zero input response and Zero state response, Concept of controllability &observability

Text Books:

1. K. Ogata, "Modern control Engineering", Prentice Hall, 2015.
2. M. Gopal., "Control Systems", Tata McGraw Hill, 2012.
3. D. Roy Choudhury, "Control System Engineering", PHI, 2005

Suggested Reading:

1. Norman S.Nise., “Control Systems Engineering”, John Wiley & sons, Inc., 2018.
2. R.C. Dorf, “Modern Control systems”, Addison Wesley, 2011

18ME E19

ARTIFICIAL INTELLIGENCE

(Core Elective - V)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. Provide a strong foundation of fundamental concepts in Artificial Intelligence.
2. Discuss the various paradigms involved in solving an AI problems which involve perception, reasoning and learning
3. Apply the AI concepts to build an expert system to solve the real-world problems.
4. Familiarize with the types of machine learning.
5. Applications of AI in the field of mechanical engineering.

Outcomes: At the end of the course, the students are able to

1. Differentiate between a rudimentary Problem and an AI problem, its Characteristics and problem solving Techniques. (BL-2)
2. Compare and contrast the various knowledge representation schemes of AI. (BL-4)
3. Analyze various reasoning and planning techniques involved in solving AI problems. (BL-4)
4. Understand the different learning techniques. (BL-2)
5. Apply the AI techniques in the field of mechanical engineering. (BL-3)

UNIT - I

Introduction: Definition, history, applications. Problem Solving: AI problems, AI Technique, Defining problem as a State-Space Search, Problem Characteristics. Heuristic Search Techniques: Generate–and–test, Hill Climbing, Constraint Satisfaction.

UNIT - II

Knowledge Representation (Logic): Representing facts in logic, proposition logic, predicate logic, resolution and unification. Knowledge Representation (Structured): Declarative representation, Semantic nets, procedural representation, frames.

UNIT - III

Reasoning: Probability and Bayes theorem, certainty factors and rule based systems, Bayesian Networks, Dempster-Shafer theory. Planning: components, goal stack planning, nonlinear planning, hierarchical planning.

UNIT - IV

Learning: Introduction, Rote learning, learning by taking advice, learning in problem solving and learning from examples: decision tree. Intelligent Agents: classification, working of an agent, single agent and multi agent systems, multi agent application.

UNIT – V

Expert System: Representing and Using Domain Knowledge, Expert systems shells, Explanation, Knowledge Acquisition. Perception and Action: Real Time Search, Vision, Speech Recognition, Action: Navigation, Manipulation, Robot architectures. Scope and applications of AI in Mechanical Engineering

Text Books:

1. Elaine Rich, Kevin Night, Shivashankar B Nair, “Artificial Intelligence”, 3/e, TMH, 2008
2. Russell Norvig, “Artificial Intelligence-Modern Approach”, 3/e, PearsonEducation, 2010
3. Nilakshi Jain “Artificial Intelligence: Making a System Intelligent”, Wiley India, 2019

Suggested Reading:

1. Saroj Kaushik, “Artificial Intelligence”, Cengage Learning India, 2012
2. Deepak Khemani, “A First Course in Artificial Intelligence”, TMH, 2017

18ME E20

INDUSTRIAL ADMINISTRATION AND FINANCIAL MANAGEMENT

(Core Elective - V)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives:

1. Various types of business organizations and organization structures and importance of plant location and plant layout
2. Importance of industrial engineering techniques like method study and work measurement.
3. The significance of quality control and production planning and control
4. The importance of project management techniques
5. The total cost of a product based on elements of cost

Outcomes: At the end of the course, the students are able to

1. Understand different types of business organizations, functions of management and importance of various types of plant layouts. (BL-2)
2. Apply techniques of method study and work measurement in organizations to enhance productivity (BL-3)
3. Usequality control charts and tools in industries. (BL-3)
4. Apply various optimization and project management techniques for solving real time problems. (BL-3)
5. Understand basic concepts of Cost accounting and financial management . (BL-2)

UNIT-I

Industrial Organization: Definition of an organization, types of various business organizations, organizationstructures and their relative merits and demerits, functions of management.

Plant location and layouts: Factors affecting the location of plant and layout, types of layouts and their meritsand demerits.

UNIT-II

Work study: Definitions, objectives of method study and time study, steps in conducting method study,symbols and charts used in method study, principles of motion economy, calculation of standard time by time study and work sampling, performance rating factor, types of ratings, job evaluation and performance appraisal, wages and incentive plans.

UNIT-III

Inspection and quality control: Types and objectives of inspection, S.Q.C., its principles. Quality control charts and sampling plans, quality circles, introduction to ISO.

Production planning and control (PPC): Types of production systems, principles of PPC and itsfunctions.

UNIT-IV

Optimization: Introduction to linear programming and graphical solutions, assignment problems.

Project Management: Introduction to CPM and PERT, determination of critical path.

Material Management: Classification of materials, materials planning, duties of purchase manager,determination of economic ordering quantities, types of materials purchase.

UNIT-V

Cost accounting: Elements of cost, various costs, types of overheads, break even analysis and its applications,depreciation, methods of calculating depreciation fund, nature of financial management, time value of money, techniques of capital budgeting and methods, cost of capital, financial leverage.

Text Books:

1. O.P. Khanna “Industrial Engineering and Management”, Dhanapat Rai & Sons, 2018
2. S.D. Sharma, “Operations Research” , Kedarnat , Ramnath & Co., Meerut,2012
3. Pandey I.M. , “ Financial Management”, Vikas Publ. House, New Delhi, 2016

Suggested Reading:

1. William J Stevenson, “Operations Management”, McGraw Hill, 2018
2. Paneer Selvam, “Production and Operations Management”, Pearson Education, 2012.

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18PE E10

` **TOTAL QUALITY MANAGEMENT** (Core Elective - V)

Instruction	3	Hours per week
Duration of Semester End Examination	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

Objectives: Student will understand

1. The essence of total quality management in design and manufacturing a product
2. The various principles and concepts of total quality management
3. The various technical tools of quality like control charts and ANOVA etc
4. The quality information system
5. The awareness about measuring and satisfying customer needs

Outcomes: At the end of the course, the student is able to

1. Apply TQM techniques in engineering applications
2. Use various theories and principles related to TQM
3. Use statistical techniques in TQM
4. Have awareness and use quality information system and innovative systems
5. Deal with customer grievances and satisfying the customers

UNIT-I

Strategic Quality Management: Quality policies, quality goals, obstacle to achieving successful strategic quality management, Organization for quality role of {Top, middle, work force team (Quality Circles)}, Developing a quality work culture, Maslow need theory, Herzberg two factor theory, Theory X, Y & Z methods to create and maintain awareness of quality, provide evidence of management leadership, types of self development and empowerment programmes, methods of participations means of inspiring action, recognition and rewards, Supplier quality rating plans (lot plot plan, OC curve, parent analysis), assignment of supplier capability, methods of evaluating supplier products, contract management (Joint economic plan, joint technological forecasting

UNIT-II

Design for Quality: Basic functional requirements of quality, design for (reliability, safety, cost and product performance), concurrent engineering (DFMA) value engineering, support for quality improvement processes (block diagram, brain storming, cause effect analysis, pareto analysis), quality function deployment, reliability analysis, failure rate, failure pattern of complex products (bath tub curve), weibull distribution relationship between part and the system, exponential reliability, availability, FMEA (Fracture Mode and Effect Analysis), Design for experiments: Factorial experiments, construction fractional designs

UNIT-III

Technical Tools for Quality: Analysis of variance (ANOVA), 4 factor ANOVA experiment, 2 levels, analysis of means, Techniques for online quality: data collection plan, variable and attribute charts, interpreting the control charts, Techniques for offline quality control: background to Taguchi method (quality loss and loss function, controllable factor, and non controllable factors in parameter performance, tolerance design

Taguchi analysis techniques: net variation and contribution ratio, estimation of process performance, accumulating analysis, performance measures, Taguchi tolerance design and tolerance (re) design

UNIT-IV

Quality Information System: Scope of Quality Information System, differences between QIS and MIS, creating new software (steps, types, defects) reports on quality (operational and executive reports), features of QIS software, software for inspection

Inspection System: Operational sorting and correlation sorting, AQL, LTPD, AOQL, Nondestructive test, Audit systems: (quality improvement planning and implementation, describing quality function, process control system, control of measurement system, material identification and control, drawing and specification control, process corrective action), the concept of POKAYOKE

UNIT-V

Measure of Customer Needs: The need to measure customer satisfaction, importance of proper packaging, customer processing and installation of product, dealing with customer complaints, using weibull analysis, field feedback, parameter to measure customer (dis)satisfaction, problems with the customer satisfaction system

Beyond TOM: Difficulties in implementing TOM system, rating your quality system, JIT system, the people side of TOM system, system integration, Kansei engineering and flexibility in manufacturing

Text Books:

1. L. Suganthi, Aanand A. Samuel, "Total Quality Management", PHI Learning Pvt. Ltd., 2004.
2. H.G. Menon, "TQM in view Production Manufacturing", McGraw Hill Publishers.

Suggested Reading:

1. Joel E. Ross & Susan Perry, "Total Quality Management: Text, Cases, and Readings", 3/e, CRC Press, 1999.
2. John S Oakland, "Total Quality Management: The route to improving performance", 2/e, A Butterworth-Heinemann Title, 1994.
3. Jankiraman, "Total Quality Management: Text and Cases", 1/e, PHI Learning Private Limited-New Delhi, (2006).

18ME C20

CAD/CAM LAB

Instruction	2	Hours per week
Duration of SEE	2	Hours
SEE	35	Marks
CIE	15	Marks
Credits	1	

Objectives:

1. To teach the basic design process and the importance and types of geometric modeling techniques
2. To teach Assembly modeling by applying suitable assembly constraints
3. To generate orthographic views of components and assemblies.
4. To demonstrate the Indication of size, form and positional tolerances on the drawing sheets
5. To demonstrate the working of CNC machines and write part programs for different operations

Outcomes: At the end of the course, the students are able to

1.	Model components using CAD software. Select appropriate commands to generate 3D model	(BL-3)
2.	Select constraints to assemble the components	(BL-3)
3.	Develop manufacturing drawings from 3D models	(BL-3)
4.	Analyze the concept CNC part program to generate tool path for different machining operations	(BL-4)
5.	Develop a product using CAD/CAM technology	(BL-6)

List of the Exercises:

1. Introduction to CAD Package, Working with sketch mode and introduction to various Part Features.
2. Part modeling of various machine components
3. Format of drawing sheet, title block, Generating and editing drawings
4. Assembly modeling of Stuffing Box
5. Assembly modeling of Screw Jack
6. Assembly modeling of Crosshead
7. Production drawing of components and indicating tolerances on size and geometrical form, Position; Indicate Surface finish, surface treatments if any and writing process sheet for anyone component
8. Introduction to CNC machines, Working, writing of process sheets, Contouring on CNC Milling Machine.
9. Rectangular & Circular Pocketing on CNC Milling Machine
10. Step Turning and Taper Turning on CNC Lathe Machine
11. Multiple Turning on CNC Lathe Machine
12. Study of 3D printer
13. Design a product and Manufacture / generate CNC Machining tool path for its components

Note: Student should complete a minimum of 10 exercises including exercise number 13 which is compulsory.

Text books:

1. P.N. Rao, "CAD/CAM: Principles and Applications",Tata McGraw-Hill, July 2017
2. N Mehta, "Machine Tool Design and Numerical Control", McGraw Hill Education, 3/e, 2017

3. Dassault Systems, “SOLIDWORKS Essentials: Training”, SolidWorks corp., 2011

Suggested Reading:

1. https://my.solidworks.com/solidworks/guide/SOLIDWORKS_Introduction_EN.pdf
2. https://help.solidworks.com

18PE C10

MACHINE TOOL ENGINEERING LAB

Instruction	2 Hours per week
Duration of Semester End Examination	2 Hours
SEE	35 Marks
CIE	15 Marks
Credits	1

Objectives: Students will learn

1. To grind single point cutting tool using HSS as cutting tool.
2. To do various operations on lathe and drilling machines
3. The gear cutting and to cut gear on milling machine.
4. Measure cutting forces during machining on Lathe machine, milling.
5. Unconventional machining operations like EDM & ECM.

Outcomes:

At the end of the course, a student will be able to

1. Grind single point cutting tool with various angles.
2. Perform various machines on lathe.
3. To manufacture a gear using milling machine.
4. Do operation on shaper.
5. Get exposure to various unconventional processes.

List of the Experiments

1. Introduction to Machine Tools, like Lathe, Drilling, Milling and Shaper.
2. Plain and step turning operations on Lathe.
3. Step turning and Knurling on Lathe machine.
4. Taper turning on Lathe.
5. Drilling and Boring on Lathe.
6. Thread Cutting on Lathe.
7. Grinding of Single Point Cutting Tool.
8. Gear Cutting using (a) Plain Indexing (b) Compound Indexing.
9. Measurement of Cutting forces during machining on Lathe machine and Milling machine.
10. Finding Shear angle experimentally in turning operation.

Text Books:

1. B.L. JuneJa and Shekon, "Fundamentals of Metal Cutting & Machines Tools", Wiley Eastern Ltd. 1987.
2. P.N. Rao, "Manufacturing Technology – Metal Cutting & Machine Tools", Vol. 2, Tata McGraw Hill Education Pvt. Ltd, 2010.
3. M.C. Shaw, "Metal Cutting Principles", Clarendon Press, Oxford 1984.

Suggested Reading:

1. Hazra Choudary, "Workshop Technology", Vol. II, Media Pub., New Delhi.
2. Kibbe Richand R, Meyer, R.D, Neely etal, "Machine Tool Practices", 9/e, PHI, 2014.
3. Jain & Chitale, "Text Book of Production Engineering", 2/e, PHI, 2014.