SGGS INSTITUTE OF ENGINEERING & TECHNOLOGY, NANDED

(An Autonomous Institute of Government of Maharashtra)

Department of Production Engineering

T.Y. B.Tech. (Production Engineering)

w. e. f. Academic year 2016-17

Semester V						
Course Code	Course Title	Lectures (L)	Tutorials (T)	Practical (P)	Credits	
					Th.	Pr.
PR 351	Mechanical Working of metals	03	--	02	03	01
PR 352	Machine Design	03	01	02	04	01
PR 355	Production Planting & Control	03	--	02	03	01
PR 356	Tool Design	03	--	02	03	01
PR 357	Computational Lab	--	--	02	--	01
MA 302 A-C	Elective – I (Mathematics IV)	04	--	--	04	--
PR 358	Manufacturing Lab – II	--	--	02	--	01
					17	06
Total		16	01	12	23	

Semester VI						
Course Code	Course Title	Lectures (L)	Tutorials (T)	Practical (P)	Credits	
					Th.	Pr.
PR 371	Modern Mfg. Technology	03	--	02	03	01
PR 372	Heat and Mass Transfer	02	01	02	03	01
PR 373	Fluid Mechanics & Hyd. Machines	03	--	02	03	01
PR 374 to PR 381	Elective – II	03	--	02	03	01
	Elective – III	03	--	02	03	01
PR 376	Seminar	--	--	02	--	01
					15	06
	Total	14	01	12	21	

Elective – I

MA 302A: Complex Analysis

MA 302B: Statistics and Probability

MA 302C: Numerical Methods

Elective – II and Elective – III (Students can register for any two from the list provided)

PR374: Finite Element Analysis

PR375: Product Design and Development

PR376: Plastics and Composites

PR377: Renewable Energy Sources

PR378: Mechatronics

PR379: Automobile engineering

PR380: Object Oriented Programming and tools

PR381: Elective offered by Industry

Open Elective(s): ----------

Mechanical Working of Metals
(Credits Theory-03, Practical-01)

Course Code: PR 351 **Contact Hours: Th. 03 T- 00 Pr. 02**

Course Objective

a. The objective is to study the press working terminology and equipment, Press tool operations, Press selection and rating, Principle of metal cutting, working of cutting die, die clearance and its effect, types of die construction and design of piercing, blanking, compound and progressive.
b. Study of Design of Bending and drawing dies along with bending methods, spring back effect, bend allowance, solid form, curling, embossing, coining and bulging, deep and shallow drawing, metal flow in drawing, variables affecting metal flow during drawing.
c. Study of press working materials, strip layout, stripping devices, press tonnage, methods of reducing cutting forces, punch and die design and mounting, pilots, stock strip stops.
d. Study of types of forging processes, with equipment and machines used, design analysis of forging dies.
e. Study of classification of rolling processes, rolling mills, rolling of bars and shapes, forces and geometrical relationships in rolling, problems and defects in rolled products and analysis of rolling process.
f. Study of classification of extrusion processes, Extrusion equipment, deformation, Lubrication and defects in extrusion, hydrostatic extrusion, Extrusion of tubing. Production of seamless pipe and tubing.
g. Measurement of strain hardening exponent, n value, Measurement of strain-rate, sensitivity; m value, measurement of plastic strain ratio, r value.
h. Study of concept need, classification, types of formability test, critical assessment of formability tests, determination of forming limit diagram.
i. The knowledge of this subject is very essential for an engineer in selection of various alloys and composite materials for suitable application in industry.

Evaluation Scheme

Theory:	MTE+ETE: 30+70	***Term work/Practical:***	CE+EVV: 50+50

Course Content

1. Introduction: Principle of metal forming, classification of metal-forming process, plastic deformation, cold working, Hot working, materials for cold and hot working.
2. Dies For Sheet Metal Cutting And Shaping: Press working terminology and equipment; Press tool operations, Press selection and rating, Principle of metal cutting, working of cutting die, die clearance and its effect, types of die construction.
3. Die Design Fundamentals: Press working materials, strip layout, stripping devices, press tonnage, Methods of reducing cutting forces, punch and die design, mounting of punch and die, pilots, stock strip stops. Design of dies: Piercing, Blanking, Compound and progressive.
4. Dies For Sheet Metal Shaping: Bending methods, spring back effect, bend allowance. Forming dies: solid form, curling, embossing, coining and bulging. Drawing dies: deep and shallow drawing, metal flow in drawing, variables affecting metal flow during drawing. Design of Bending and drawing dies.
5. Forging Dies: Types of forging dies, advantages and limitations; forging equipment and machines, press forging, drop forging, open die forging, close forging, dogging defects. Forging design, factors-draft, fillet, corner radius, parting line, shrinkage, die wear, mismatch, and tolerances, forging operations stock size determination, forging die design, forging Analysis.
6. Rolling Of Metals: Classification of rolling processes, rolling mills, hot rolling, cold rolling, rolling of bars and shapes, Forces and geometrical relationships in rolling, problems and defects in rolled products, process Analysis.
7. Extrusion: Classification of extrusion processes, Extrusion equipment, hot extrusion, cold extrusion, Deformation, Lubrication and defects in extrusion, hydrostatic extrusion, Extrusion of tubing. Production of seamless pipe and tubing.
8. Introduction To Drawing Of Rods, Wires And Tubes
9. Measurement of Intrinsic Properties: Measurement of strain hardening exponent, n value, Measurement of strain-rate, sensitivity; m value, measurement of plastic strain ratio, r value.
10. Quality Evaluation Methods For Raw Materials Used In Metal Forming Applications

11. What is formability, need for formability test, and classification of formability tests: bending, drawing, stretching, combined mode test, critical assessment of formability test, forming limit diagram: Determination of forming limit diagram.

Term Work

It shall consist of one full imperial sheet each on

a. Cutting die design.
b. Shaping die design.
c. Rolling /forging/extrusion.

And a journal based on above syllabus for

a. Design of a cutting die (punching, blanking, compound, and progressive), bending die, and drawing die
b. Study of forging, Extrusion, and rolling equipment.
c. Press tool Design and / or 3D Modeling, Assembling and drawing assignment using computer.
d. Determine strain hardening exponent, n value.
e. Determine plastic stain ratio, r value.
f. Study test procedure to get various indices: bend test, swift cup, drawing test, Ericson/Olsen test, LDH test (minimum three)
g. Study the method to get forming limit diagram from experimental data.

Text Books

Mechanical Metallurgy by George E. Dieter, McGraw-Hill Book Company, 1988.

Rao PN, Manufacturing Technology-Foundry, Forming and welding Tata McGraw Hill, 2006

Sharma P. C. – Production Engineering, (S. Chand and co. Ltd. New Delhi 7th edition 1982)

Reference Books

1. ASTME – Fundamentals of tool design- (Prentice Hall of India Pvt .Ltd New Delhi 1984)
2. Donaldson, Lecain, Good – Tool Design Tata McGraw – Hill co. Ltd 3rd Edition 1976)
3. Pollack Herman W- Tool Design (D. B. Tarapurwall sons and co. pvt. Ltd. Mumbai 1983)
4. Dieter George E. - Mechanical Metallurgy (International student Edition, McGraw – Hill International Book co. 2nd Edition 1981)
5. Manufacturing Science, Amitabha Ghosh and Ashok Kumar Mallik, 1985, Affiliated East West Press Pvt.Ltd., New Delhi.

6. Metal Forming Hand Book by Schuler, Springer, 1998.
7. Materials and Processes in manufacturing, by E. Paul Degarmo, Prentice-Hall of India, 2005.
8. Primer course on sheet metal forming- by Prof. K. Narasimhan, IIT Bombay.
9. K. Narsimhan and V. M. Nanded, Formability Testing of Sheet Metals, Transaction of Indian Institute of Metal, Vol. 49, No. 5, October 1996, pp 659 - 676.

Course Outcomes

On successful completion of this course, Students should be able to;

1. *Classify different metal forming processes.*
2. *Design dies for cutting, forging, bending, drawing, piercing, and blanking.*
3. *Compute material properties, forces and defects in metal forming processes.*
4. *Select equipment for metal forming processes.*

Machine Design

(Credits Theory-04, Practical-01)

Course Code: PR 352 **Contact Hours: Th. 04 T- 00 Pr. 02**

Course Objective

This subject is introduced to third year students with an objective of understanding fundamentals of static and dynamic loading. Design of different machine components used in real life.

Evaluation Scheme

Theory:	MTE+ETE: 30+70	***Term work/Practical:***	CE+EVV: 50+50

Course Content

1. Introduction :Mechanical Engineering design, Traditional design methods, Design synthesis, Aesthetic considerations in design, Ergonomic considerations in design, Use of standard in design, Selection of preferred sizes, value analysis, Engineering materials, Selection of materials, manufacturing considerations in design, statistical considerations in design
2. Design of Machine Part Subjected to Static Load: Modes of failure, F. O. S., Stress due to B. M., stress due to torsional moment, Eccentric axial loading, combined stress Direct and bending e. g. C- clamp, frame, screw press, frame etc.
3. Design of Machine Parts Subjected To Fluctuating Load: Stress concentration, stress concentration factors, methods to reduce stress concentration effects, fluctuating stresses, fatigue failure, notch sensitivity, endurance limit, Rotating beam test. Fatigue strength, factor affecting fatigue strength, Soderburg, and Goodman diagram, S. N. diagram, cumulative damage in fatigue: - Miner's equation.
4. Power Screws: Forms of threads, force analysis of square threads and trapezoidal threads, self-locking in power screws, collar friction, stresses in screw, Differential and compound screws, Recirculating type ball screws.
5. Shafts, Keys and Couplings: Transmission shafting, Design against static load and torsional rigidity, keys: Design of various types of keys, couplings: design of rigidity and flexible couplings.
6. Friction Clutches: Torque transmitting capacity, single disc and multiple disc clutches, fraction materials, cone clutches, and centrifugal clutches.

7. Gears: Types of gears, V. R. for each type, selection of types of gear, modes of failure, gear design for maximum power transmitting capacity, Design of spur and helical gear, Lewis equation, Buckingham's Equation, Wear strength of spur & helical gears, gear lubrication.
8. Belt Drives: Flat and V- belts, geometrical relationships, ratio of belt tension, selection of V belt and flat belts, condition for maximum power transmission.

Term Work

1. Numerical assignments based on above syllabus.
2. Drawing/CAD sheets based on design of any of 2 machine components

Text Books

Design of machine element -V. B. Bhandari (Tata McGraw – Hill Co. Ltd)

Design of Machine elements -M. F. Spotts (Prentice Hall India Ltd.)

Reference Books

Mechanical Engineering Design. -J. E. Shigley (McGraw- Hill Int. Ltd.)

Machine Design -Pandey and Shah (Charotar Publisher Co.)

Machine Design -Shamus series (McGraw Hill Co - Ltd.)

Course Outcomes

At the end of course students will able to;

1. *Interpret basic design procedure and various design considerations.*
2. *Define, describe and distinguish static and fluctuating loads/stresses.*
3. *Solve numerical problems for safe design under static and fluctuating loads/stresses.*
4. *Design gears, clutches, power screws etc. for real life applications.*

Production Planning and Control
(Credits Theory-03, Practical-01)

Course Code: PR 355 **Contact Hours: Th. 03 T- 00 Pr. 02**

Course Objectives

a. To gain an understanding and appreciation of the fundamental principles and methodologies relevant to planning, design, operation, and control of Production Systems.
b. To reinforce analytical skills already learned, and build on these skills to further increase ones "portfolio" of useful analytical tools.
c. To gain ability to recognize situations in a production system environment those suggest the use of certain quantitative methods to assist in decision making.
d. To learn how to think about, approach, analyze, and solve production system problems using both technology and people skills.
e. To increase knowledge and broaden perspective of the "industrial world" in which one will contribute his / her talent and leadership as an Industrial Engineer.

Evaluation Scheme

Theory:	MTE+ETE: 30+70	***Term work/Practical:***	CE+EVV: 50+50

Course Content

1. Introduction: Functions of PPC, types of production, production consumption cycle, coordination of production decisions
2. Product Development and Design: Product Design and Company Policy, Product Analysis: Marketing Aspect, Product Characteristics, Economic Analysis, production Aspect.
3. Forecasting: Introduction, Time Series Methods, Casual Methods, Forecast Errors
4. Facility Layout: Introduction, Flow Systems, Types of Layout: Product, Process, Group Layout, Computerized Layout Planning
5. Production Order: Purpose of production order, procedure for formulating production order, process outlines, process and activity charts, production master program, operation and route sheet, production order
6. Batch Production: Quantities in batch production, criteria for batch size determination, minimum cost batch size, production range, maximum profit batch size, maximum return and maximum rate of return economic batch size

7. Machine Output: Machine output, multi-machine supervision by one operator, machine interference, balancing of machine lines, analysis of process capacities in a multi-product system
8. Production And Operations Planning: Aggregate Planning, Strategies and techniques for Aggregate Planning, Production Planning in Mass Production Systems and Assembly Line Balancing, Sequencing problems such as 1 machine n jobs, 2 machines n jobs & its extension, m machines 2 jobs, scheduling jobs with random arrivals
9. Inventory Control: Inventory and its purpose, the relevant costs, selective inventory analysis (ABC analysis), Classical Inventory Model, EOQ with quantity discounts, EOQ for multiple items with constraints on resources, Safety Stock, determining safety stock when usage and lead time vary, Fixed Order Period Inventory Control System

Term Work

At least six assignments based on theoretical concepts and problems

Text Books

1. Simuel Eilon, Elements of Production Planning and Control, Macmillan Publications
2. James L. Riggs, Production Systems Planning and Analysis & Control

Reference Books

1. Narasimhan, Mcleavey, Billingten, Production Planning & Inventory Control, Prentice Hall of India
2. Chary S. N., Theory and Problems in Production and Operation Management, Tata McGraw Hill, Edition 1995.

Course Outcomes

1. *Discuss the different types of production systems.*
2. *Analyse the product development and design technique.*
3. *Use forecast techniques to forecast the demand.*
4. *Differentiate between production layouts.*
5. *Understand the production order procedure.*
6. *Construct and model Aggregate production plans.*
7. *Gain the knowledge of different inventory control systems and inventory models.*

Tool Design
(Credits Theory-03, Practical-01)

Course Code: PR 356 **Contact Hours: Th. 03 T- 00 Pr. 02**

Course Objective

a. This course encompasses the fundamental of machining method, in terms of tool-work material interactions. The contents if framed with the following objectives
b. To understand tool configuration, it's functioning and wear characteristics.
c. Tool materials and developments& application be informed to students
d. To understand orthogonal cutting process and forces involved in the cutting
e. To evolve design of jigs and fixtures for the effective use of machining processes

Evaluation Scheme

Theory:	MTE+ETE: 30+70	***Term work/Practical:***	CE+EVV: 50+50

Course Content

1. Theory of Metal Cutting: Elements of machining by cutting, Tool geometry of single point cutting tool, tool signature, effect of tool angles on machining, Tool materials - properties, selection and applications.
2. Chip-formation, types of chips, built-up-edge, chip breakers, orthogonal cutting and force diagram, Merchant's circle, Force measurement by dynamometers, introduction to multi-point cutting tools and recent advances in cutting tools. . Cutting Tool Materials.
3. Machinability: Definition, Factors affecting, machinability index, machinability of aluminium, metallurgical aspects of tools and their performance.
4. Tool Life: Factors affecting tool life, Taylor's equation, tool failure, tool wears, types of tool failures, Tool condition monitoring. Effect of various parameters on tool life.
5. Locating And Clamping Devices: Degrees of freedom, 3-2-1 method of location, choosing a locating surfaces, redundant locaters, fool proofing, locating methods and devices, clamping methods, power clamping: pneumatic, hydraulic, hydro–pneumatic, vacuum, magnetic and non-conventional clamps.
6. Jig / Fixture Design Considerations: Design principles of Jig/Fixture and their parts, fastening elements, construction elements, and process planning for Jig/Fixture manufacturing.

7. Jig Design**:** Drill bush types, fixed, plain, headed renewable, slip, threaded and special, design principles for drill bush, drill bush materials, jig feet, Types of jigs, templates, plate, angle-plate, leaf, turnover, box, multi-station and indexing jigs.
8. Fixture Design**:** Cutter setting and mounting devices, milling fixture design, single piece, sting, progressive, index and rotary milling, design of lathe, boring and broaching fixtures.

Term Work

It shall consist of at least six assignments based on the following

a. Preparation of single point cutting tools for turning, parting, threading.
b. Tool signature and basic shapes of cutting tools
c. Demonstration of different tools (single and multi-point cutting tools)
d. One sheet each on locating i.) Elements& clamping elements, ii.) jig design and iii.) fixture design.

Text Books

1. Metal Cutting Theory and Practice, a. Bhattacharyya, Central Book Publishing, Calcutta (1984)
2. Tool Design: Donaldson, Tata McGraw–Hill publishing Co. Ltd., New Delhi

Reference Books

1. Introduction to Jig and Tool Design: Kempster M. H. A. English language book society.
2. Jigs and Fixtures by Joshi P. H., Tata McGraw Hill, New Delhi
3. Production Technology by HMT, TMH publications
4. Production Science: Pandya and Singh, Standard Publications
5. Metal cutting theory and cutting tool design: V. Arshinov, G. Alekseev: Mir Publishers, Moscow.
6. Properties and Selection of Tool materials, V. A. Kortesoja, ASM publications, Ohio (1975)

Course Outcomes

1. *Apply basic tool engineering concepts like tool designation, right selection of cutting tool, machining parameters in tooling applications.*
2. *Interpret tool failure criteria using Taylor's equation for several materials and their effect on machinability.*

3. *Compute different forces in metal cutting, angles involved in chip formation by using merchant circle diagram.*
4. *Compare types of metal cutting like orthogonal and oblique cutting.*
5. *Understand basics of locating and clamping devices including degrees of freedom, 3-2-1 principle.*
6. *Implement the design knowledge of jigs and fixture with different design considerations and features.*

Computational Lab

(Credits: Theory-00, Practical-01)

Course Code: PR 357 **Contact Hours: Th. 00 T- 00 Pr. 02**

Course Objectives:

a. To introduce open source software tools, spreadsheet and DBMS useful for engineering and scientific computations.
b. To apply basic programming fundamentals to solve engineering problems.

Evaluation Scheme:

Theory:	MTE+ETE: 30+70	***Term work/Practical:***	CE+EVV: 50+50

Course Content:

1. Introduction to Engineering and scientific computing using,
    a. Scilab/Octave/Matlab,
    b. Spreadsheet,
    c. Database Management (DBMS) software and
    d. Procedure oriented programming languages like C
    e. Object oriented programming languages like C++/Java

Term Work:

The term work shall consist of the assignments based on the above syllabus. The student shall submit the record of term work in the form of journal.

Text Book:

1. Schaum's outline of theory and problems of programming with C++. - John R. Hubbard (Schaum's outline series, McGraw-Hill)
2. [Long] P.J.G. Long, Introduction to Octave, available at the website, http://www-mdp.eng.cam.ac.uk/web/CD/engapps/octave/octavetut.pdf (September 2005).

Reference Books:

1. The complete reference C++ (Third edition)- Herbert Schildt (Tata McGraw -Hill)
2. Scilab/Octave/Matlab, spreadsheet software manuals
3. Tutorials, manuals and documentation of spreadsheet packages

Course outcomes:

Upon completing this course, the students will be able to:

1. *Apply use of open source software like octave/Scilab to solve engineering and scientific problems*
2. *Write C/C++/Java programs for simple engineering applications.*

Elective I Mathematics IV Complex Analysis
(Credits Theory-04)

Course Code: MA 302 A **Contact Hours: Th. 03 T- 01 Pr. 02**

Course objectives:

a. To perform algebra with complex numbers.
b. To identify complex-differentiable functions.
c. To compute complex line integrals.
d. To use residue theorem.
e. To understand the conformal mappings and their engineering applications.

Evaluation Scheme:

Theory:	MTE+ETE: 30+70

Course Content:

1. **Introduction:** Introduction to Complex Variables.
2. **Function of complex variables: L**imit, continuity, differentiability, analytic functions and their properties, Cauchy-Riemann equation, harmonic functions, elementary complex functions and their properties.
3. **Line Integral:** Cauchy's theorem, Cauchy's Integral formula, and their applications.
4. **Series:** Taylor and Laurent theorems, classification of singularities, residues, Cauchy's residue theorem, improper Integrals, conformal mappings.

Reference Books:

1. Anant R. Shastri, *An Introduction to Complex Analysis*, Macmillan Publishers India (2000).
2. James W. Brown, Ruel V. Churchill, *Complex Variables and Applications (Seventh Edition),* Mc Graw Hill (2003).
3. Erwin Kreyszig, *Advanced Engineering Mathematics (10th Edition), Wiley Publication*

Course Outcomes:

1. *Student will be able to compute sum, product, division, polar form, and nth roots of complex numbers and will also be able to understand their geometry.*
2. *Student will able identify the analytic functions and will be able to express these functions as a power series.*
3. *Student will be able to compute line integrals of complex functions through parameterization of curves.*

4. *Student will be able to use Cauchy's theorem, residue theorem to calculate line integrals and improper integrals.*
5. *Student will be able to use analytic functions as conformal mappings.*

Elective I Mathematics IV Statistics and Probability
(Credits Theory-04)

Course Code: MA 302 B **Contact Hours: Th. 03 T- 01 Pr. 02**

Course Objective

a. To equip the students with the broad perspective of probability theory.
b. To develop the understanding of various discrete and continuous distributions along with their properties.
c. To understand and differentiate among various statistical and random processes techniques

Evaluation Scheme:

Theory:	MTE+ETE: 30+70

Course Content

1. Introduction: Sample Space and Events, Classical Probability, Conditional Probability, Independent Events, Bayes Theorem, Random Variable, Probability Measure, Sigma Field, Distribution Function

2**. Functions of Random Variables:** Expectation, Moment Generation Function and Its Properties, Characteristic Function.

3. Distributions: Special Discrete Distributions – Binomial, Poisson, Geometric, Special Continuous Distributions – Uniform, Exponential, Beta, Gamma. Normal Distribution

4. Chebychev's Inequality, Transformation of Variables, Joint and Marginal Distributions, Conditional Distribution.

5. Covariance: Correlation, Transformation of Variables, Independence of Random Variables, Random Vector, Weak Law of Large Numbers, Central Limit Theorem, Bivariate Normal Distribution

6. Regression: Regression, Least Square Method, Sampling Distributions of Parameters, Chi-Square, t and F Distribution.

7. Theory of Estimation: Theory of point estimation, Properties of Point Estimator, Maximum Likelihood Estimator, Interval Estimation, Confidence Interval, Testing of Hypotheses, Likelihood Ratio Test, Goodness of Fit test, Stochastic Processes

Reference Books:

1. Sheldon M. Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, Elsevier (2012)

2. Vijay K. Rohatgi and A. K. Md. Ehsanes Saleh, *An introduction to probability and statistics,* Wiley (2011)
3. Richard A. Johnson, Miller and Freund, *Probability and Statistics for Engineers*, PHI Learning (2010)
4. Athanasios Papoulis and S. Unnikrishna, *Probability, Random Variables, and Stochastic Processes*, Tata McGraw Hill (2002)
5. Erwin Kreyszig, *Advanced Engineering Mathematics (Tenth Edition),* Wiley Publication.

Course Outcomes:

1. *Student will demonstrate the ability of data analysis and will be able to describe sample space for various random experiments*
2. *Student will identify the random variables as discrete and continuous random variables and will be able to apply appropriate distribution methods.*
3. *Student will be able to interpret the mean of a random variable in terms of the Law of Large Numbers.*
4. *Student will be able to use the Normal distribution, including the preservation of Normality under linear transformation.*
5. *Student will apply the Central Limit Theorem to problems involving sums and averages of variables from arbitrary distributions.*
6. *Student will be able to apply the tests of goodness of fit*

Elective I Mathematics IV Numerical Methods
(Credits Theory-04)

Course Code: MA 302 C **Contact Hours: Th. 03 T- 01 Pr. 02**

Course Objective:

a. To be aware of the use of numerical methods in modern scientific computing.
b. To make the students familiar with finite precision computation, and numerical solutions of nonlinear equations in a single variable
c. To learn numerical interpolation and approximation of functions
d. To be familiar with numerical integration and differentiation, numerical solution of ordinary differential equations, partial differential equations.
e. To provide knowledge of eigenvalue problems, QR Method.

Evaluation Scheme:

Theory:	MTE+ETE: 30+70

Course Content:

1. Interpolation by polynomials, divided differences, error of the interpolating polynomial, piecewise linear and cubic spline interpolation.
2. Numerical integration, composite rules, error formulae.
3. Solution of a system of linear equations, implementation of Gaussian elimination and Gauss-Seidel methods, partial pivoting, row echelon form, LU factorization Cholesky's method, ill-conditioning, norms.
4. Solution of a nonlinear equation, bisection and secant methods.
5. Newton's method, rate of convergence, solution of a system of nonlinear equations, numerical solution of ordinary differential equations, Euler and Runge-Kutta methods, multi-step methods, predictor-corrector methods, order of convergence, finite difference methods, numerical solutions of elliptic, parabolic, and hyperbolic partial differential equations.
6. Eigenvalue problem, power method, QR method.

Reference Books:

1. Kendall Atkinson, Weimin Han, Elementary Numerical Analysis (Third edition), Wiley Publication (2004)
2. Amos Gilat, Numerical Methods for Engineers and Scientists (Third Edition), Wiley Publication (2014)

3. Steven Chapra, Raymond Canale, Numerical Methods for Engineers (Seventh Edition), McGraw Hill Education (2014)
4. Erwin Kreyszig, Advanced Engineering Mathematics (10th Edition), Wiley Publication

Course Outcomes:

1. *Students would be able to assess the approximation techniques to formulate and apply appropriate strategy to solve real world problems and be aware of the use of numerical methods in modern scientific computing.*
2. *Be aware of numerical methods to solve nonlinear equations.*
3. *Students would be able to apply interpolation formulas for real life problems.*
4. *Be familiar with numerical solution of integration, linear equations, ordinary differential equations, interpolations.*
5. *Students would be able to use linear algebra techniques and numerical techniques*

Manufacturing Lab- II
(Credits Practical - 01)

Course Code: PR 358 **Contact Hours: Th. 00 T- 00 Pr. 02**

Course Objective

a. The objective is to study details of CNC milling, Programming, DNC machines.
b. Manufacturing of a job consisting of operations like turning, trading, knurling, shaping, drilling
c. Study of grinding and radial drilling machines for demonstration of a job.

Evaluation Scheme

Term work/Practical:	CE+EVV: 50+50

Course Content

1. Details of CNC milling, Programming, DNC and related topics.
2. A job consisting of operations like turning, trading, knurling, shaping, drilling.
3. Demonstration job on grinding and radial drilling.

References Books

1. Books of Machining Process and Manuals of the Machine Tool being used.

Modern Manufacturing Technology
(Credits Theory-03, Practical-01)

Course Code: PR 371 **Contact Hours: Th. 03 T- 00 Pr. 02**

Course Objective

a. This course covers the alternative manufacturing solutions especially for the difficult to machine materials/components. The syllabus consists of information about advanced manufacturing techniques and their capabilities. The student's interest is sustained by making them awake about use of different energy sources like mechanical, electrical, chemical, and thermal for manufacturing technologies. It is aimed to evaluate the students by set of objectives as under
b. To understand the potential of different energy sources and medium for removing the material by various alternative machining routes,
c. To make use of hard core science fundamentals and its practical applicability for material removal and manufacturing,
d. To map the manufacturing alternatives for difficult to machine materials and configurations which otherwise are not productively viable,
e. To make the student aware about technological advancements in machining operations for challenged material/configuration/size in terms of their applications,
f. To develop the abilities by appealing for "Technology Pull" and "Process developments'

Evaluation Scheme

Theory:	MTE+ETE: 30+70	***Term work/Practical:***	CE+EVV: 50+50

Course Content

1. Introduction**:** Historical background of Non Traditional Machining Technologies., Classification, Basic fundamentals of various process, their process capabilities and related comparison.
2. Mechanical Processes**:** Processes principles, equipment, processes parameters & Applications of: Abrasive Jet Machining, Ultrasonic Machining, Water Jet Cutting, and Magnetic Abrasive Machining. Evaluation of material removal rate (MRR) in AJM.
3. Electrochemical Machining (ECM): Background, Electrochemistry, Classification, Equipment required, Process capabilities, Processes parameters & Trouble shootings. Electro chemical Grinding, Electrochemical deburring, electro chemical cutting. Application examples of ECM processes, Evaluation of MRR of pure metal in ECM.

4. Electrical Discharge Machining (EDM): Fundamental principle, Equipments required, mechanism of machining, process parameters, process capabilities, application example &trouble shooting, Introduction to wire EDM and other recent developments in EDM technologies.
5. Chemical Machining: Introduction, fundamental principles, process parameters, classification & selection of etchant, accuracy of the process, applications etc. Photo chemical machining and blanking.
6. Laser Beam Machining (LBM): Introduction, Background of laser action, production of photon cascade in solid optical laser. Machining applications of laser wire drilling, cutting, marking, welding, heat treating, cladding, and surfacing.
7. Allied Processes: Process principles, equipment, and mechanism of machining, applications examples of: Plasma Arc Cutting, Thermal Energy Method, Abrasive Water Jet Machining, and Electro-Chemical Discharge Machining.
8. Introduction To Micro Manufacturing: Micro manufacturing fundamentals, significance, application of NCMPs for micro manufacturing Micro to nano finishing processing information - AFM, MAF.

Term Work

It shall consist of at least 5-6 assignments based on the following

1. Demonstration and study report of any two non-traditional machining processes.
2. Determination of MRR of AJM: an experiment comparing above result with theoretical MRR.
3. Determination of MRR in ECM.
4. An experiment based on Chemical Machining.
5. A term paper based on chapter No. 3, 4, 6, 7 & 8.

Text Books

1. Advanced Machining Processes, by V. K. Jain, Allied Publishers Pvt. Ltd, (2005)
2. Non-conventional machining by – P. K. Mishra (Narosa Publications)

Reference Books

1. Modern machining process – P. C. Pandey & H. S. Shah
2. Manufacturing Science – Amitabha Ghosh & Ashok Kumar Mallik (EWP)
3. Non-traditional Machining Process – E. J. Weller
4. Non-traditional Manufacturing Processes – G. F. Benedict (Marcel Dekker Jnc.)

Course Outcomes

On Successful completion of this module, the students should be able to;

1. *Classify non-conventional machining processes on the basis working principles and process characteristics.*
2. *Analyse effect of process parameters on performance of non-conventional machining processes.*
3. *Evaluate merits of each process for typical applications.*
4. *Propose a non-conventional machining process for real life case.*

Heat and Mass Transfer
(Credits Theory-03, Practical-01)

Course Code: PR 372 **Contact Hours: Th. 02 T- 01 Pr. 02**

Objectives

This subject is introduced to third year students with an objective of understanding fundamentals of heat and mass transfer.

Evaluation Scheme

Theory:	MTE+ETE: 30+70	***Term work/Practical:***	CE+EVV: 50+50

Course Content

1. Introduction To Heat Transfer: Introduction, modes of heat transfer, steady state heat transfer, thermal conductivity and coefficient of heat transfer, factors affecting the above properties, unsteady state of heat transfer, heat transfer with internal heat generation, practical applications
2. Conduction Heat Transfer**:** Steady State heat conduction, one-dimensional conduction, Fourier's equation, and heat conduction through objects solid slabs Steady heat conduction through cylindrical objects heat conduction through composite cylinders. Critical thickness of insulation, Effect of variable conductivity. Fins, types of fins, steady state heat conduction with heat dissipation to surrounding, Thermometric well, electrical analogy for study of heat transfer problems.
3. Convective Heat Transfer**:** Introduction to natural and forced convection, empirical relation, significance of different non dimensional numbers in convective heat transfer. Nusselt number, Reynolds number, Grashoff number, etc.
4. Radiation Heat Transfer: Introduction, definitions, laws of radiation, shape factor, surface resistance, Radiations shields, Electrical analogy for steady radiation problems.
5. Heat Exchangers**:** Classification, concept of overall heat transfer coefficient, LMTD relations, effectiveness, and effectiveness by NTU method, simple numerical problems.
6. Introduction to Mass Transfer: Analogy between heat and mass transfer, mass diffusion, Fick's Law, boundary conditions, steady mass diffusion through a wall, cylinder and sphere, water vapour migration in buildings, transient mass diffusion,

mass transfer in a moving medium, diffusion of vapor through a stationary gas: Stefan Flow

Term Work

Term work shall consist of the record of following laboratory experiments.

1. Determination of thermal conductivity of insulating powder.
2. Determination of thermal conductivity of Composite slab.
3. Experiment on natural convection apparatus.
4. Determination of Emissivity of test – plate.
5. Stefan Boltman's apparatus.
6. Experiment on heat exchangers.
7. Determination of critical radius of insulation.

Text books

1. Heat and Mass transfer- Dr. D. S. Kumar, S. K. Kataria and sons publishers

Reference books

1. Heat transfer - Dr. Sukhatme.
2. Heat transfer -J. P. Holman, McGraw-Hill international

Course Outcomes

On successful completion of this course, students should be able to;

1. *Define, differentiate and interpret basic modes of heat transfer.*
2. *Compute temperature distribution and heat transfer rate for 1-D problems*
3. *Design heat exchanger as per the requirement.*
4. *Interpret the knowledge in the field of mass transfer.*

Fluid Mechanics and Hyd. Machines
(Credits Theory-03, Practical-01)

Course Code: PR 373 **Contact Hours: Th. 03 T- 00 Pr. 02**

Objectives

This subject is introduced to third year students with an objective of understanding fundamentals of fluid statics, fluid kinematics & dynamics of fluid flow. This subject forms a basis of advance topics like CFD.

Evaluation Scheme

Theory:	MTE+ETE: 30+70	***Term work/Practical:***	CE+EVV: 50+50

Course Content

1. Introduction**:** Definition of fluid, Properties of fluids, Viscosity, Compressibility, Bulk modulus of elasticity, Surface tension and capillarity
2. Fluid Statics**:** Pressure at a point, Pascal's law, Hydrostatic pressure on plane and curved surfaces, Absolute, Gauge, Atmospheric and vacuum pressures, pressures, Measurement of pressure by manometers and gauges, Buoyant equations Buoyance, Centre of buoyancy, Stability of floating bodies, Metacenter, Metacentric height and its determination.
3. Fluid Kinematic**:** Types of fluid flows: Steady, Unsteady, Uniform and non-uniform, laminar and turbulent, Compressible and incompressible, rotational and irrotational, Rate of flows, continuity equation for one dimensional, Velocity and acceleration, Velocity potential function and stream function, vortex flow.
4. Dimensional analysis: Introduction, secondary or derived quantities, dimensions of physical quantities, dimensional homogeneity, methods of dimensional analysis, model analysis, types of forces acting in moving fluid, dimensionless numbers, model laws.
5. Fluid Dynamics**:** Equation of motion, Euler's equation, Bernoulli's equation, and practical applications of Bernoulli's equation: Venturimeter, orifice meter, Pitot tube, Momentum equation.
6. Flow through pipes: introduction, loss of energy in pipes, frictional loss in pipe flow, equations for loss of head, minor losses, flow through pipes; series, parallel, compound, branched.

7. Introduction to hydraulic machines: Turbines, classification of hydraulics turbines, pelton turbine, Francis turbine, centrifugal pumps, main parts of centrifugal pump, workdone by centrifugal pump, reciprocating pump.

Term Work

Term work shall consist of the record of following laboratory experiments.

1. Verification of Bernoulli s equation.
2. Calibration of Venturimeter.
3. Calibration of Orifice meter.
4. Determination of Hydraulic Coefficients for an orifice
5. Study of pressure measuring devices.
6. Study hydraulics turbine setup
7. Study of centrifugal setup

Text books

1. Fluid mechanics and Hydraulic Machines by Dr. R. K. Bansal, Laxmi publications (P) ltd., New Delhi.

Reference books

1. Hydraulics and Fluid Mechanics by Modi and Seth
2. Theory and Application of Fluid Mechanics by Subramanya
3. Fluid Mechanics by V. L. Streeter and E. Benjamin, Wiley

Course Outcomes

On successful completion of this course, students should be able to;

1. *Describe the basic properties of fluids.*
2. *Define and differentiate between fluid statics and fluid dynamics.*
3. *Solve real life problems in the field of fluid mechanics.*
4. *Acquire fundamentals to study the advanced topics such as CFD.*
5. *Interpret the basics of hydraulic machines/systems.*

Elective II/III Finite Element Analysis
(Credits Theory-03, Practical-01)

Course Code: PR 374 **Contact Hours: Th. 03 T- 00 Pr. 02**

Course Objectives

a. To improve the problem solving ability using numerical method like FEA. To understand and use the commercial finite element packages effectively through hands on practice during practical.

Evaluation Scheme

Theory:	MTE+ETE: 30+70	***Term work/Practical:***	CE+EVV: 50+50

Course Content

1. Fundamental Concept Of FEM: Introduction, History background, stresses & equilibrium boundary conditions, strain displacement relations, stress – strain relations, temperature, effects, variational approach solution techniques
2. Description of The Method: Step wise procedure of Finite element method, variational techniques for derivation of finite element equations, assembly procedure, solution methods.
3. FEA of One Dimensional Problems: Introduction, finite element modelling, shape functions, variational approach, weighted residual approach, Assembly of finite element equations, Higher- order element, Boundary conditions, Temperature effects.
4. FEA of Two Dimensional Problems: Introduction, FE modelling, formulation of constant strain triangular element, problem modelling& boundary conditions.
5. Pre-processor and Post Processors: Introduction, Mesh Generation, post processing, requirements of a pre-processor and post processor, pre-processor and post processors in analysis software.
6. Introduction to FEA Software like ANSYS, NASTRAN, COSMOS-WORKS.
7. Applications of FEA To Heat Transfer and Sheet Metal Forming

Term Work

The term work shall consist of the following assignments, using ANSYS, Nastran, Hypermesh and other analysis softwares.

1. Assignment on mesh generation for different geometries
2. Assignment on static structural analysis.
3. Assignment on steady state thermal analysis

4. Assignment on thermo-structural analysis

Term Work

It shall consist of tutorial and case presentation based on the syllabus.

Text Books

1. Introduction to Finite Element Method in Engineering by S. S. Rao, Butterworth Heinmann Publication.

Reference Books

1. Finite Element Procedures by Bathe K. J., Prentice Hall of India, New Delhi.
2. ANSYS & other software manuals.

Course Outcomes

On successful completion of this module, students should be able to

1. *Identify mathematical model for solution of common engineering problems.*
2. *Formulate simple problems into finite elements.*
3. *Solve structural, thermal, fluid flow problems.*
4. *Use professional-level finite element software to solve engineering problems in Solid mechanics, fluid mechanics and heat transfer.*
5. *Derive element matrix equation by different methods by applying basic laws in mechanics and integration by parts.*

Elective-II/III Product Design and Development
(Credits Theory-03, Practical-01)

Course Code: PR 375 **Contact Hours: Th. 03 T- 00 Pr. 02**

Course Objective

a. The course is aimed to appreciate the design and development as the central activity for the product utility view point. The general objectives for the course are
b. To provide the realistic understanding of the design process
c. To develop the attitude and approaches towards product development than merely presentencing design techniques
d. To understand modern tools and methods like collaborative practices, internet based design, PLM in context of product development
e. To study example case studies to learn from the implemented practices for product design and development

Evaluation Scheme

Theory:	MTE+ETE: 30+70	***Term work/Practical:***	CE+EVV: 50+50

Course content

1. Introduction: Engineering design, Process and purpose of design, Types of design, importance of design, morphology of design, design considerations.
2. Product Design Process: Steps in design: need identification & problem definition, Functional requirement analysis, defining a product development team, gathering information, concept generation & evaluation, organization for design, product specification and detailed design.
3. Material And Manufacturing Process Selection In Design: Factors influencing material and process selection, approaches, tools and software used in selection.
4. Development of Design: Concept to product, design for: function, manufacture/production, shipping, handling, installation, use, maintenance etc.
5. Design Cost Evaluation: Need, methods, design to cost and life cycle, economics and financial feasibility, costing and use of software for estimation.
6. Product Development Approaches: Concurrent engineering, partnership with supplier, collaborative and Internet based design.
7. Design Project Management: PDM, PLM and related software tools.
8. Case studies based on Concurrent and collaborative product development approaches,

Modular product design, mechanical and electronic products design.

Term Work

It shall consist of tutorial and case presentation based on the syllabus.

Text Books

1. Engineering Design by Dieter George E. McGraw Hill Pub. Company, 2008.
2. Product design and development by Ulrich Karl T and Eppinger Steven D., McGraw Hill Pub. Company 1995.
3. Product Design and Manufacture by Chitale AK and Gupta RC, Prentice-Hall of India, New Delhi
4. Fundamentals of Design and manufacturing, GK Lal, Vijay Gupta, N Venkata Reddy, Narosa Publications, 2006

Reference Book

1. Handbook of Product Design for Manufacturing, Bralla, James G., McGraw Hill Pub. 1986
2. Design for X, G. Q. Huang, Chapman & Hall, 1996

Course Outcomes

1. *Employ engineering principles to execute a design from concept to finished product.*
2. *Select the optimum material and manufacturing process for a given component under a set of given working condition*
3. *Recommend a substitute material and/or a process for making a component in order to improve its performance, cost or other attributes under a given set of service conditions*
4. *Demonstrate design and development of the product, the associated manufacturing equipment and processes, and the repair tools and processes using concurrent engineering.*
5. *Realize concept of PDM and PLM*

Elective-II/III Plastics and Composites
(Credits for Theory-03, Practical-01)

Course Code: PR376 **Contact Hours: Th. -03, Pr.-02**

Course Objectives

a. To create awareness about composites/plastics as an alternative material.
b. To provide information about composites, its manufacture, applications.
c. To provide knowledge of design of composite for a particular application.

Evaluation Scheme

Theory:	MTE+ETE: 30+70	***Term work/Practical:***	CE+EVV: 50+50

Course Contents

1. Plastics: Structure and mechanical properties of plastics, thermoplastics and thermosets, Processing of Plastics, Extrusion, Injection moulding, Thermoforming, Compression moulding, Transfer moulding, General behaviour of polymer melts, Machining of plastics.
2. Introduction to Composite Materials: Definition, Classification, Types of matrices material and, reinforcements, Characteristics & selection, Fibre composites, laminated composites, applications, Particulate composites, Prepegs and sandwich construction.
3. Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two – dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Invariant properties. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.
4. Macro mechanical behaviour of a laminate: Introduction, classical lamination theory, single layered configurations, symmetric, anti-symmetric laminates.
5. Manufacturing: Layup and curing - open and closed mould processing, Hand lay up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining and joining, tooling, Quality assurance, Introduction.
6. Testing of composites: Material qualification, Types of defects, NDT methods.

Text Books

1. Composite Materials handbook, Mein Schwartz McGraw Hill Book Company, 1984.
2. Mechanics of composite materials, Autar K. Kaw CRC Press New York.

Reference Books

1. Mechanics of Composite Materials, Rober M. Jones, McGraw Hill Kogakusha Ltd. 1975
2. Stress analysis of fibre Reinforced Composite Materials, Michael W, Hyer MGH International.
3. Composite Material Science and Engineering, Krishan K. Chawla Springer.

Course Outcomes

At the end of course students will able to,

1. *Describe the fundamental properties of plastics.*
2. *Differentiate between monolithic and composite materials.*
3. *Evaluate the properties of composite laminate.*
4. *Interpret the manufacturing method for plastics and composite materials*

Elective II/III Renewable energy sources
(Credits Theory-03, Practical-01)

Course Code: PR 377 **Contact Hours: Th. 03 T- 00 Pr. 02**

Course Objectives:

1. To study energy generation, different energy sources and their utilization and impact on environment
2. To gain knowledge of solar radiation and its applications
3. To understand the wind energy and its nature
4. To analyze the performance of solar collectors and wind turbines
5. To learn fuel cell and its efficiency

Evaluation Scheme

Theory:	MTE+ETE: 30+70	***Term work/Practical:***	CE+EVV: 50+50

Course Content

1. Energy Resources and Utilization

Conservation and forms of energy, energy reserves in India, nuclear power, hydroelectric power potential, India's power scene, renewable energy sources, energy parameters, cogeneration, rational energy use of energy, energy efficiency and conservation, new technologies, distributed energy systems and dispersed generation,

2. Environmental aspects of electric energy generation

Atmospheric pollution, hydrocarbons, particulates, thermal pollution, hydroelectric projects, operational phase of hydro power projects, operational safety in nuclear power plants, disposal of nuclear waste, global environmental awareness, impact of renewable energy generation on environment, GHG emissions from various energy sources, cost of electricity production from different energy sources, electromagnetic radiation from high voltage overhead lines, energy options for Indian economy.

3. Solar radiation and measurement

Solar constant, spectral distribution of extraterrestrial radiation, terrestrial solar radiation, solar radiation geometry, computation of COSθ, sunrise, sunset, day length, LAT, Empirical equation of for estimating the availability of solar radiation, solar radiation measurement and Solar radiation data for India.

4. Solar collector and applications

Solar Thermal energy collectors, design parameters, analysis, performance, laws of thermal radiation, radiation heat transfer between real bodies, radiation optics, transmitivity, heat losses and coefficient, Solar Thermal energy storage.

Solar thermal energy conservation systems - Solar water heating, solar distillation, thermodynamic cycles and power plants, solar ponds, solar pumping system, solar cooker, solar passive technologies, solar furnace, solar green house

5. Solar photovoltaic systems

Photovoltaic effect, solar photovoltaic system, materials for solar cells, characteristics, efficiency, applications PV system, plastic solar cell with nanotechnology, peltier cooling, solar photovoltaic in India, JNNSM

6. Wind energy

Classification, types of rotors, terminology, operation of wind turbines, wind energy extraction, wind characteristics, wind speed, energy estimation, power density duration curve, density function, field data analysis, direction and wind speed, variation of wind speed, wind scale, energy pattern factor in wind power studies, land for wind energy, design of wind turbine rotor, regulating system, wind power generation curve, horizontal axis wind turbine generator, modes of wind power generation, advantages and disadvantages. wind energy farms

7. Ocean Energy

Tidal Energy, Tidal characteristics, Tidal Energy estimation, Development of a tidal power scheme, Yearly power generation from Tidal Plants, Economics of Tidal Power, Wave energy-characteristics-energy and power from the waves, wave energy conversion devices

8. Geothermal energy

Structure of earth's interior, sites, field, gradient, resources, power generation, geothermal resources in India, utilization, global status of electricity generation from geothermal resources, advantages of geothermal energy

9. Fuel Cells

Principle of operation of an acidic Fuel Cell, Technical parameter, Fuel Processor, methanol fuel cell, fuel cell types, Advantages of fuel cell power plants, fuel cell battery powered bus system, comparison between acidic and alkaline hydrogen-oxygen fuel cells, state of art fuel cells, energy output of a fuel cell, efficiency and EMF of a fuel cell, Gibbs-Helmholtz equation, hydrogen fuel cell analysis with thermodynamic potentials, comparison of electrolysis and the fuel cell process, operating characteristics of fuel cells, thermal efficiency, future potential

Hybrid Energy Systems

Need for hybrid systems, types, electric and hybrid electric vehicles, hydrogen powered electric vehicle

Term Work

It shall consist of assignments and case presentation based on the syllabus.

Text Books

1. D.P.Kothari, K.C.Singal and Rakesh Ranjan, "*Renewable Energy Sources and Emerging Technologies"*, Prentice Hall of India, New Delhi, 2009

Reference Books

1. Chetan Singh Solanki, *"Renewable Energy Technologies",* Prentice Hall of India, New Delhi, 2009
2. G. D. Rai, *"Non- conventional Energy Sources",* Khanna publishers, New Delhi, 2011.
3. Malti Goel, *"Energy Souces and Global Warming"*, allied publishers Pvt Ltd. New Delhi, 2005.
4. S.P. Sukhatme, *"Solar Energy: Principles of Thermal Collection and Storage"*, TMH, New Delhi, 2008

Course Outcomes:

On successful completion of the course, students able to:

1. *Interpret energy reserves of India and potential of different energy sources.*
2. *Measure the solar radiation parameters and performance of different solar collectors.*
3. *Calculate different parameters of wind turbine rotor.*
4. *Implicit the importance and applications of geothermal and ocean energy.*
5. *Demonstrate knowledge in field of fuel cell and potential for power generation.*

Elective-II/III Mechatronics
(Credits Theory-03, Practical-01)

Course Code: PR 378 **Contact Hours: Th. 03 T- 00 Pr. 02**

Course Objectives

a. To gain an understanding and appreciation of the fundamental principles of Mechatronics System.
b. To gain understanding of the various components and interactions therein of such a system.
c. To reinforce analytical skills already learned, and use these skills to in analyzing and designing Mechatronic systems.
d. To learn how to think about, approach, analyze, and solve control problems.
e. To understand and appreciate the data and signal transfer among various sub-systems.

Evaluation Scheme

Theory:	MTE+ETE: 30+70	***Term work/Practical:***	CE+EVV: 50+50

Course Contents

1. Introduction: Mechatronics system, microprocessor-based controllers, response of system
2. Sensors and Transducers: Definition, terminology, types of sensors (displacement, position and proximity, velocity and motion, force, fluid pressure, liquid flow, liquid level, temperature, light sensors) selection of sensors, problems
3. Signal Conditioning: Introduction, operational amplifier, protection, filtering, Wheatstone bridge, digital signals, multiplexers, data acquisition, digital signal processing, pulse modulation, problems
4. Actuation Systems: Introduction, Mechanical, Electrical, Pneumatic and hydraulic systems
5. Basic System Models: Mathematical models, mechanical system building blocks, electrical system building blocks, Fluid system building blocks, thermal system building blocks
6. System Models: mechanical translational and rotational systems, electrochemical, hydro-mechanical systems
7. Dynamic Responses of Systems: Modeling dynamic systems, first -order systems, second-order systems, performance measures for second-order systems

8. Controllers: Continuous and discrete processes, control modes, two-step mode, proportional mode, derivation control, integral control, PID controller, digital controllers, control system performance

Text Books

Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, W. Bolton, Pearson Education Asia, (1999)

Reference Books

Introduction to Mechatronics and Measurement Systems, D. G. Alciatore and M. B. Histand, Tata McGraw& Hill (2003

Mechatronics (HMT), Tata McGraw Hill (1998)

Course Outcomes

1. *Demonstrate how Mechatronics integrates knowledge from different disciplines in order to realize engineering and consumer products that are useful in everyday life.*
2. *Application of theoretical knowledge: understanding selection of suitable sensors, actuators and controllers.*
3. *Design time response of first and second order system and basic state variable analysis.*
4. *Design Mechatronics component, system or process to meet desired needs.*
5. *To design the hydraulic and pneumatic systems employed in manufacturing industry.*
6. *Identify & explain the different types of controllers.*

Elective-II/III Automobile Engineering
(Credits Theory-03, Practical-01)

Course Code: PR 379 **Contact Hours: Th. 03 T- 00 Pr. 02**

Course Objectives

a. To make student capable of applying knowledge and skill to design, analyse and evaluate mechanical and automotive engineering systems.
b. To make student capable of identifying and solving engineering problems systematically, critically, creatively and analytically.
c. To help student to become competent, possess leadership qualities and be able to act professionally in the field of mechanical and automotive engineering.

Evaluation Scheme

Theory:	MTE+ETE: 30+70	***Term work/Practical:***	CE+EVV: 50+50

Course Content

1. Introduction: History of automobiles, classification, vehicle specifications, chassis layout, main components of automobiles
2. Engine And Transmission: Main components of engine, Power requirements, Clutches: single and multiple plate clutch, diaphragm clutch, electro-magnetic clutch, overrunning clutch, fluid couplings, torque convertors, clutch linkages, Gear box, speed selection, sliding mesh, constant mesh, synchro mesh types, gear shift mechanisms, epicyclic and automatic transmission, Universal joint, Constant velocity joint, Propeller shaft, Slip joint, Hotchkiss drive, Differential
3. Brakes, Wheels And Tyres: Need of brakes, types: mechanical, hydraulic, pneumatic, vacuum brakes, Drum and Disc brakes, their relative merits, Power brakes, Brake components: Master cylinder, wheel cylinder, brake actuating linkages, Wheel types and their relative merits, wheel balancing, Specifications of tyres, construction details and materials, tyre wear.
4. Steering System: Introduction, Steering linkages, Steering geometry - toe in, toe out, camber, caster angles, kingpin inclination, wheel alignment, Steering system forces and moments, Power Steering, Steer by wire
5. Suspension System: Solid axle suspension, Independent suspension, Suspension geometry, Roll centre analysis, Active suspensions

6. Vehicle Dynamics: Introduction to vehicle dynamics, fundamental approach to modelling, Aerodynamics, Rolling resistance, Total road loads, Excitation sources of vehicle ride vibrations, Vehicle response properties, perception of ride power limited and traction limited performance of automobile for acceleration, braking, hill climbing, etc.
7. Electrical And Electronic Systems: Generators, Alternators, Principle and operation of cut-out and regulators, Starter motors, Bendix drive, Solenoid drive, Lighting and electrical accessories, Panel board instruments, Air conditioning, Power windows, Central locking, Multi-point fuel injection, Introduction to electronic control systems
8. Vehicle Testing: Need, Testing standards, Different vehicle tests

Term Work

1. Study of Chassis Layout of a commercially available vehicle
2. Study of a type of braking system including testing and trouble shooting
3. Demonstration of steering system, measurement of steering geometry to understand its impact on vehicle performance
4. Study of one type of suspension system
5. Study of King pin inclination, Camber, Castor, Toe in / out, Scrub radius, etc. for a commercially available vehicle
6. Study of Engine with all subsystems of a commercially available vehicle
7. Study of complete transmission system of a commercially available vehicle
8. Study of Electrical / Electronic system of a commercially available vehicle

Text Books

1. Automobile Engineering (Vol. I & II) by Dr. Kirpal Singh, Standard Publishers
2. Fundamentals of Vehicle Dynamics by Thomas Gillespie

Reference Books

1. Automotive Technology by H. M. Sethi
2. Automobile Mechanics by W. H. Crouse, McGraw Hill Publishing Co.
3. Magazines like Automotive Engineering International, Overdrive, Auto India, etc.

Course Outcomes

On successful completion of this module, students should be able to

1. *Identify the main components of automobiles and its classification.*
2. *Define the function of the clutches in automobile.*

3. *Compare between the manual transmission and automatic transmission system in automobile.*
4. *Describe the steering geometry and steering system forces and different types of brakes, wheel and tries.*
5. *Acquire knowledge of various suspension types and methods of analysis to determine their essential properties.*
6. *Explain the working principle of electrical and electronics accessories used in automobile.*

Elective-II/III Object Oriented Programming (OOP) and tools
(Credits Theory-03, Practical-01)

Course Code: PR 380 **Contact Hours: Th. -03, Tu. -00, Pr. -02**

Course Objectives

a. To explore tools for engineering problem solving
b. To learn basics of OOP and C++, Java programming, Excel VBA
c. To learn programming in DBMS
d. To learn programming in computing tools like Octave/Scilab/Matlab for engineering applications

Evaluation Scheme

Theory:	MTE+ETE: 30+70	***Term work/Practical:***	CE+EVV: 50+50

Course Contents

1. Introduction: Introduction to computer and software architecture, Programming languages, Octave, Scilab, spreadsheet functions and pivot table/chart, Excel and VBA, Matlab
1. Data representations and Fundamental concepts: Bits, nibbles, bytes and words, Binary arithmetic, Algorithms, flowcharts and Pseudocodes, Getting started in C++ and Overview of IDEs and program development, Input / Output streams
2. Procedural programming basics and An introduction to object-oriented analysis, Loops, functions, Variable Types, Data Abstraction, arrays and structures, Pointers and dynamic memory allocation
3. Basic Java programming, Java classes and objects, Applets and applications development in Java
4. Octave/ Scilab/ Matlaband Excel VBA programming
5. SQL Programming in DBMS

Term Work

Assignments based on each topic in above syllabus.

Practical Examination

The practical examination consists of an oral and/or practical based on the syllabus prescribed above.

Text Books

1. Kanetkar, Y. *Let us C++*, BPB Publications

2. Balagurusamy, E. *Object Oriented Programming* with *C++* and *JAVA*, Tata McGraw-Hill Education
3. John W. Eaton, David Bateman, Soren Hauberg and Rik Wehbring. *GNU Octave: A high-level interactive language for numerical computations*, 4th Ed. for Octave version 4.0.3, July 2016. https://www.gnu.org/software/octave/download.html
4. Scilab software documentation, http://www.scilab.org/download/latest

Reference Books

1. Stroustrup, B. *The C++ Programming Language*, Addison-Wesley
2. *MS Excel software documentation*
3. *Matlab software documentation*
4. AlfioQuarteroni and Fausto Saleri. *Scientific Computing with MATLAB and Octave*, 2nd Ed, Springer Publishers
5. Steven C. Chapra, Raymond P. Canale. *Numerical Methods for Engineers*, 5th Ed, Tata McGraw-Hill Education

Course Outcomes

After completion of this course a student should be able to

1. *Solve engineering and scientific problems using computing tools and/or programs*
2. *Design and develop programs in C/C++/Java*
3. *Design and develop SQL programs in DBMS*
4. *Design and develop functions, templates, custom tools/programs using spreadsheet software with VBA API.*