BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ORISSA
MECHANICAL ENGINEERING

5th SEMESTER				6th SEMESTER			
THEORY		*Contact Hours*		*THEORY*		*Contact Hours*	
Code	*Subject*	*L-T-P*	*Credits*	*Code*	*Subject*	*L-T-P*	*Credits*
PCME4301	Machine Dynamics	3-0-0	3	HSSM3302	Optimization in Engineering	3-0-0	3
PCME4303	Design of Machine Elements	3-0-0	3	PCME4307	Advanced Mechanics of Solids	3-0-0	3
PCME4304	Machining Science & Technology	3-0-0	3	PCME4306	Design of Machine Components	3-0-0	3
PCME4302	I.C. Engines & Gas Turbines	3-0-0	3	PCME4305	Heat Transfer	3-0-0	3
	Professional Elective – I (Any one)	3-0-0	3		Professional Elective – I (Any one)	3-0-0	3
PEME5301	Automobile Engineering			PEME5305	Robotics & Robot Applications		
PEME5302	CAD & CAM			PEME5306	Modern Manufacturing Processes		
PEME5304	Tribology			PEME5307	Computer Integrated Manufacturing & FMS		
PEME5303	Rapid Prototyping			PEME5308	Non Conventional Energy Sources		
	Free Elective – I (*Any One*)	3-0-0	3		Free Elective – II (*Any One*)	3-0-0	3
FESM6302	Advance Numerical Methods			FEME6301	Finite Element Method		
PCEC4301	Microprocessors			PCEC4304	Digital Signal Processing		
FEME6302	Project Management			PCIT4301	Internet and web technology		
PCBM4301	Elements of Biomedical Instrumentation/			PECS5303	Pattern Recognition		
PCIT4303	Java Programming.			PEIT5301	Ecommerce		
		Credits (Theory)	18			Credits (Theory)	18
	PRACTICALS/SESSIONALS				*PRACTICALS/SESSIONALS*		
PCME7302	Production Lab & IC Engines Lab.	0-0-3	2	PCME7305	Heat Transfer & Heat Power Lab .	0-0-3	2
PCME7301	Machine Dynamics & Heat Power Lab	0-0-3	2	PCME7307	Numerical Computation & Solids Modeling Lab	0-0-3	2
PCME7303	Machine Design Project - I	0-0-3	2	PCME7306	Machine Design Project - II	0-0-3	2
	Credits (Practicals / Sessionals)		**6**		**Credits (Practicals/Sessionals)**		**6**
	TOTAL SEMESTER CREDITS		**24**		**TOTAL SEMESTER CREDITS**		**24**
	TOTAL CUMULATIVE CREDITS		**133**		**TOTAL CUMULATIVE CREDITS**		**157**

PCME4301 **MACHINE DYNAMICS** (3-0-0)

Module – I **(12 hours)**

1. Mechanisms with lower pairs : Motor Vehicle Steering Gears - Davis Steering Gear & Ackermann Steering Gear, Hooke's Joint.
2. Gyroscope : Concept on Gyroscopic Couple for Plane Disc & Two-bladed airscrew, Effect of Gyroscopic Couple on Ships & Aeroplanes, Stability of Two Wheelers and Four Wheelers. Analysis on bearing reactions due to Forced Precession of Rotating Disc mounted on Shafts, Introduction on Gyroscopic Stabilisation.
3. Toothed gears : **:** Gear terminology, law of gearing , Theory of shape and action of tooth properties and methods of generation of standard tooth profiles, Standard proportions, Path of contact, Arc of contact, Contact ratio, Interference and Under – Cutting, Methods for eliminating Interference, Minimum number of teeth to avoid interference.

Module II **(12 hours)**

4. Cams : Types of cams, Types of followers, Types of follower motions - Simple Harmonic, Uniform Velocity and Constant Acceleration & Retardation Types, Analysis for Displacement, velocity and Acceleration of Follower, Generation of Cam Profiles by Graphical Method, Introduction on Cams with specified contours.
5. Governors : Centrifugal Governors - Watt, Porter, Proell and Spring Loaded Governor of Hartnell type, Controlling Force & Controlling Force Curve, Sensitiveness, Stability, Isochronism, Hunting, Governor Effort and Power, Effect of Friction & Coefficient of insensitiveness.
6. Dynamics of Machines : Dynamic Force Analysis of Four-Bar Mechanism and Slider Crank Mechanism. using D'Alemberts Principle, Flywheel and Determination of its size from Turning Moment Diagram & Maximum Fluctuation of Energy.

Module III **(12 hours)**

7. Balancing : Static and Dynamic Balancing, Balancing of Single Rotating Mass by Balancing Masses in Same plane and in Different planes. Balancing of Several Rotating Masses rotating in Same plane and in Different planes. Effect of Inertia Force due to Reciprocating Mass on Engine Frame, Partial balance of single cylinder engines. Primary and Secondary Balance of Multi-cylinder In-line Engines. Direct and Reverse Crank method of balancing for radial engines.
8. Vibrations: Introduction to Mechanical Vibration – Longitudinal, Torsional & Transverse Systems, Concept on Degrees of Freedom. Free and Forced Vibration of Un-damped and Damped Single Degree Freedom Systems, Vibration isolation and transmissibility, Whirling of shafts and Evaluation of Critical Speeds of shafts..

Text Books

1. Theory of Machines by Thomas Bevan, CBS Publications
2. Theory of Machines by S.S.Rattan, Tata MacGraw Hill
3. Theory of Mechanisms and Machines by A.. Ghosh and A.. K.. Mallik, EWP

Reference

1. Kinematics & Dynamics of Machinery-Charles E. Wilson & J.Peter Saddler,Pearson Ed.
2. Theory of Machines and Mechanisms (India Edition) by John J. Uicker Jr., Gordon R. Pennock and Joseph E. Shigley, Oxford University Press
3. Kinematics and Dynamics of Machinery by R.L.Norton, Tata MacGraw Hill
4. Theory of Machines and Mechanisms by P.L.Ballaney, Khanna Publishers
5. Mechanism and Machine Theory by J.S.Rao and R.V.Dukipatti, New Age International
6. Theory of Mechanisms and Machines by C.S.Sharma and K.Purohit, PHI
6. Theory of Machines by R.S.Khurmi and J.K.Gupta, S.Chand Publication
7. Theory of Machines by Shah Jadwani, Dhanpat Rai
8. A Textbook of Theory of Machines by R. K. Bansal, Laxmi Publication
9. Theory of Machines by Abdulla Shariff, Dhanpat Rai Publishers
10. Theory of Machines by Sadhu Singh, Pearson Education.

PCME4303 **DESIGN OF MACHINE ELEMENTS** (3-0-0)

[Only specified data book as mentioned in the syllabus is permitted during examination]

Module-I (**12 hours)**

Stages in design, Standardization, Interchangeability, Preferred numbers, Fits and Tolerances, Engineering materials, Ferrous, Non-ferrous, Non-metals, Indian standard specifications for Ferrous materials, Fundamentals of Machine Design, Allowable stress, Factor of safety, Use of Code/Data books.

Design of Joints: Riveted joints, Boiler joints, Welded and bolted joints based on different types of loading. Illustrative problems with solutions.

Module-II (14 hours)

Design of Cotter joints with socket and spigot, with a Gib. Design of knuckle joint. Illustrative problems with solutions.

Design of shafts, solid and hollow based on strength and on rigidity. Illustrative problems with solutions.

Design of keys and pins, Suck key, Feather key, Taper pin. Illustrative problems with solutions.

Design of shaft couplings : Rigid Flange coupling, Flexible Flange coupling.

Module-III (14 hours)

Design of circular section, Helical springs, Tension and compression types, Design of leaf springs: Cantilever and semi-elliptical types. Illustrative problems with solutions. Levers, classification, Design of Foot levers, Hand lever, Cranked lever, Lever of lever loaded – safety - valve. Design of belt and pulley Power screw design with square thread, such as screw jack. Illustrative problems with solutions.

TEXT BOOKS:

1. Mechanical Engineerng Design, J.E.Shigley, C.R.Mischke, R.G.Budynas and K.J.Nisbett, TMH
2. Machine Design, P.Kanaiah, Scietech Publications

REFERENCE BOOKS:

1. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.
2. Machine Design, P.C.Sharma and D.K.Agrawal, S.K.Kataria & Sons
3. Machine Design, Pandya and Shah, Charotar Book Stall
4. Machine Design**,** Robert L. Norton, Pearson Education Asia, 2001.
5. Machine Design, A CAD Approach: Andrew D Dimarogonas, John Wiley Sons, Inc, 2001.
6. Fundamentals of Machine Component Design, Robert C. Juvinall and Kurt M Marshek, Wiley India Pvt. Ltd., New Delhi, 3rd Edition, 2007
7. A Text Book of Machine Design, R.S.Khurmi and J.K.Gupta, S.Chand Publication
8. Machine Design, H.Timothy and P.E.Wentzell, Cengage Learning
9. Computer Aided Analysis and Design, S.P.Regalla, I.K.International Publishing

DESIGN DATA HAND BOOKS:

1. P.S.G.Design Data Hand Book**,** PSG College of Tech Coimbature
2. Design Data Hand Book**,** K. Lingaiah, McGraw Hill, 2nd Ed. 2003.
3. Design Hand Book by S.M.Jalaluddin ; Anuradha Agencies Publications

PCME4304 **MACHINING SCIENCE & TECHNOLOGY** (3-0-0)

Module – I **(13 hours)**

Geometry of cutting tools in ASA and ORS, Effect of Geometrical parameters on cutting force and surface finish, Mechanics of chip formation, Merchant's theory, Force relationship and velocity relationship, Cutting tool materials, Types of Tool Wear: Flank wear, Crater wear, Wear measurement, Cutting fluid and its effect; Machinability Criteria, Tool life and Taylor's equation, Effect of variables on tool life and surface finish, Measurement of cutting force, Lathe tool dynamometer, Drill tool dynamometer. Economics of machining.

Module – II **(13 hours)**

Conventional machining process and machine tools – Turning, Drilling, Shaping, Planning, Milling, Grinding. Machine tools used for these processes, their specifications and various techniques used.

Principles of machine tools : Kinematics of machine tools, speed transmission from motor to spindle , speed reversal mechanism, mechanism for feed motion, Tool holding and job holding methods in different Machine tools, Types of surface generated, Indexing mechanism and thread cutting mechanism, Quick return mechanism,.

Production Machine tools – Capstan and turret lathes, single spindle and multi spindle semiautomatics, Gear shaper and Gear hobbing machines, Copying lathe and transfer machine

Module – III **(10 hours)**

Non-traditional Machining processes :

Ultrasonic Machining, Laser Beam Machining, Plasma Arc Machining, Electro Chemical Machining, Electro Discharge Machining, Wire EDM , Abrasive Jet Machining

Text Books :

1. Fundamentals of Machining and Machine Tools, G.Boothroyd and W.A.Knight, CRC Press
2. Metal Cutting Principles, M.C.Shaw, Oxford University Press
3. Metal Cutting Theory and Practice, A.Bhattacharya, Central Book Publishers

Reference Books :

1. Manufacturing Technology – by P.N.Rao, Tata McGraw Hill publication.
2. Modern Manufacturing Processes, P.C.Pandey, H.S.Shan, Tata McGraw Hill
3. Manufacturing Science, Ghosh and Mallik, East West Press.
4. Metal Cutting Theory and Practice, D.A.Stephenson and J.S.Agapiou, CRC Press
5. Machining Technology; Machine Tools and Operation, H.A.Youssef and H. El-Hofy, CRC Press
6. Machine Tools and Manufacturing Technology, Krar, Rapisarda and Check, Cengage Learning
7. Technology of Machine Tools, Krar, Gill and Smidt, Tata McGraw Hill
8. Principles of Metal Cutting, G.Kuppuswamy, Universities Press
9. Metal Cutting and Machne Tools, G.T.Reddy, Scitech
10. Fundamentals of tool Engineering Design, S.K.Basu, S.K.Mukherjee, R. Mishra , Oxford & IBH Pub Co.
11. Machine Tools, R.N.Datta, New Central Book Agency

PCME4302 **IC ENGINES & GAS TURBINES** (3-0-0)

Module - I **(11 hours)**

Introduction :

Classification, Engine nomenclature, engine operating and performance parameters, Valve timing diagram of SI & CI Engines, Comparison of SI and CI engine.

Modern developments in IC Engines, EGR, MPFI, CRDI, GDI, HCCI, dual fuel engine, Lean burn engine, Stratified engine (basic principles).

Thermodynamic Analysis of cycles :

Significance of Fuel-Air & Actual cycles of I.C. engines. Comparison with Air Standard Cycles. Analysis of Fuel-Air & Actual cycles (Effect of chemical equilibrium and variable specific heats. Effect of air fuel ratio and exhaust gas dilution. Time Loss Factor, Heat Loss Factor, Exhaust Blow down, Loss Due to Gas Exchange Processes, Volumetric Efficiency, Loss due to Rubbing Friction)

Fuels : Fuels of SI and CI engine, Fuel additives, Properties, potential and advantages of alternative liquid and gaseous fuels for SI and CI engines (biofuels, LPG and CNG)

Fuel Induction Techniques in IC engines :

Fuel induction techniques in SI and CI engines, Mixture Requirements at Different Loads and Speeds.

Carburetion: Factors Affecting Carburetion, Principle of Carburetion, Simple Carburetor and its drawbacks, Calculation of the Air–Fuel Ratio, Modern Carburetors.

Module II **(15 hours)**

Fuel Injection: Functional Requirements of an Injection System, Classification of Injection Systems, Fuel Feed Pump, Injection Pump, Injection Pump Governor, Mechanical Governor, Pneumatic Governor, Fuel Injector, Nozzle, Injection in SI Engine, Electronic Injection Systems Multi-Point Fuel Injection (MPFI) System, Functional Divisions of MPFI System, Injection Timing, Group Gasoline Injection System, Electronic Diesel Injection System.

Ignition : Energy requirement for ignition, requirements of an ignition system, conventional ignition systems, modern ignition systems (TCI and CDI), firing order, Ignition timing, Spark advance mechanism,

Combustion : Stages of combustion in SI and CI engines, effects of engine variables on flame propagation and ignition delay, Abnormal combustion, Preignition & Detonation, Theory of Detonation. Effect of engine variables on Detonation, control of Detonation. Diesel Knock & methods to control diesel knock, Requirements of combustion chambers. Features of different types of combustion chambers system for S.I. engine. (I-head, F-head combustion chambers), C.I. engine combustion chambers - Open and divided type, Air swirl turbulence-M. type combustion chamber. Comparison of various types of combustion chambers.

Super Charging & Scavenging : Thermodynamics Cycles of supercharging. Effect of supercharging, Efficiency of supercharged engines. Methods of super charging, supercharging and scavenging of 2-stroke engines.

Module-III **(14 hours)**

Testing and Performances : Power, fuel & air measurement methods, Performance characteristic curves of SI & CI engines, variables affecting performance and methods to improve engine performance.

Cooling & Lubricating Systems, Engine Emission & Controls : Air cooling & water cooling systems, Effect of cooling on power output & efficiency, Properties of lubricants and different types of lubricating system.

Engine Emission and control :
Mechanism of pollutant formation and its harmful effects. Methods of measuring pollutants and control of engine emission.
Gas Turbines : Introduction, Open and closed cycle gas turbines, Analysis of practical gas turbine cycle.
Air Craft Propulsion : Analysis of Turbo Jet, Turbo Prop, Turbo fan & Ram jet engines.
Axial Flow & Centrifugal Compressor : Basic construction of centrifugal and axial flow compressor, Velocity diagram, performance characteristics of centrifugal and axial flow compressor, effects of slip, surging and stalling on compressor.

Text Books:
1. Internal Combustion Engines, V. Ganesan, TMH, 3rd edition
2. Gas Turbines, V.Ganesan, TMH, 3rd edition

Reference books:
1. IC Engines, Mathur & Sharma
2. Fundamentals IC Engines, J.B.Heywood, McGraw Hill
3. A course in IC Engines, V.M.Domkundwar, Dhanpat rai and sons
4. Gas Turbines, Cohen and Roser
5. An Introduction to Energy Conversion, Vol.III, V.Kadambi and Manohar Prasad, New Age International
6. Fundamentals of Internal Combustion Engines, H.N.Gupta, PHI
7. Internal Combustion Engines, K.K.Ramalngam, Scitech Publications

Professional Elective-I

PEME5301 **AUTOMOBILE ENGINEERING** (3-0-0)

Module I **(14 hours)**

Introduction
Main units of automobile chassis and body, different systems of the automobile, description of the main parts of the engine, motor vehicle act.

Power for Propulsion
Resistance to motion, rolling resistance, air resistance, gradient resistance, power required for propulsion, tractive effort and traction, road performance curves.

Breaking systems
Hydraulic breaking system, breaking of vehicles when applied to rear, front and all four wheel, theory of internal shoe brake, design of brake lining and brake drum, different arrangement of brake shoes, servo and power brakes.

Module II **(12 hours)**

Transmission Systems
Layout of the transmission system, main function of the different components of the transmission system, transmission system for two wheel and four wheel drives. Hotchkiss and torque tube drives.
Gear box : Sliding mesh, constant mesh and synchromesh gearbox, design of 3 speed and 4 speed gear box, over drive, torque converter, semi and fully automatic transmission.
Hookes joint, propeller shaft, differential, rear axles, types of rear axles, semi floating, there quarter floating and full floating types.

Module III **(14 hours)**

Front wheel Geometry and steering systems : Camber, castor, kingpin inclination, toe-in and toe-out, centre point steering condition for true rolling, components of steering mechanism, power steering.

Electrical system of an automobile : Starting system, charging system, ignition system, other electrical system.

Electrical vehicles:

History, electrical vehicles and the environment pollution, description of electric vehicle, operational advantages, present EV performance and applications, battery for EV, Battery types and fuel cells, Solar powered vehicles, hybrid vehicles.

Textbooks :

1. Automobile Mechanics , N.K.Giri, Khanna publishers
2. Automobile Engineering, K.M. Gupta, VolI & II, Umesh Publication

Reference Books

1. Automotive mechanics: William h. Crouse and Donald L. Anglin, TMH
2. The motor vehicle, Newton and Steeds
3. Automobile Mechanics, J. Heitner, East West Press
4. Automobile Engineering, Jain and Asthana, Tata McGraw Hill
5. Automobile Engineering, K.K.Ramalingam, Scitech
6. Automobile Engineering, Vol. I & II, Kirpal Singh, Standard Publications
7. A Text Book of Automobile Engineering, R.K.Rajput, Laxmi Publishers

PEME5302 **COMPUTER AIDED DESIGN AND COMPUTER AIDED MANUFACTURING** (3-0-0)

Module I **(11 hour)**

Fundamentals of CAD: Design process, Applications of computer for design, Creating the Manufacturing Database, The Design workstation, Graphical Terminal, Operator input Devices, Plotters and other devices, Central Processing Unit, Memory types.

Module II **(11 hour)**

Computer graphics Software and Database: Configuration, Graphics Packages, Constructing the Geometry, Transformations of geometry, Database structure and content, Wire frame versus solid modeling, Constraint– Based modeling, Geometric commands, Display control commands, Editing.

Module III **(14 hour)**

CAM - Numerical Control and NC Part Programming: Numerical Control, Numerical Control elements, NC Cordinate system, NC motion control system, Manual and Computer Aided programming, the APT language, Miscellaneous Functions, M, Advanced part-programming methods.

Problems with conventional NC, NC technology: CNC, DNC, Combined DNC/ CNC system, Adaptive control manufacturing systems, Computer Integrated Manufacturing system, Machine Tools and related equipment, Materials Handling system: AGV, Robots, Lean manufacturing.

Text Books

1. CAD/CAM Computer Aided Design and Manufacturing, M.P.Goover and E.W.Zimmers, Jr., Pearson

Reference Books

1. CAD/CAM Theory and Practice, Zeid and Subramanian, TMH
2. CAD/CAM Principles, Practice and Manufacturing Management, McMahon and Browne, Pearson Education
3. CAD/CAM Concepts and Applications, C.R.Alavala, PHI
4. Computer Aided Design and Manufacturing, Lalit Narayan, Mallkarjuna Rao and Sarcar, PHI
5. CAD/CAM Theory and Conepts, K.Sareen and C.Grewal, S.Chand Publication
6. CAD/CAM/CAE, N.K.Chougule, Scitech
7. Principle of Interactive Computer Graphics, W.W.Newman, R.F.Sproull, TMH

PEME5304 **TRIBOLOGY** (3-0-0)

Module - I **(12 hours)**

Introduction : Lubricant and lubrication, Types of bearings, properties and testing of lubricants,

Basic equations: Generalized Reynolds equation, Flow and Shear Stress, Energy equation, Equation of state

Hydro dynamic lubrication :

Mechanism of pressure development and load carrying capacity, Plane-slider bearing, Idealized slider bearing with a pivoted shoe, Step bearing, Idealized journal bearing. – infinitely long journal bearing, Petroffs equation for a lightly loaded bearing, narrow bearing,

Module - II **(11 hours)**

Oil flow and thermal equilibrium - Heat balance of lubricants

Hydrostatic Bearing **:**

Principles, Component of hydrostatic lubrication , Hydrostatic circular thrust bearing , calculation of pressure, load carrying capacity, flow rate , power loss in bearing due to friction.

Module - III **(12 hours)**

Concept of gas lubricated bearing

Concept of Elastohydrodynamic lubrication, Design and selection of antifiction bearing

Friction and wear of metals :

Theories of friction, surface contaminants, Effect of sliding speed on friction, classification and mechanism of wear, Wear resistant materials.

Text Books

1. Introduction to Tribology of Bearing , B.C .Majumdar , S. Chand & Co

Reference Books

1. Fundamentals of Tribiology , Basu S K., Sengupta A N., Ahuja B. B., , PHI 2006
2. Basic Lubrication theory, A. Cameron, John Wiley & sons
3. Lubrication Fundamentals, D.M.Pirro and A.A.Wessol, CRC Press
4. Theory and Practice of Lubrication for Engineers**,** Fuller, D., New York company 1998
5. Principles and Applications of Tribiology**,** Moore, Pergamaon press 1998
6. Tribiology in Industries**,** Srivastava S., S Chand and Company limited, Delhi 2002
7. Lubrication of bearings – Theoretical Principles and Design**,** Redzimovskay E I., Oxford press company 2000

PEME5303 **RAPID PROTOTYPING** (3-0-0)

Module – I **(12 hours)**

Product Development: Classification of manufacturing processes, Different manufacturing systems, Introduction to rapid Prototyping (RP), Need of RP in context to batch production, FMS and CIM and its application. Product prototyping – solid modeling and prototype representation, reverse engineering, prototyping and manufacturing using CNC machining.

Basic principles of RP steps in RP, Process chain in RP in integrated CAD-CAM environment, Advantages of RP

Module - II **(12 hours)**

Rapid Manufacturing Process Optimization: factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation.

Classification of different RP techniques based on raw materials, layering technique (2D or 3D) and energy sources.

Process technology and comparative study of stereo lithography (SL) with photopolymerisation, SL with liquid thermal polymerization, solid foil polymerization, selective laser sintering, selective powder binding, Ballastic particle manufacturing – both 2D and 3D, Fused deposition modeling, Shape melting

Module – III **(12 hours)**

Laminated object manufacturing solid ground curing, Repetitive masking and deposition.

Beam interference solidification, Holographic interference solidification special topic on RP using metallic alloys, Programming in RP modeling, Slicing, Internal Hatching, Surface skin films, support structure.

Software for RP: STL files, Overview of Solid view, magics, imics, magic communicator, etc. Internet based software, Collaboration tools.

Text Book :

1. Rapid Prototyping and Engineering Applications, Frank W. Liou, CRC Press
2. Introduction to Rapid Prototyping, Amitav Ghosh, North West Publication, New Delhi

Reference Books :

1. Rapid Manufacturing, Flham D.T & Dinjoy S.S Verlog London 2001.
2. Rapid Prototyping Materials, Gurumurthi, IISc Bangalore.
3. Rapid Automated, Lament wood. Indus press New York
4. Stereo Lithography and other RP & M Technologies**,** Paul F. Jacobs: SME, NY 1996.
5. Rapid Prototyping**,** Terry Wohlers Wohler's Report 2000" Wohler's Association 2000.

Free Elective – II

FESM6302 **ADVANCE NUMERICAL METHODS** (3-0-0)

Unit-I :
Interpolation: Piecewise Linear Interpolation, Piecewise Quadratic Interpolation, Piecewise Cubic Hermite Interpolation, Piecewise Spline Interpolation.
Numerical Differentiation: First Derivative, Higher Derivatives, Partial Derivative, Richardson's Extrapolation.
Romberg algorithm for numerical integration.

Unit-II
Eigen values and Eigen Vectors: Basic power method, Rayleigh Quotient, Shifted power method, Accelerating convergence, Inverse power method, Basic QR method, Better QR method, Finding eigen vectors, Accelerating convergence
Fourier methods: Discrete Fourier Transforms, Fast Fourier Transforms, Matrix form of FFT, Algebraic form of FFT, Mixed-Radix FFT

Unit-III
Ordinary Differential Equations: Adams-Bashforth Methods, Adams-Moulton Methods, Adams Predictor-Corrector methods, Other Predictor-Corrector methods (Simpson's method and Milne's method)
Parabolic Partial Differential Equation: Explicit Method, Implicit method, Crank-Nicolson method
Hyperbolic Partial Differential Equation: Explicit Method, Implicit method.
Elliptic Partial Differential Equation: Finite-Element method.

Text Book:

1. L.V. Fausett," Applied Numerical Analysis Using MATLAB", Pearson Education

Reference Books:

1. W.Cheney and D. Kincaid,"Numerical Mathematics and Computing", Fifth Edition, Thomson/CENGAGE Learning
2. S. C. Chapra, "Applied numerical methods with MATLAB", second edition, Tata McGraw Hills
3. R.J. Schilling and S.L.Harris,"Applied Numerical Methods for Engineering", CENGAGE learning

PCEC4301 **MICROPROCESSORS** (3-0-0)

Unit I:

Organization of Microprocessor

Introduction to the general concept of microprocessor organization, I/O sub-systems, programming the system, ALU, instruction execution, instruction word format, addressing modes, address/data/control bus, tristate bus, interfacing I/O devices, data transfer schemes, architectural advancements of microprocessor, evolution of microprocessors.

Unit II:

Intel 8086- Hardware Architecture:

Introduction, Bus interface unit(BIU), Execution unit(EU), pin description, register organization, instruction pointer, data register, pointer and index registers, status register, stack, external memory addressing, bus cycle (minimum mode):memory or I/O read/write for minimum mode, clock generator Intel- 8284A, bidirectional bus trans-receiver 8286/8287, bus controller 8288, bus cycle memory read/write for minimum mode, 8086 system configuration (minimum mode as well as maximum mode), memory interfacing, interrupt processing; software interrupts, single step interrupt, non-maskable interrupt, maskable interrupt, interrupt priority, DMA, Halt State, Wait for Test state, comparison between 8086 an 8088.

Unit III:

Instruction set and programming:

Programmer's model of Intel 8086, operand type, addressing modes 8086 assembler directives, instruction set, programming examples on data transfer group, arithmetic-logical groups, control transfer groups (loop and loop handling instruction), conditional and unconditional group, procedures and stack operations, string instructions.,branch program structure like IF-THEN-ELSE REPEAT-UNTIL and WHILE-DO,

I/O Interfacing ;

8-bit input- output port 8255 PPI, memory mapped i/o ports,8254 programmable Interval Timer, 8273 Programmable Direct Memory Access Controller, 8251 USART, 8279 Programmable Keyboard/Display Controller.

Text Books:

1.The 8088 and 8086 Microprocessors Programming, Interfacing, Softw, Hardware and Application; by Walter A. Triebel & Avtar Singh ; Pearson India.

2. Microprocessors and Interfacing; by Douglas V Hall ; McGraw Hill.

Reference Book:

1. Microprocessors and Micro controllers Architecture, programming and system Design 8085, 8086, 8051, 8096: by Krishna Kant; PHI.

2. The 8086 Microprocessor: Programming & Interfacing the PC- Kenneth J. Ayala, Delmar Cengage Learning, Indian Ed.

FEME6302 **PROJECT MANAGEMENT** (3-0-0)

Module-I Project Management Concepts and Needs Identification

Attributes of a Project, Project Life Cycle, The Project management Process, Benefits of Project Management, Needs Identification, Project Selection, Project organization, the project as part of the functional organization.
Project feasibility Analysis: Technical feasibility, commercial and financial visibility, Environment Analysis.

Module-II Project Planning and Scheduling:

Design of project management system; project work system; work breakdown structure, project execution plan, work packaging plan, project procedure manual; project scheduling;
bar charts, line of balance (LOB) and Network Techniques (PERT / CPM)/ GERT, Resource
allocation, Crashing and Resource Sharing, capacity planning and expansion capacity decision.

Module III Project Monitoring and Control and Project Performance
Planning, Monitoring and Control; Design of monitoring system; Computerized PMIS (Project Management Information System). Coordination; Procedures, Meetings, Control;
Scope/Progress control, Performance control, Schedule control, Cost control, Performance
Indicators; Project Audit; Project Audit Life Cycle, Responsibilities of Evaluator/ Auditor, Responsibilities of the Project Manager.

Books:

1. Project Planning, Analysis, Selection, Financing, Prasana Chandra, TMH
2. Project Management, Grey, TMH.
3. Project Management, Richman, PHI
4. Project Management, Vasant Desai, HPH
5. Project Management, Bhavesh M.Patel, Vikash
6. Project Engineering & Management- Prasanna Chandra, Prentice Hall.

PCBM4301 **Elements of Biomedical Instrumentation** (3-0-0)

Module I (13 Hours)

(i) What is bioengineering: Engineering versus Science, Bioengineering, Biochemical Engineering, Biomedical Engineering, and Career Opportunities.

(ii) Medical Instrumentation: Sources of Biomedical Signals, Basic medical Instrumentation system, Performance requirements of medical Instrumentation system, use of microprocessors in medical instruments, PC based medical Instruments, general constraints in design of medical Instrumentation system & Regulation of Medical devices.

(iii) Bioelectrical Signals & Electrodes: Origin of Bioelectric Signals, Electrocardiogram, Electroencephalogram, Electromyogram, Electrode-Tissue Interface, Polarization, Skin Contact Impedance, Motion Artifacts.

(Text Book-I-Chapter-0 , Text Book-II —Chapter-1, Text book-II- Chapter-2)

Module -II (14 Hours)

(iv) Electrodes for ECG: Limb Electrode, Floating Electrodes, Prejelled disposable Electrodes, Electrodes for EEG, Electrodes for EMG.

(v) **Physiological Transducers:** Introduction to Transducers, Classification of Transducers, Performance characteristics of Transducers, Displacement, Position and Motion Transducers.

(Text book-II- Chapter-2 , Text Book-II, Chapter- 3)

Module –III (13 Hours)

(vi) **Physiological Transducers:** Strain gauge pressure transducers, Thermocouples, Electrical Resistance Thermometer, Thermister, Photovoltaic transducers, Photo emissive Cells & Biosensors or Biochemical sensor

(vii) Recording Systems: Basic Recording systems, General considerations for Signal conditioners, Preamplifiers, Differential Amplifier, Isolation Amplifier, Electrostatic and Electromagnetic Coupling to AC Signals, Proper Grounding (Common Impedance Coupling)

(Text Book-II, Chapter- 3, Text Book-II-Chapter-4)

Text Books:-

I- Introduction to Biomedical Engineering by Michael M. Domach, Pearson Education Inc,-2004

II- Hand Book of Biomedical Instrumentation-2nd Ed by R.S.Khandpur, Tata McGraw Hill, 2003.

Reference Books:

1) Introduction to Biomedical equipment technology, 4e. By JOSEPH.J.CAAR

& JOHN.M.BROWN (Pearson education publication)
(2) Medical Instrumentation-application & design. 3e – By JOHN.G.WEBSTER John Wiley & sons publications
(3) Leslie. Cromwell – Biomedical instrumentation & measurements, 2e PHI
(4) Dr. M. Arumugam – Biomedical instrumentations, Anuradha Publishers

PCIT4303 **JAVA Programming** (3-0-0)

Module – I **12 Hrs**

Introduction to Java and Java programming Environment. Object Oriented Programming. Fundamental Programming Structure: Data Types, variable, Typecasting Arrays, Operators and their precedence.

Control Flow: Java's Selection statements (if, switch, iteration, statement, while, do-while, for, Nested loop).

Concept of Objects and Classes, Using Exiting Classes building your own classes, constructor overloading, static , final, this keyword .

Inheritance: Using Super to Call Super class constructor, Method overriding, Dynamic method Dispatch, Using Abstract Classes, Using final with inheritance. The Object Class.

Packages & Interfaces : Packages, Access Protection, Importing package, Interface, Implementing Interfaces, variables in Interfaces, Interfaces can be extended.

Exception Handling: Fundamentals, Types Checked , Unchecked exceptions, Using try & catch, Multiple catch, throw , throws, finally, Java's Built in exceptions, user defined exception.

Module - II **12 Hrs**

Multi Threading: Java Thread Model, Thread Priorities, Synchronization, Creating a thread, Creating Multiple threads, Using isAlive ( ) and join ( ), wait () & notify ( ).

String Handling: String constructors, String length, Character Extraction, String Comparison, Modifying a string.

Java I/O: Classes & Interfaces, Stream classes, Byte streams, Character streams, Serialization.

JDBC: Fundamentals, Type I, Type II, Type III, Type IV drivers.

Networking: Basics, Socket overview, Networking classes, & interfaces, TCP/IP client sockets, whois, URL format, URL connection, TCP/IP Server Sockets.

Module - III **12 Hrs**

Applets: Basics, Architecture, Skeleton, The HTML APPLET Tag, Passing Parameters to Applets, Applet context and show documents ().

Event Handing: Delegation Event model, Event Classes, Event Listener Interfaces, Adapter classes.

AWT: AWT Classes window fundamentals, component, container, panel, Window, Frame , Canvas, Creating a frame window in an Applet , working with Graphics , Control Fundamentals , Layout managers, Handling Events by Extending AWT components.

Core java API package, reflection, Remote method Invocation (RMI)

Swing: J applet, Icons & Labels, Text fields, Buttons, Combo boxes, Tabbed panes, Scroll panes, Trees, Tables.

Exploring Java-lang: Simple type wrappers, Runtime memory management, object (using clone () and the cloneable Interface), Thread, Thread Group, Runnable.

Text Books:

1. Introduction to Java Programming: Liang, Pearson Education, 7th Edition.

2. Java The complete reference: Herbert Schildt, TMH, 5th Edition.

Reference Books:

1. Balguruswamy, Programming with JAVA, TMH.
2. Programming with Java*:* Bhave &. Patekar, Pearson Education.
3. Big Java: Horstman, Willey India, 2nd Edition.
4. Java Programming Advanced Topics: Wigglesworth, Cengage Learning.
5. Java How to Program: H.M. Deitel & Paul J. Deitel, PHI, 8th Edition

PCME7302 **PRODUCTION AND I. C. ENGINE LAB** (0-0-3)

Production Laboratory (Minimum 06 experiments)

1. Determination of grain size, clay content, permeability and green compressive strength of molding sand. (2 to 3 experiments)
2. Foundry Practice
3. Determination of strength of brazed and soldered joints.
4. Study of non-traditional machining process (ultrasonic machining/ abrasive jet machining/ electro-discharge machining)
5. Determination of cutting forces in turning using lathe tool dynamometer
6. Determination of cutting forces in drilling using drilling tool dynamometer
7. Study on C. N.C. Machines and demonstration of making of job through CNC machine.
8. Calibration of slip gauge using sine bar
9. Measurement of roughness / straightness / flatness of surfaces
10. Study of microstructure of steel specimen

I. C. Engine Laboratory **(Minimum 04 experiments)**

1. Load test on 4-stroke single cylinder C.I. engine.
2. Load test on 4-stroke single cylinder S.I. engine.
3. Morse Test on multi-cylinder S.I. or C.I. engine
4. Load test on variable compression ratio S.I. engine
5. Load test and Heat balance on 2 stroke S.I. Engine

PCME7301 **MACHINE DYNAMICS & HEAT POWER LAB** (0-0-3)

Machine Dynamics Laboratory (Minimum 06 experiments)

1. Experiment on Rope brake / Band brake dynamometer
2. Experiment on Epicyclic gear train
3. Determination of gyroscopic couple using gyroscopic test rig.
4. Performance characteristics of a spring loaded governor
5. Determination of critical speed of rotating shaft
6. Experiment on static and dynamic balancing apparatus
7. Determination of natural frequencies of un-damped as well as damped vibrating systems.
8. Study of interference and undercutting for gear drives
9. Experiment on Cam Analysis Apparatus.

10. Experiment on Journal Bearing Apparatus.

Heat Power (Automobile) Laboratory **(Minimum 04 experiments)**

1. Valve timing diagram of an IC engine
2. Study of a modern carburetor (e.g.Solex Carburtor)
3. Study of fuel injection system of a diesel engine
4. Analysis of exhaust gas of automobile
5. Study of different cooling systems in automobiles (Air cooling and water cooling).
6. Study of lubrication systems in automobiles.

PCME7303 **MACHINE DESIGN PROJECT – I** (0-0-3)

1. Assembly drawing of tail-stock of lathe with bill of materials
2. Assembly drawing of screw jack with bill of materials
3. Design & drawing of Riveted joint
4. Design and drawing of Cotter joint
5. Design and drawing of Knuckle joint
6. Design of shafts subjected to combined loading
7. Design and drawing of Flange coupling
8. Design of lever
9. Design and drawing of belt and pulley

Total number of Design : Minimum 6 nos.

Total No. of Drawing : 5 sheets (Two sheets for assembly drawing as per Sl no. 1 and 2 and three sheets for design, under Sl. No. 3, 4, 5, 7 and 9)

6th Semester

HSSM3302 OPTIMIZATION IN ENGINEERING (3-0-0)

Module-I (10 Hours)

Idea of Engineering optimization problems, Classification of optimization algorithms, Modeling of problems and principle of modeling.

Linear programming: Formulation of LPP, Graphical solution, Simplex method, Big-M method, Revised simplex method, Duality theory and its application, Dual simplex method , Sensitivity analysis in linear programming

Module -II (10 Hours)

Transportation problems: Finding an initial basic feasible solution by Northwest Corner rule, Least Cost rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method

Assignment problems: Hungarian method for solution of Assignment problems

Integer Programming: Branch and Bound algorithm for solution of integer Programming Problems

Queuing models: General characteristics, Markovian queuing model, M/M/1 model, Limited queue capacity, Multiple server, Finite sources, Queue discipline.

Module -III (10 Hours)

Non-linear programming: Introduction to non-linear programming.

Unconstraint optimization: Fibonacci and Golden Section Search method.

Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method

Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming

Introduction to Genetic Algorithm.

Recommended text books

1. A. Ravindran, D. T. Philips, J. Solberg, *" Operations Research- Principle and Practice*", Second edition, Wiley India Pvt Ltd
2. Kalyanmoy Deb, " *Optimization for Engineering Design*", PHI Learning Pvt Ltd

Recommended Reference books:

1. **S**tephen G. Nash, A. Sofer, *" Linear and Non-linear Programming*", McGraw Hill
2. A.Ravindran, K.M.Ragsdell, G.V.Reklaitis," *Engineering Optimization*", Second edition, Wiley India Pvt. Ltd
3. H.A.Taha,A.M.Natarajan, P.Balasubramanie, A.Tamilarasi, "*Operations Research*", Eighth Edition, Pearson Education
4. F.S.Hiller, G.J.Lieberman, *" Operations Research*", Eighth Edition, TMH.
5. P.K.Gupta, D.S.Hira, "*Operations Research*", S.Chand and Company Ltd.

PCME4307 **ADVANCED MECHANICS OF SOLIDS** (3-0-0)

Module – I **(12 hours)**

Elementary concept of elasticity, stresses in three dimensions, Principal Stresses, Stress Invariants, Mohr's Circle for 3-D state of stress, Octahedral Stresses, State of pure shear, Differential equations of equilibrium and compatibility conditions, plane stress.

Analysis of strain, State of strain at a point, Strain Invariant, Principal Strains, Plane state of strain, Strain measurements.

Theories of Failure, Various yield criteria

Module – II **(14 hours)**

Energy Methods: Work done by forces and elastic strain energy stored. Reciprocal relations, Theorem of virtual work, Castigliano's theorems,

Bending of beams: Asymmetrical bending, Shear centre, Bending of curved beams, Stress distribution in beam with rectangular, circular and trapezoidal cross section, stresses in crane hooks, ring and chain links., Deflection of thick curved bars.

Axisymmetric problems: Thick walled cylinder subjected to internal and external pressures, Compound cylinders, Shrink fit,

Module – III **(10 hours)**

Repeated stresses and fatigue in metals, Fatigue tests and fatigue design theory, Goodman, Gerber and Soderberg criteria, Concept of stress concentration, Notch sensitivity.

Introduction to Mechanics of Composite Materials: Lamina and Laminates, Micromechanics of FRP Composites.

Introduction to Fracture Mechanics: Basic modes of fracture, Fracture toughness evaluation.

Text book:

1. Advanced Mechanics of Solids, L.S. Srinath, Tata McGraw Hill
2. Advanced Mechanics of Materials : Boresi and Schmdt, Willey

Reference book:

1. Advanced Mechanics of Materials : Siley and Smith
2. Strength of Materials Vol.II, by S.Timoshenko
3. Mechanical Metallurgy by Dieter
4. Strength of Materials by G. H. Ryder, Macmillan Press
5. Mechanics of Materials by Beer and Johnston, Tata McGraw Hill
6. Mechanics of Materials by R.C.Hibbeler, Pearson Education
7. Mechanics of Materials by William F.Riley, Leroy D.Sturges & Don H.Morris, Wiley Student.
8. Mechanics of Materials by James M. Gere, Thomson Learning
9. Engineering Machanics of Solids by Egor P. Popov, Prentice Hall of India
10. Strength of Materials by S.S.Rattan, Tata Mc Graw Hill

PCME4306 **DESIGN OF MACHINE COMPONENTS** (3-0-0)

Module I (12 hours)

1. Review of axial, bending and torsional stresses in machine parts; Theories of Failure, Applications in practical problems.
2. Variables stresses (Fatigue), Endurance limit, S - N curve, Fatigue stress concentration factor, Goodman, Gerber and Soderberg criteria, Application to design and practical problems.
3. Design of Pressure vessels : Thin cylindrical and spherical shells, Design of end closures, Thick cylindrical shells, Application to practical problems.

Module II (12 hours)

4 Design of clutch: Friction clutch, Cone clutch and Centrifugal clutch,
5. Design of Brake : Block & Band brake, Internal expanding shoe brake.
6. Design of sliding contact bearings, Journal bearing, foot step bearing
7. Types and selection of ball and roller bearings, Dynamic and static load ratings, Bearing life, Problem illustration.

Module III (12 hours)

8. Design of straight and Helical spur gears, bevel gears.
9. Design of Engine components : Piston, Connecting Rod, Crank Shaft, Flywheel, Illustrative problems with solutions.

DESIGN DATA HAND BOOKS:

1. Design Hand Book by S.M.Jalaluddin ; Anuradha Agencies Publications
2. P.S.G.Design Data Hand Book**,** PSG College of Tech Coimbatore
3. Machine Design Data Book, K.Lingaiah, Tata Mcgraw Hill

TEXT BOOKS:

1. A Text Book of Machine Design, R.S.Khurmi and J.K.Gupta, S.Chand Publication, 14th Edn,
2. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edn

REFERENCE BOOKS:

1. Mechanical Engineerng Design, J.E.Shigley, C.R.Mischke, R.G.Budynas and K.J.Nisbett, TMH
2. Design of Machine Elements, M.F.Spotts,
3. Machine Design, P.C.Sharma and D.K.Agrawal, S.K.Kataria & Sons
4. Machine Design**,** Robert L. Norton, Pearson Education Asia, 2001.
5. Fundamentals of Machine Component Design, Robert C. Juvinall and Kurt M Marshek, Wiley India Pvt. Ltd., New Delhi, 3rd Edition, 2007
6. Machine Design, P.Kanaiah, Scietech Publications

PCME4305 **HEAT TRANSFER (3-0-0)**

Module-I (15 hours)

1. **Introduction:**
   Modes of heat transfer: conduction, convection, and radiation ,Mechanism & basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity, Thermal conductance &Thermal resistance, Contact resistance, convective heat transfer coefficient, radiation heat transfer coefficient , Electrical analogy, combined modes of heat transfer.initial conditions *and* Boundary conditions of 1st, 2nd and 3rd Kind.
2. **Heat Conduction:**
   The General heat conduction in Cartesian, polar-cylindrical and polar-spherical co-ordinates, Simplification of the general equation for one and two dimensional steady/ transient conduction with constant/ variable thermal conductivity with / without heat generation.
   Solution of the one dimensional steady state heat conduction problem in case of plane walls, cylinders and spheres for simple and composite cases. Critical insulation thickness, Heat transfer in extended surfaces (pin fins) without heat generation, Long fin, short fin with insulated tip and without insulated tip and fin connected between two heat sources. Fin efficiency and fin effectiveness.
   Conduction in solids with negligible internal temperature gradient (Lumped heat analysis).

   Solution of Cartesian problems in two dimensions (steady state conduction with constant thermal conductivity and no heat generation) by variable separation method. Numerical methods for heat conduction analysis.

Module-II (15 hours)

3. **Convective Heat Transfer:**
   (a) Introduction to convective flow - forced and free. Dimensional analysis of forced and free connective heat transfer. Application of dimensional analysis, physical significance of Grashoff , Reynolds, Prandtl, Nusselt and Stanton numbers.
   (b) Conservation equations for mass, momentum and energy for 2-dimensional convective heat transfer in case of incompressible flow, Hydrodynamic and thermal boundary layers for flow over a flat plate. Critical Reynolds number; general expressions for drag coefficient and drag force Reynolds-Colbourn analogy. Thermal boundary layer; general expression for local heat transfer coefficient; Average heat transfer Coefficient; Nusselt number. Flow inside a duct-velocity boundary layer, hydrodynamic entrance length and hydro dynamically developed flow; flow through tubes (internal flow). Use of empirical relations for solving turbulent conditions for external and internal flow.

4. Mechanism of heat transfer during natural convection, Experimental heat transfer correlations for natural convection in the following cases
   (a) Vertical and horizontal plates
   (b) Inside and outside flows in case of tubes

5. **Heat transfer for boiling liquids and condensing vapours :**
   Types of condensation, use of correlations for condensation on vertical flat surfaces, horizontal tube and; regimes of pool boiling, pool boiling correlations. Critical heat flux, concept of forced boiling. Numerical problems.

Module-III (10 hours)

6. **Radiative heat exchange :**
   Introduction, Radiation properties, definitions of various terms used in radiation heat transfer; Absorptivity,reflectivity & transmissivity.Emissive power & emissivity, Kirchoff's identity, Planck's relation for monochromatic emissive power of a black body, Derivation of

Stefan-Boltzmann law and Wien's displacement law from Planck's relation, Radiation shape factor, Relation for shape factor and shape factor algebra. Heat exchange between black bodies through non-absorbing medium. Gray bodies and real bodies, Heat exchange between gray bodies. Radiosity and Irradiation, Electrical analogy and radiation network for 2-body and 3-body radiations exchange in non-absorbing medium, Radiation shields.

7. Heat Exchangers :

Introduction, Types of heat exchanger, The overall heat transfer coefficient and fouling factors, LMTD and - NTU analysis of heat exchangers.

Text Books :

1. Fundamentals of Engineering Heat and Mass Transfer: R.C.Sachdeva, New Age International Publishers, 4th Edition

2. Heat Transfer : J.P.Holman, TMH Publications

3. Basic Heat Transfer by Necati Ozisik, Mcgrawhills Publications

References :

1 Heat Transfer: P.S.Ghosdastidar, Oxford University Press

2. Heat Transfer by P.K. Nag, TMH

3. Heat Transfer by S.P. Sukhatme, TMH

4. Heat Transfer: A.F.Mills and V.Ganesan, Pearson Education, 2nd Edition

5. Heat and Mass Transfer: Domkundwar and Arora, Danpatrai and sons

6. Heat Transfer : R.K.Rajput, Laxmi Publications

7. Heat and Mass Transfer: A Practical Approach, Y.A.Cengel, Tata Macgraw Hills Education Private Limited

PEME5305 **ROBOTICS & ROBOT APPLICATIONS (3-0-0)**

Module – I

1. Fundamentals of Robotics: Evolution of robots and robotics, Definition of industrial robot, Laws of Robotics, Classification, Robot Anatomy, Work volume and work envelope, Human arm characteristics, Design and control issues, Manipulation and control, Resolution; accuracy and repeatability, Robot configuration, Economic and social issues, Present and future application.

2. Mathematical modeling of a robot: Mapping between frames, Description of objects in space, Transformation of vectors.
   Direct Kinematic model: Mechanical Structure and notations, Description of links and joints, Kinematic modeling of the manipulator, Denavit-Hartenberg Notation, Kinematic relationship between adjacent links, Manipulator Transformation matrix.

Module – II

3. Inverse Kinematics: Manipulator workspace, Solvable of inverse kinematic model, Manipulator Jacobian, Jacobian inverse, Jacobian singularity, Static analysis.
4. Dynamic modeling: Lagrangian mechanics, 2D- Dynamic model, Lagrange-Euler formulation, Newton-Euler formulation.
5. Robot Sensors: Internal and external sensors, force sensors, Thermocouples, Performance characteristic of a robot.

Module – III

6. Robot Actuators: Hydraulic and pneumatic actuators, Electrical actuators, Brushless permanent magnet DC motor, Servomotor, Stepper motor, Micro actuator, Micro gripper, Micro motor, Drive selection.
7. Trajectory Planning: Definition and planning tasks, Joint space planning, Cartesian space planning.
8. Applications of Robotics: Capabilities of robots, Material handling, Machine loading and unloading, Robot assembly, Inspection, Welding, Obstacle avoidance.

Text Books:

1. Robotics and Control**,** R.K. Mittal and I.J. Nagrath, Tata McGraw Hill
2. Introduction to Robotics: Mechanics and control, John J Craig, PHI
3. Robotics Technology and Flexible Automation, S.R.Deb and S. Deb, TMH

Reference Books:

1. Introduction to Robotics, S. K. Saha, Tata McGraw Hill
2. Robotics: Control, Sensing, Vision and Intelligence, K.S.Fu, R.C.Gonzalez and C.S.G.Lee, McGraw Hill
3. Robotics, Appuu Kuttan K.K., I.K. international
4. Robot Dynamics and Control, M.W.Spong and M. Vidyasagar , Wiley India.
5. Industrial Robotics Technology, programming and application, M.P.Groover, TMH.
6. Introduction to Robotics: Analysis, Systems, Applications, S.B.Niku, PHI
7. Robotics: Fundamental Concepts and Analysis, A. Ghosal, Oxford University Press
8. Fundamentals of Robotics: Analysis and Control, R. J. Schilling, PHI
9. Robotic Engineering: An Integrated Approach, R.D. KLAFTER, T. A. Chmielewski, and M. Negin, PHI
10. Robot Technology: Fundamentals: J. G. Keramas, Cengage Learning

PEME5306 **MODERN MANUFACTURING PROCESSES** (3-0-0)

Module I **(12 hours)**

ULTRASONIC MACHINING (USM): Introduction, equipment, tool materials & tool size, abrasive slurry, cutting tool system design:- Effect of parameters on Material removal rate, tool wear, Accuracy, surface finish, applications, advantages & Disadvantages of USM.

ABRASIVE JET MACHINING (AJM): Introduction, Equipment, Variables in AJM: Carrier Gas, Type of abrasive work material, stand off distance (SOD), nozzle design, shape of cut. Process characteristics- Material removal rate, Nozzle wear, Accuracy & surface finish. Applications, advantages & Disadvantages of AJM.
Water Jet Machining: Principle, Equipment, Operation, Application, Advantages and limitations of Water Jet machining.

ELECTROCHEMICAL MACHINING (ECM): Introduction, study of ECM machine, elements of ECM process: ECM Process characteristics – Material removal rate, Accuracy, surface finish, Applications, Electrochemical turning, Grinding, Honing, deburring, Advantages, Limitations.

CHEMICAL MACHINING (CHM): Introduction, elements of process, chemical blanking process, process characteristics of CHM: material removal rate, accuracy, surface finish, Hydrogen embrittlement, advantages & application of CHM.

Module II **(13Lectures)**

ELECTRICAL DISCHARGE MACHINING (EDM): Introduction, mechanism of metal removal, dielectric fluid, spark generator, EDM tools (electrodes) Electrode feed control, EDM process characteristics: metal removal rate, accuracy, surface finish, Heat Affected Zone. Machine tool selection, Application, electrical discharge grinding, wire EDM.

PLASMA ARC MACHINING (PAM): Introduction, equipment, non-thermal generation of plasma, selection of gas, Mechanism of metal removal, PAM parameters, process characteristics. Applications, Advantages and limitations.

LASER BEAM MACHINING (LBM): Introduction, equipment of LBM mechanism of metal removal, LBM parameters, Process characteristics, Applications, Advantages & limitations.

ELECTRON BEAM MACHINING (EBM): Principles, equipment, operations, applications, advantages and limitation of EBM.

Module III **(11 Lectures)**

Introduction to Surface engineering, High speed machining and grinding: Application of advanced coatings in high performance modern cutting tools and high performance super-abrasive grinding wheels, Micro and nano machining of glasses and ceramics. Theory and application of chemical processing: Chemical Machining, Aching of semi conductors, Coating and Electroless forming, PVD and CVD; Introduction to Reverse Engineering, Concurrent Engineering and Rapid prototyping:

Text Books:

1. Modern machining process, Pandey and Shan, Tata McGraw Hill 2000
2. Manufacturing Engg. & Technology, Kalpakjian , Pearson Education
3. Manufacturing Science, A.Ghosh & A.K. Mallik, EWP

Reference Books

1. Metals Handbook: Machining Volume 16, Joseph R. Davis (Editor), American Society of Metals.
2. Surface Wear Analysis, Treatment & Prevention - ASM International, Materials Park, OH, U.S.A., 1st Ed. 1995
3. Production Technology, HMT, Tata McGraw Hill. 2001
4. Modern Machining Process, Aditya. 2002
5. Non-Conventional Machining, P.K.Mishra, The Institution of Engineers (India) Test book series, Narosa Publishing House – 2005.
6. Introduction to Rapid Prototyping, A Ghosh, North West Publication

PEME5307 COMPUTER INTEGRATED MANUFACTURING AND FMS (3-0-0)

Module I **(12 hours)**

Fundamentals of Manufacturing and Automation: Production systems, automation principles and its strategies; Manufacturing industries; Types of production function in manufacturing; Automation principles and strategies, elements of automated system, automation functions and level of automation; product/production relationship, Production concept and mathematical models for production rate, capacity, utilization and availability; Cost-benefit analysis.

Computer Integrated Manufacturing: Basics of product design, CAD/CAM, Concurrent engineering, CAPP and CIM.

Module II **(12 hours)**

Industrial Robotics: Robot anatomy, control systems, end effectors, sensors and actuators; fundamentals of NC technology, CNC, DNC, NC part programming; Robotic programming, Robotic languages, work cell control, Robot cleft design, types of robot application, Processing operations, Programmable Logic controllers: Parts of PLC, Operation and application of PLC, Fundamentals of Net workings; Material Handling and automated storage and retrieval systems, automatic data capture, identification methods, bar code and other technologies.

Module III **(12 hours)**

Introduction to manufacturing systems: Group Technology and cellular manufacturing, Part families, Part classification and coding, Production flow analysis, Machine cell design, Applications and Benefits of Group Technology.

Flexible Manufacturing system: Basics of FMS, components of FMS, FMS planning and implementation, flexibility, quantitative analysis of flexibility, application and benefits of FMS.

Computer Aided Quality Control: objectives of CAQC, QC and CIM, CMM and Flexible Inspection systems.

Text Books:

1. Automation, Production Systems and Computer Integrated Manufacturing: M.P. Groover, Pearson Publication.
2. Automation, Production systems & Computer Integrated Manufacturing, M.P Groover, PHI.
3. CAD/CAM/CIM, P.Radhakrishnan, S.Subramanyam and V.Raju, New Age International
4. Flexible Manufacturing Systems in Practice, J Talavage and R.G. Hannam, Marcell Decker

Reference Books:

1. CAD/CAM Theory and Practice, Zeid and Subramanian, TMH Publication
2. CAD/CAM Theory and Concepts, K. Sareen and C. Grewal, S Chand publication
3. Computer Aided Design and Manufacturing, L. Narayan, M. Rao and S. Sarkar, PHI.
4. Principles of Computer Integrated Manufacturing, S.K.Vajpayee, PHI
5. Computer Integrated Manufacturing, J.A.Rehg and H.W.Kraebber, Prentice Hall

PEME5308 NON-CONVENTIONAL ENERGY SOURCES(3-0-0)

Module I (10 Classes)

Energy, Ecology and environment: Introduction, Classification of Energy Resources, Common Forms of Energy, Energy Chain, Advantages and Disadvantages of Conventional Energy Sources, Importance and Salient Features of Non-Conventional Energy Sources, Environmental and ecological Aspects of Energy use, Environment-Economy-Energy and Sustainable Development, World Energy Status, Energy Scenario in India.

Energy Conservation and Energy Storage: Salient Features of "Energy Conservation Act, 2001", Various Aspects of Energy Conservation, Principles of Energy Conservation, General Electrical ECO's (Energy Conservation Opportunities),

Solar Energy: Basics, The Sun as a Source of Energy, Sun, Earth Radiation Spectrums, Extraterrestrial and Terrestrial Radiations, Spectral Energy Distribution of Solar Radiation, Depletion of Solar Radiation, Measurements of Solar Radiation, Solar Time (Local Apparent Time), Solar Radiation Geometry, Solar Day Length, Empirical Equations for Estimating Solar Radiation(Hourly Global, Diffuse and Beam Radiations) on Horizontal Surface Under Cloudless and Cloudy Skies, Solar Radiation on Inclined Plane Surface only (empirical relations for numerical)

Module II (15 Classes)

Solar Thermal Systems: Solar Collectors: Flat plate and concentric collectors, Solar Water Heater, Solar Passive Space - Heating and Cooling Systems, Solar Refrigeration and Air-Conditioning Systems, Solar Cookers, Solar Furnaces, Solar Green House, Solar Dryer, Solar Distillation (or Desalination of Water),

Solar Photovoltaic Systems: Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Solar Cell, Module, Panel and Array Construction, Solar PV Systems, Solar PV Applications.

Wind Energy: Origin of Winds, Nature of Winds, Wind Turbine Siting, Major Applications of Wind Power, Wind Turbine Types and Their Construction, Wind Energy Conversion Systems (WECS), Effects of Wind Speed and Grid Condition (System Integration),

Module III (15 Classes)

Biomass Energy: Photosynthesis Process, Usable Forms of Biomass, their Composition and Fuel Properties, Biomass Resources , Biomass Conversion Technologies, Urban Waste to Energy Conversion, Biomass Gasification ,Biomass Liquefaction, Biomass to Ethanol Production, Biogas Production from Waste Biomass, Energy Farming.

Miscellaneous Non-conventional Technologies

Geothermal Energy: Applications, Origin and Distribution of Geothermal Energy, Types of Geothermal Resource.

Ocean Energy: Tidal Energy, Wave Energy, Ocean Thermal Energy

Fuel Cell Technology: Types, Principle of operation, Advantages and disadvantages.

Text Book:

1. Non Conventional Energy Sources: B.M Khan, TMH Publications
2. Renewable Energy Sources and Emerging Technology: D.P.Kothari and etal., PHI
3. Renewable Energy Sources & Conversion Technology: N.K.Bansal, Manfred Kleenman & Michael Meliss, TMH Publication.

Reference:

1. Renewable Energy Sources:Fundamentals & Applications:G.N.Tiwari & M.K.Ghosal, Narosa Pub
2. Non Conventional Energy Resources: D.S. Chauhan and S.K.Srivastava, New Age International
3. Non Conventional Energy Sources: H.P.Garg
4. Non-Conventional Energy Systems: G.D.Rai, Khanna publications
5. Solar Energy Technology: Sukhatme and Nayak, TMH
6. Renewable Energy, Godfrey Boyle, Oxford University Press

FEME6301 **FINITE ELEMENT METHOD** (3-0-0**)**

Module – I **(12 hours)**

Review of 2-D and 3-D stress analyses, vibration, fluid flow and heat conduction problems.
FEM fundamental concepts, Variational principles, Rayleigh Ritz and Galerkin Methods.
Finite Element Modeling of one dimensional problems.
Finite Element Analysis of 2-D and 3-D framed structures.

Module – II **(12 hours)**

FEM formulation of 2-D and 3-D stress analysis problems.
Axisymmetric solids subjected to axisymmetric loadings.
Two-dimensional isoparametric elements and numerical integration.

Module – III **(12 hours)**

FE modeling of basic vibration problems
Finite element modeling of fluid flow and heat conduction problems
Computer programs: preprocessing and post processing.
Exposure to commercial FE codes such as ANSYS, NASTRAN and IDEAS etc.

Text Books

1. Finite Elements in Engineering, T.R.Chandraputla and A.D.Belegundu, PHI
2. The Finite Element Method – Its Basis & Fundamentals, Zienkiewicz, Taylor and Zhu, Elsevier, 6th Edn

Reference

1. Introduction to Finite Element Method, C.Desai and J.F.Abel, CBS publishers
2. Introduction to Finite Element Method, J.N.Reddy, Tata McGraw Hill
3. Numerical Methods in Finite Element Analysis, K.J.Bathe and E.L.Wilson, PHI
4. Concepts & Applications of Finite Element Analysis,Cook, D.S.Malkus & M.E.Plesha, Wiley
5. The Finite Element Method in Engineering, S.S.Rao, Elsevier
6. A First Course in the Finite Element Method, D.L.Logan, Cengage Learning
7. Fundamentals of Finite Element Analysis, David V. Hutton, Tata McGraw Hill

PCEC4304 **DIGITAL SIGNAL PROCESSING** (3-0-0)

Module – I (10 hours)

The Z-Transform and Its Application to the Analysis of LTI Systems:

The Z-Transform: The Direct Z-Transform, The Inverse Z-Transform; Properties of the Z-Transform; Inversion of the Z-Transforms: The Inversion of the Z-Transform by Power Series Expansion, The Inversion of the Z-Transform by Partial-Fraction Expansion; Analysis of Linear Time-Invariant Systems in the z-Domain: Response of Systems with rational System Functions, Transient and Steady-State Responses, Causality and Stability, Pole-Zero Cancellations.

Selected portions from Chapter 3 (3.1.1, 3.1.2, 3.2, 3.4.2, 3.4.3, 3.5.1, 3.5.2, 3.5.3, 3.5.4) of Textbook – I

The Discrete Fourier Transform: Its Properties and Applications

Frequency Domain Sampling: Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals, The Discrete Fourier Transform, The DFT as a Linear Transformation, Relationship of the DFT to other Transforms; Properties of the DFT: Periodicity, Linearity, and Symmetry Properties, Multiplication of Two DFTs and Circular Convolution, Additional DFT Properties; Linear Filtering Methods Based on the DFT: Use of the DFT in Linear Filtering, Filtering of Long Data Sequences; Frequency Analysis of Signals using the DFT; The Discrete Cosine Transform: Forward DCT, Inverse DCT, DCT as an Orthogonal Transform.

Chapter – 7 of Textbook – 1.

Module – II (10 hours)

Implementation of Discrete-Time Systems:

Structure for the Realization of Discrete-Time Systems, Structure for FIR Systems: Direct-Form Structure, Cascade-Form Structures, Frequency-Sampling Structures; Structure for IIR Systems: Direct-Form Structures, Signal Flow Graphs and Transposed Structures, Cascade-Form Structures, Parallel-Form Structures.

Selected portions from Chapter 9 (9.1, 9.2.1, 9.2.2, 9.2.3, 9.3.1, 9.3.2, 9.3.3, 9.3.4) of Textbook – I

Design of Digital Filters:

General Considerations: Causality and Its Implications, Characteristics of Practical Frequency-Selective Filters; Design of FIR Filters: Symmetric and Antisymmetric FIR

Filters, Design of Linear-Phase FIR Filters by using Windows, Design of Linear-Phase FIR Filters by the Frequency-Sampling Method; Design of IIR Filters from Analog Filters: IIR Filter Design by Impulse Invariance, IIR Filter Design by the Bilinear Transformation.

Selected portions from Chapter 10 (10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.2.3, 10.2.4, 10.3.2, 10.3.3) of Textbook – I

Module- III (15 hours)

Efficient Computation of the DFT: Fast Fourier Transform Algorithms

Efficient Computation of the DFT: FFT Algorithms: Direct Computation of the DFT, Radix-2 FFT Algorithms: Decimation-In-Time (DIT), Decimation-In-Time (DIF); Applications of FFT Algorithms: Efficient Computation of the DFT of two Real Sequences, Efficient Computation of the DFT a 2N-Point Real Sequence, Use of the FFT Algorithm in Linear Filtering and Correlation.

Selected portions from Chapter 8 (8.1.1, 8.1.3, 8.2.1, 8.2.2, 8.2.3) of Textbook – I

Adaptive Filters:

Application of Adaptive Filters: System Identification or System Modeling, Adaptive Channel Equalization, Adaptive Line Enhancer, Adaptive Noise Cancelling; Adaptive Direct-Form FIR Filters-The LMS Algorithm: Minimum Mean Square Error Criterion, The LMS Algorithm.

Selected portions from chapter 13 (13.1.1, 13.1.2, 13.1.5, 13.1.6, 13.2.1, 13.2.2) of Text book –I

Text Books

1. Digital Signal Processing – Principles, Algorithms and Applications by J. G. Proakis and D. G. Manolakis, 4th Edition, Pearson.

Reference Book :

1. Digital Signal Processing: a Computer-Based Approach – Sanjit K. Mitra, TMH.
2. Digital Signal Processing – S. Salivahan, A. Vallavraj and C. Gnanapriya, TMH.
3. Digital Signal Processing – Manson H. Hayes (Schaum's Outlines) Adapted by Subrata Bhattacharya, Tata McGraw Hill.
4. Digital Signal Processing: A Modern Introduction – Ashok Ambardar, Cengage Learning.
5. Modern Digital Signal Processing – Roberto Cristi, Cengage Learning.
6. Digital Signal Processing: Fundamentals and Applications – Li Tan, Academic Press, Elsevier.
7. Digital Signal Processing: A MATLAB-Based Approach – Vinay K. Ingle and John G. Proakis, Cengage Learning.
8. Fundamentals of Digital Signal Processing using MATLAB – Robert J. Schilling and Sandra L. Harris, Cengage Learning.

PCIT4301 **INTERNET AND WEB TECHNOLOGY** (3-0-0)

Module –I (Lecture Hour 12)

The Internet and WWW

Understanding the WWW and the Internet, Emergence of Web, Web Servers, Web Browsers, Protocols, Building Web Sites

HTML

Planning for designing Web pages, Model and structure for a Website, Developing Websites, Basic HTML using images links, Lists, Tables and Forms, Frames for designing a good interactive website

Module –II (Lecture Hour 12)

JAVA Script

Programming Fundamentals, Statements, Expressions, Operators, Popup Boxes, Control Statements, Try…. Catch Statement, Throw Statement, Objects of Javascript: Date object, array object, Boolean object, math object

CSS

External Style Sheets, Internal Style Sheets, Inline Style, The class selector, div & span tag

DOM

HTML DOM, inner HTML, Dynamic HTML (DHTML), DHTML form, XML DOM

Module –III (Lecture Hour 11)

CGI/PERL

Introduction to CGI, Testing & Debugging Perl CGI Script, Using Scalar variables and operators in Perl

Java Applet

Introduction to Java, Writing Java Applets, Life cycle of applet

Textbooks

1. Web Warrior Guide to Web Design Technologies, Don Gosselin, Joel Sklar & others, Cengage Learning

Reference Books

1. Web Programming: Building Internet Applications, Chris Bates, Wiley Dreamtech
2. Programming the World Wide Web, Robert W Sebesta, Pearson
3. Web Technologies, Uttam K Roy, Oxford
4. Web Technology: A developer perspective, Gopalan & Akilandeswari, PHI

PECS5303 **PATTERN RECOGNITION** (3-0-0)

Module –I (Lecture Hour 12)

Introduction

Features, Feature Vectors and Classifiers, Supervised vs. unsupervised pattern

Classifier

Classifier based on Bayes Decision Theory, Linear classifier: Least square methods, Mean square estimation, Support vector machines, nonlinear classifier: Two layer & three layer perceptron, Back propagation algorithm, combining classifiers

Module –II (Lecture Hour 12)

Feature Selection

Preprocessing, Statistical hypothesis testing, Class separability measures

Feature Generation

Linear transforms, Discrete Fourier transform (DFT), Hadamard transform, Discrete Time Wavelet transform (DTWT)

Fourier feature, Moment-based features

Fractals: Self similarity, Fractional Brownian Motion (FBM), Fractal dimension

Module –III (Lecture Hour 11)

Template Matching

Based on optimal path searching techniques, correlations

Clustering

Sequential algorithms: Estimation of number of clusters

Hierarchical algorithms: Agglomerative algorithms

Textbooks

1. Pattern Recognition, Sergios Theodoridis & Konstantinous Koutroumbas, Elsevier

PEIT5301 **E-COMMERCE** (3-0-0)

Module –I (Lecture Hour 11)
Basics of E-commerce
Basic Elements, of e-commerce, e-commerce framework, basic infrastructure for e-commerce: Technical, capital, media, Human Resource, Public policy
Technical Infrastructure
Internet connectivity, protocols, web server, software for web server, e-commerce software, security threats to e-commerce, protecting e-commerce system

Module –II (Lecture Hour 12)
Payment System for E-commerce
Online payments system, pre-paid and post-paid electronic payment systems, Electronic data interchange (EDI)
Business Models for E-commerce
Revenue Model, Business model based on strategies, Marketing on the web: Internet based Advertisement, Website usability, consumer oriented e-commerce

Module –III (Lecture Hour 12)
Internet Business Strategies
Electronic marketplaces, Electronic Auctions, Mobile Commerce, Virtual Communities

Textbooks
1. Ecommerce, Gary P. Schneider, Cengage Learning
2. Electronic Commerce: Framework Technologies & Applications, Bharat Bhasker, TMH

Reference Books
1. Electronic Commerce: A Manager's Guide, Kalakota & Whinston, Pearson
2. E-commerce, Jibitesh Mishra, Macmillan
3. E-commerce: Concepts, models & strategies, C.V.S Murthy, Himalaya Publishing

Heat Transfer and Heat Power Laboratory (0-0-3)

(Minimum 10 experiments with minimum 4 from each group)

Heat Transfer Laboratory

1. Determination of Thermal conductivity of composite slab
2. Determination of heat transfer coefficient in natural/forced convention.
3. Determination of surface emissivity
4. Performance test on parallel flow and counter flow heat exchanger
5. Efficiency and effectiveness of fins (Natural / Forced convection)
6. Determination of Critical heat flux during boiling heat transfer.
7. Verification of Stefan Boltzman's law.

Heat Power Laboratory

1. Performance analysis of reciprocating air-compressor
2. Performance analysis of Centrifugal / Axial Flow compressor
3. Study of steam power plant
4. Study of gas turbine power plant.
5. Determination of performance characteristics of gear pump.
6. Study of power transmission system of automobiles

Numerical Computation & Solids Modeling Lab (0-0-3)

Numerical Computation

(Using MATLAB or other software/language)

1. Basics of MATLAB or similar software/language
2. Finding solution by Numerical Methods (including graphics) for the following: **(Minimum 06 problems)**
   a) Bisection Method
   b) Newton-Raphson Method
   c) Secant Method
   d) Gauss Elimination Method
   e) Numerical Differentiation
   f) Numerical Integration (e.g. Newton Cotes Quadrature)
   g) Curve fitting Method
   h) Initial-Value Problems (e.g. Runge-Kutta Method)
   i) Boundary Value Problem (eg. Shooting Method)
   j) Eigen Value Problem

Solids Modeling

(Using Solid Modeling software eg. AUTOCAD/ProE/CATIA/SolidWorks etc)

1. Learning the Basics of Solid Modeling Software
2. Describe and Apply the CONE, SPHERE and TORUS command to draw solid primitives
3. Describe and Apply the EXTRUDE and REVOLVE command to draw solid models that can not be drawn with a composition of primitives

Books

(i) Applied Numerical Methods with MATLAB, S.C.Chapra, TMH
(ii) Numerical Methods for Engineers and Scientists, J.D.Hoffman, CRC Press
(iii) Numerical Methods, E Balagurusamy, TMH
(iv) Numerical Methods for Engineers, Chapra and Canale, TMH
(v) MATLAB Programming for Engineers, Chapman, Thomson Learning
(vi) Getting Started with MATLAB, Rudra Pratap, Oxford University Press
(vii) Mastering MATLAB 7, Hanselman and Littlefield, Pearson Education

MACHINE DESIGN PROJECT – II (0-0-3)

1. Design of shaft on the basis of theories of failure
2. Design of machine components under dynamic stress
3 Design of thin/ thick cylindrical shells under internal fluid pressure
4. Design of clutch
5. Design of Brake
6. Design of Journal Bearing
7. Design of straight/ helical gears
8. Design of piston
9. Design of connecting rod
10. Design of crank shaft
11. Design of fly wheel

Note : At least 7 to 8 designs with relevant drawings should be carried out. Rest of the design problem can be given as assignments.

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