**INDUSTRY LINKED B.TECH AUTOMOTIVE ENGINEERING**
**(With Automotive product design specialization)**

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| **1st Semester** | **MULTIVARIABLE CALCULUS & PARTIAL DIFFERENTIAL EQUATIONS** | 3 | 1 | 0 | 4 |
| **PREREQUISITES** | 10+2 Level mathematics / Basic Mathematics | | | | |
| OBJECTIVES | This Mathematics course provides requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists. Three important topics of applied mathematics, namely the Multiple integrals, Vector Calculus, Laplace transforms which require knowledge of integration are introduced. | | | | |
| Expected Outcome | By the end of the course the students are expected to learn<br>(i) how to evaluate multiple integrals in Cartesian, Cylindrical and Spherical geometries.<br>(ii) the powerful language of Vector calculus with physical understanding to deal with subjects such as Fluid Dynamics and Electromagnetic fields.<br>(iii) to solve ordinary differential equations directly and also use transform methods where its possible | | | | |
| Module 1 | Multivariable Calculus & Multiple Integrals | | | | |
| Functions of two variables-limits and continuity-partial derivatives –total differential–Taylor's expansion for two variables–maxima and minima–constrained maxima and minima-Lagrange's multiplier method- Jacobians Evaluation of double integrals–change of order of integration– change of variables between cartesian and polar co-ordinates- evaluation of triple integrals-change of variables between cartesian and cylindrical and spherical polar co-ordinates-beta and gamma functions– interrelation-evaluation of multiple integrals using gamma and beta functions-error functionproperties | | | | | |
| Module 2 | Vector Calculus & Ordinary Differential Equations | | | | |
| Scalar and vector valued functions - gradient–physical interpretation-total derivative–directional derivative-divergence and curl –physical interpretations-vector identities(without proof) - scalar and vector potentials-line, surface and volume integrals-Green's , Stoke's and Gauss divergence theorems (without proof)-verification and evaluation of vector integrals using Them ,Linear higher order ordinary differential equation with constant coefficients– solutions of homogenous and non homogenous odes- method of undetermined coefficients –method of variation of parameters – equations reducible to linear equations with constant coefficients | | | | | |
| Module 3 | Laplace Transforms | | | | |
| Definition-Laplace transforms of functions-properties of Laplace transforms-initial and final values theorems-inverse transforms-transforms of periodic functions-convolution theorems–step functions, impulse functions-concept of transfer functions –applications to the solution of differential equations | | | | | |
| Text Books | 1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition., John Wiley & Sons, (Wiley student Edison) (2013). | | | | |
| Reference | 1. G.B.Thomas and R.L.Finney, Calculus and analytical geometry, 11th Edition, Pearson Education, (2006). | | | | |

| | **MODERN PHYSICS** | 3 | 0 | 2 | 4 |
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| prerequisites | Physics as one subject in 12th Standard or equivalent level. | | | | |
| Objectives | To enable the students to understand the basics of the latest advancements in Physics, viz., Quantum Mechanics, Lasers, Fiber Optics, Ultrasonics,Microwaves and Nanotechnology | | | | |
| Expected Outcome | At the end of the course, students will acquire the necessary knowledge about modern physics and its applications in various engineering and technology Disciplines. | | | | |
| Module 1 | Quantum Physics | | | | |
| Dual nature of electron magnetic radiation - de Broglie waves – Compton effect experimental verification -Heisenberg uncertainty principle – Schrodinger equation – application - particle in a box (ID) – Spectroscopy. Application of Quantum Mechanics - Scanning Tunneling Microscope - Atomic Force Microscope problems<br>Laser characteristics - Einstein's coefficients - its significance - population inversion – three level, four level laser – Schawlow and Townes condition – Nd. YAG, He-Ne-CO2 laser – welding, drilling, cutting – optical disk systems – recording – data readout from optical disks – Holography – Recording and Reconstruction – Problems. | | | | | |
| Module 2 | Fiber Optics , Ultrasonic's & Microwaves | | | | |
| Light propagation through fibers – Acceptance angle - numerical aperture – types of fibers – step index, graded index – single mode, multimode – dispersion– intermodal, intramodal – application of fiber optics in communication – source LED – Laser diode – Detector – PIN photodiode – endoscope – problems<br>Properties – generation – Magnetostriction method – Piezo-electric method – detection of ultrasonic – applications-NDT Characteristic features of micro waves – TE and TM modes – Klystron – Gunn diode – applications of microwaves. | | | | | |
| Module 3 | Nano Technology | | | | |
| Nanoscale – Nanomaterials – properties of Nanomaterials – Moore's Law Semiconductor nanoparticles – Nanocomposites – Quantum well – Wire – Dots – Nanolithography – Applications of Nanotechnology – Aerospace components – sensors – Medicine | | | | | |
| Text Books | | | | | |
| 1.Modern Physics, Raymond A. Serway, Clement J. Mosses, Curt A. Moyer, Cengage learning (3rd Indian Edition 2010).<br>2. Laser Systems and Applications, Nityanand Choudhary and Richa Verma, PHI Learning Private Limited 2011.<br>3. Introduction to Fiber Optics, Ajoy Ghatak and K. Thyagarajan, Cambridge University Press (2011)<br>4. Microwave devices and circuits-second edition-Samuel Y.Liao – Pearson Education-New Delhi, 3rd Edition 2012. | | | | | |
| Reference | | | | | |
| 1. Concepts of Modern Physics, Arthur Beiser, Tata McGraw Hill,2009<br>2. Modern Physics for Scientists and Engineers, John R. Taylor, Chris D. Zafiratos and Michael A. Dubson, PHI Learning Private Limited 2011.<br>3. Modern Physics, Kenneth Krane, Wiley, Indian Edition, 2010.<br>4. Modern Physics, Stephen T. Thornton and Andrew Rex, Cengage learning, First Indian Reprint 2008<br>5. The essentials understanding nanoscience and nanotechnology, J. Pradeep, Tata McGraw-Hill Publishing Company Ltd., 2007.<br>6. Solid State Physics (New Revised Sixth Edition), S. O. Pillai, New Age International | | | | | |

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| | **CIRCUITS ,ELECTRONICS & ELECTRICAL MACHINES** | 3 | 1 | 0 | 4 |
| **PREREQUISITES** | - | | | | |
| OBJECTIVES | To make the student understand the fundamentals of electrical circuit analysis, logic circuits, and make them understand the working of semiconductor devices and electrical machines | | | | |
| Expected Outcome | The students will be able to make simple electrical circuits and logical Circuits. The students will be able to select suitable semiconductor devices and electrical machine | | | | |
| Module 1 | ELEMENTARY CIRCUIT ANALYSIS | | | | |
| Ohm's law, KCL, KVL, node voltage analysis, mesh current, circuits with dependant and controlled sources, Thevenin's & Norton's equivalent, maximum power transfer and superposition theorem, VI characteristics for capacitors and inductors, Steady state DC analysis, RL and RC transients in circuits with DC source, analysis of a second order circuit with a DC source, RMS values, the use of phasors for constant frequency sinusoidal sources, steady state AC analysis of a series circuit, series and parallel combinations of complex impedances, AC power calculations. | | | | | |
| Module 2 | DIGITAL SYSTEMS & SEMICONDUCTOR DEVICES | | | | |
| Basic logic circuit concepts, representation of numerical data in binary form - combinatorial logic circuits, synthesis of logic circuits, minimization of logic circuits - sequential logic circuits - computer organization, memory types, digital process control,computer based instrumentation systems, measurement concepts and sensors, signal conditioning, analog to digital conversion. Basic diode concepts, zener diode voltage regulator concepts, ideal diode model, rectifier and wave-shaping circuits, linear small signal equivalent circuits, basic amplifier concepts, cascaded amplifiers, ideal amplifiers, differential amplifiers, NMOS and PMOS transistors, bias circuits, small signal equivalent circuits, CMOS logic gates, bipolar junction transistors, current and voltage relationship, common emitter characteristics, large signal DC circuit models, small signal equivalent circuits, ideal operational amplifiers, inverting and non-inverting amplifiers, integrators & differentiators | | | | | |
| Module 3 | ELECTROMECHANICS | | | | |
| Magnetic fields and circuits, self and mutual inductance, ideal and real transformers, principles of rotating DC machines, shunt, separately excited and series connected DC motors, speed control of DC motors, 3-phase induction motors, synchronous machines and single phase induction motors, stepper motors and brushless DC motors. | | | | | |
| Text Books | 1. Allan R. Hambley, "Electrical Engineering-Principles & Applications", Pearson Education, Ed. 6, 2014.<br>2. Basic Electrical Engineering Third edition by Kothari D. P and Nagrath I. J., Tata MacGraw Hills, 2010. | | | | |
| Reference | 1. W. H. Hayt, J.E. Kemmerly and S. M. Durbin, 'Engineering Circuit Analysis',8/e, Tata McGraw Hill, New Delhi, 2012.<br>2. Theory and Problem of Basic Electrical Engineering by Kothari D. P and Nagrath. I. J. Prentice Hall of India New Delhi - 2009. | | | | |

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| | **APPLICATION OF ENGINEERING MECHANICS** | 3 | 1 | 0 | 4 |
| **PREREQUISITES** | - | | | | |
| OBJECTIVES | 1. To calculate the reactive forces.<br>2. To analyse the structures.<br>3. To know the geometric properties of the different shapes.<br>4. To teach energy and momentum methods. | | | | |
| Expected Outcome | Student will be able to<br>1. Solve the engineering problems in case of equilibrium conditions.<br>2. Calculate the reaction forces of various supports of different structures.<br>3. Solve the problems involving dry friction.<br>4. Determine the centroid, centre of gravity and moment of inertia of various surfaces and solids.<br>5. Calculate the forces acting on the rigid body, structures using the principle of virtual work. | | | | |
| Module 1 | STATICS | | | | |
| Introduction to Mechanics – Fundamental Principles – Coplanar forces – Equilibrium of Particles – Free body diagram – Equilibrium of particle in space – Single equivalent force -- Equilibrium of rigid bodies in two dimensions. Analysis of plane trusses – Method of joints – Method of sections – Zero-force member. Characteristics of dry friction – Problems involving dry friction – Ladder – Wedges –<br>Square threaded screws. Definition of virtual work – Principle of virtual work – System of connected rigid bodies – Degrees of freedom – Conservative forces – Potential energy – Potential energy criteria for equilibrium.<br>Centroid – First moment of area – Theorems of Pappus and Guldinus – Second moment of area – Moment and Product of inertia of plane areas – Transfer Theorems – Polar moment of inertia – Principal axes – Mass moment of inertia | | | | |
| Module 2 | KINEMATICS & KINETICS | | | | |
| Position, Velocity and Acceleration – Rectilinear motion – Curvilinear motion of a particle– Tangential and Normal components – Radial and Transverse components – Rotation of rigid bodies about a fixed axis – General plane motion – Absolute and relative motion method – Instantaneous centre of rotation in plane motion.<br>Linear momentum – Equation of motion – Angular momentum of a particle and rigid body in plane motion – D'Alembert's principle. | | | | | |
| Module 3 | ENERGY AND MOMENTUM METHODS | | | | |
| Principle of work and energy for a particle and a rigid body in plane motion – Conservation of energy - Principle of impulse and momentum for a particle and a rigid bodies in plane motion – Conservation of momentum – System of rigid bodies – Impact - direct and central impact – coefficient of restitution | | | | | |
| Text Books | 1. Ferdinand P. Beer, E. Russell Johnston (2013) Vector Mechanics for Engineers: Statics and Dynamics, McGraw-Hill International Edition, 10th Edition | | | | |
| Reference | 1. J.L. Meriamhttpand L. G. Kraige (2012) Engineering Mechanics: Statics and Dynamics, Wiley Publishers, 7th Edition | | | | |

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| | 2. Russell C Hibbeler (2009) Engineering Mechanics: Statics and Dynamics, Prentice |

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| | **ENGLISH FOR ENGINEERS - I** | 2 | 0 | 2 | 3 |
| **PREREQUISITES** | Clearing the English Proficiency Test | | | | |
| OBJECTIVES | Students<br>1. Can use the English language effectively with proper grammar and vocabulary to suit the needs of the present world.<br>2. Can differentiate various forms of writing according to the situation and tone.<br>Can be aware of 'cross cultural communication' | | | | |
| Expected Outcome | The learners will be efficient in English language with the development of the four skills of communication – LSRW. | | | | |
| Module 1 | | | | | |

Nature and process of communication Types of communication

- Time, tense and tense consistency
- E-mail Etiquette,
- Writing effective sentences – sentence coherence, length, avoiding ambiguity and thematic emphasis
- Use of voice (Impersonal passive)
- Writing formal letters (Call for quotations, Placing orders)
- Types of communication: Intra-personal, Interpersonal, Group-verbal and non-verbal Communication

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| Module 2 | |

Indian English

- Describing a process
- Writing Definitions
- Letter Writing-Letter of Complaint and Apology
- Concord

Cross-cultural Communication

- Conditionals
- Paragraph writing –Coherence- Jumbled Sentences
- Paragraph: Definition. Identifying the Topic Sentence. Order (Examples, reasoning, cause & effect, compare & contrast)
- Managing Paragraphs (Using Connectors)

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| Module 3 | |

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| Reading Skills - Scanning , Skimming , Intensive Reading , Word meaning and Recognition<br>• Cloze Test<br>• Use of prepositions | |
| Text Books | |
| Reference | 1.Rizvi,M.Ashraf, Effective Technical Communication, Tata McGraw – Hill, 2006<br>2.Ibbotson,Mark, Cambridge English for Engineering, Cambridge University Press, 2008<br>3. Richard Johnson-Sheehan, Technical Communication Today fourth Edition 2011<br>4. Sherron Kenton & Deborah Valentine, Cross Talk: Communicating in a Multicultural Work place, Prentice Hall (Sep 1996)<br>5. Laura M English, Sarah Lynn Business Across Cultures: Effective Communication Strategies, Addison Wesley Longman Publication |

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| | **PROBLEM SOLVING USING C** | 2 | 0 | 2 | 3 |
| **PREREQUISITES** | - | | | | |
| OBJECTIVES | To provide an overview of computers and problem solving methods using 'C' Language to serve as a foundation for the study of programming languages | | | | |
| Expected Outcome | The student would acquire various problem solving techniques and will be able to implement them in 'C' language. | | | | |
| Module 1 | OVERVIEW OF PROBLEM SOLVING | | | | |
| Introduction to Computer based Problem Solving-Program Design – Topdown design and Stepwise refinement, loops, basic programming constructs-Implementation Issues- Programming Environment : Assemblers, compilers, interpreters, linkers, loaders, Examples : Summation of set of numbers, sine function computation, Base Conversion, character to number conversion, Reversing digits of an integer, Square root of a number, Smallest divisor, generation of the Fibonacci sequence, Raising a number to a large power | | | | | |
| Module 2 | FUNDAMENTALS OF C PROGRAMMING | | | | |
| Array handling in C – declaration – single dimensional arrays, two – dimensional arrays, multi-dimensional arrays, sorting and searching on single and two dimensional arrays. Array order reversal, array counting or histogramming, finding the maximum number in a set, removal of duplicates from an ordered array, partition an array, finding the $k_{th}$ smallest element strings: Character array – string handling functions – manipulation on strings. | | | | | |
| Module 3 | PROGRAMMING CONSTRUCTS , FUNCTIONS & FILE HANDLING | | | | |
| Prototype – declaration - arguments (formal and actual) – return types – types of functions difference between built-in and user-defined functions. Functions- Prototype – declaration - arguments (formal and actual) – return types – types of functions; difference between built-in and user-defined functions; Recursion. Introduction to File handling in C: Opening, Closing, input / output. | | | | | |
| Text Books | 1. Greg Perry, Dean Miller, "C Programming Absolute Beginner's Guide", Que Publishing; 3 edition (2013) | | | | |

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| | 2. Herbert Schildt ," C: The Complete Reference", 4th Edition, McGraw Hill, 2000. |
| Reference | 1. B.W. Kernighan & D.M. Ritchie, "The C Programming Language", PHI,1989.<br>2. Richard Johnson-Baugh & Martin Kalin, "Application Programming in C", Macmillan International editions, 1990.<br>3. Kenneth A.,C, "Problem Solving and Programming", PHI.<br>4. R.G. Dromey, "How to Solve it by Computer", 1st Edition, PHI, 2008. |

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| | **ENGINEERING GRAPHICS** | 0 | 0 | 4 | 2 |
| **PREREQUISITES** | - | | | | |
| OBJECTIVES | 1. To create awareness and emphasize the need for Engineering Graphics in all the branches of engineering.<br>2. To follow basic drawing standards and conventions.<br>3. To develop skills in three-dimensional visualization of engineering component.<br>4. To develop an understanding of 2D and 3D drawings using the **SolidWorks** software. | | | | |
| Expected Outcome | On completion of this course, the students will be able to<br>1. Prepare drawings as per standards (BIS).<br>2. Solve specific geometrical problems in plane geometry involving lines, plane figures and special Curves.<br>3. Produce orthographic projection of engineering components working from pictorial drawings.<br>4. Prepare 2D Drawings using the **SolidWorks** software.. | | | | |
| Module 1 | INTRODUCTION AND PROJECTIONS | | | | |
| Introduction to Engineering Graphics – Geometrical Construction – Conics and Special Curves. Free hand Sketching – Dimensioning Principles. Orthographic Projection – Projection of Points and lines. Orthographic Projection – Projection of solids in simple position, Axis Inclined to one plane. Conversion of Pictorial view into Orthographic projections | | | | | |
| Module 2 | SECTION OF SOLID , DEVELOPMENT OF SURFACES | | | | |
| Introduction to Sections of Solids. Development of Surfaces. Isometric Projection and drawing. | | | | | |
| Module 3 | SOLID MODELLING | | | | |
| Isometric Projection and drawing. Solid Modelling of Engineering Components using SolidWorks. | | | | | |
| Text Books | 1. Venugopal K & Prabhu Raja V (2009) A Textbook of Engineering Graphics, New AGE International Publishers | | | | |
| Reference | 1. K.V.Natarajan (2009) A text Book of Engineering Graphics, Dhanalakshmi Publisher.<br>2. N.D.Bhatt (2012) Engineering Drawing", Charotar publishing house. | | | | |

| | ENGLISH FOR ENGINEERS-1 ( LAB) |
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| EXPERIMENTS | |
| • Listening to casual conversations<br>• Speaking: Introducing oneself, Strengths and Weaknesses<br>• Speaking: Asking for Information, Interrupting and disagreeing<br>• Speaking: Telephoning Skills (Through Role-plays)<br>• Speaking: Adzap`<br>• Speaking: Taking Roles in an Event | |
| REFRENCES | |
| EVALUATION | |

| | MODERN PHYSICS LABORATORY |
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| EXPERIMENTS | |
| 1. Traveling microscope – Length of a glass plate<br>2. Spectrometer – Angle of Prism<br>3. Air Wedge – Thickness of a thin wire<br>4. Planck's constant – LED method<br>5. Ultrasonic interferometer – Velocity of Ultrasonic waves in liquid<br>6. Sonometer – Frequency of AC mains<br>7. Spectrometer – Refractive index of a glass Prism<br>8. Refractive index of liquid<br>9. Laser grating – Determination of wavelength<br>10. Optical fiber – Numerical aperture and acceptance angle | |
| REFRENCES | |
| EVALUATION | |

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| | MODERN PHYSICS LABORATORY |
| EXPERIMENTS | |
| 1.Write C Program using<br>a. Input/Output<br>b. Control structures<br>c. Array<br>d. Structures<br>e. Files<br>2. Write Program for finding<br>a. Summation of set of numbers<br>b. Sine function computation<br>c. Base Conversion<br>d. Character to number conversion<br>e. Reversing digits of an integer<br>f. Square root of a number<br>g. Smallest divisor<br>h. Generation of the Fibonacci sequence<br>i. Raising a number to a large power<br>j. Factorial of number | |
| REFRENCES | |
| EVALUATION | |

## 2nd Semester

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| | **COMPLEX VARIABLE AND PARTIAL DIFFERENTIAL EQUATION** | 3 | 1 | 0 | 4 |
| **PREREQUISITES** | - | | | | |
| OBJECTIVES | The aim of this course is to present a comprehensive, compact and integrated treatment of two most important branches of applied mathematics for engineers and scientists namely<br>(i) the functions of complex variable and<br>(ii) Partial differential equations in finite and infinite domains. | | | | |
| Expected Outcome | By the end of the course, the students are expected to develop the necessary mathematical skills, physical understanding of problems and intuition to independently analyze the mathematical equations which model the problems in their respective fields of study. | | | | |
| Module 1 | **COMPLEX INTEGRATION** | | | | |
| Limits and continuity- Cauchy – Riemann equations- analytic and harmonic functions –complex potential – applications to flow around a corner and around a cylinder, multivalued functions(logz, )- branch points- branch cuts, linear transformations- bilinear transformation-cross-ratio- conformal mappings($w=z^2$, $w=e^z$)– qualitative discussion applications (regions bounded by straight lines). Integration of a complex plane along a contour - Cauchy-Goursat theorem- Cauchy's integral formula – Taylor and Laurent series- zeros- singularities – poles- residues- Cauchy's residue theorem – evaluation of integrals by the method of residues- statement of Jordan's lemma -indented contour integral. | | | | | |
| Module 2 | **APPLICATION OF PARTIAL DIFFERENTIAL EQUATIONS** | | | | |
| Introduction – formation of PDEs – solution of PDE – general, particular, and complete singular integrals – Lagrange's linear equations – linear PDE of higher order with constant coefficients – homogeneous and non homogeneous equations – solution of PDE's by the method of separation of variables. Classification of PDEs- solution of Laplaces equations in cartesian, cylindrical and spherical coordinates – variable separable method: potential flow over a sphere. Wave equation-vibrations of a stretched string- D'Alembert's solution for the initial value problem, vibrations of a circular membrane diffusion equation in cartesian and cylindrical coordinates. | | | | | |
| Module 3 | **FOURIER TRANSFORMS** | | | | |

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| Complex Fourier series – Fourier integral theorem- Fourier transform pairs – Fourier sine and cosine transform pairs – simple problems-properties of Fourier transforms – Convolution theorem for Fourier transforms – Parseval's identity for Fourier transforms -application of Fourier transforms to partial differential equations: (i) Heat flow in an infinite bar (ii) Wave propagation on a semi infinite string (iii) Steady state heat flow in a semi-infinite domain. | |
| Text Books | 1. Erwin Kreysizing, 'Advanced Engineering Mathematics', 8thEdition, John Wiley & Sons, (Wiley student Edison)(2004).<br>2. B.S.Grewal, 'Higher Engineering Mathematics', 40thEdition. Khanna Publications(2007). |
| Reference | 1. J. W. Brown and R.V. Churchill, 'Complex variables and application', Mc Graw Hill International ed., 7th Edition (2004).<br>2. R. V. Churchill and J. W. Brown, 'Fourier series and Boundary value problems', International student edition (1978). |

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| | **MATERIAL SCIENCE & METALLURGY** | 2 | 1 | 2 | 4 |
| **PREREQUISITES** | MODERN PHYSICS | | | | |
| OBJECTIVES | 1. The main objective of this course is to provide the basic knowledge needed to explore the discipline of materials science and engineering.<br>2. To develop the knowledge of how the structure of materials is Described technically, including crystallography, microstructure, defects, and phase diagrams<br>3. To develop the knowledge of how the properties of materials are described technically and how material failure is analyzed<br>4. To introduce the concepts of structure-property relationships<br>5. To develop knowledge in various class of materials and their applications | | | | |
| Expected Outcome | Student will be able to<br>1. Understand how materials are formed and their classification based on atomic arrangement<br>2. Describe the mechanical behaviour of metallic systems and its importance<br>3. Evaluate system for fatigue failures<br>4. Gain knowledge on different class of materials and their applications<br>5. Evaluate the failure mode of the materials and to know the steps to be taken to prevent the failures. | | | | |
| Module 1 | **MICROSCOPIC STRUCTURES & PHASE DIAGRAMS** | | | | |
| Introduction to materials science – Primary and Secondary bonding in materials-Crystalline and amorphous materials –Single crystal and polycrystalline materials – Space Lattice-Unit cell –Crystal systems – Bravais Lattice- Miller indices – Closed packed structures- Principal Metallic crystal structures stacking sequence and stacking faults and crystal defects- Point, Line, Planar and volume; Volume, planar and Linear density calculations- Polymorphism and allotropy. Basics of Solidification mechanism – Cooling curve of pure metal and alloy – Phase –Phase Diagram– Gibbs's Phase rule – Interpretation of mass fractions using Lever's rule – Hume Rothery rules-Binary Iso-morphous system- Binary Eutectic alloy system (Lead-Tin System) –Binary Peritectic alloy system (Iron-Nickel System) – Invariant reactions – Iron- Iron carbide phase diagram- Slow cooling of Hypo and hyper eutectoid steels – Temperature-Time-Transformation (TTT) and Continuous Cooling Transformation (CCT) Diagrams – Effect of alloying elements in steel – types of stainless steel and cast iron. | | | | | |
| Module 2 | **HEAT TREATMENT & MATERIAL TESTING** | | | | |

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| Heat Treatment – Annealing and its types, Normalizing, Hardening tempering, Austempering and Mar-tempering – Microstructure observation – Surface Heat treatment processes – Carburizing, Nitriding, cyaniding, carbonitriding, flame and induction hardening. Mechanical properties of materials – Strengthening mechanism –- Plastic deformation of single and poly-crystalline materials – Effect of Slip and twinning – Stress-strain curves of various ferrous and non-ferrous metals –Engineering stress strain – true stress strain relations –problems - Tensile test of ductile material – properties evaluation Hardness measurement tests – Fracture of metals – Ductile and Brittle fracture; Fatigue – Endurance limit of ferrous and non-ferrous metals – Fatigue test ; Creep and stress rupture– mechanism of creep – stages of creep and creep test – SEM, XRD. | |
| Module 3 | **ADVANCED MATERIALS AND APPLICATIONS** |
| Composites – Fiber reinforced, Metal Matrix, Ceramic Matrix – properties and applications; Ceramics – Alumina, Zirconia, Silicon Carbide, Sialons, Reaction Bonded Silicon Nitride(RBSN), Glasses– properties and applications- Magnetic materials – Hard and soft magnets – Ferromagnetic Hysteresis – properties of magnetic materials Intermetallic compounds-Polymers – thermosetting and thermoplastics – mechanical properties of polymers- Material selection procedure (two case studies) | |
| Text Books | 1. W.D. Callister, Jr.,(2010), Materials Science and Engineering: An Introduction, Wiley & Sons, 8th edition. |
| Reference | 1. Donald R. Askeland, Pradeep P. Fulay, Wendelin J. Wright (2010), The Science and Engineering of Materials, Cengage Learning, 6th Edition<br>2. Sidney H Avner, (2005) "Introduction to Physical Metallurgy, Tata McGraw Hill Publishing Company Limited |

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| | **VEHICLE TECHNOLOGY( Automotive chassis & Body Engineering )** | 3 | 1 | 0 | 4 |
| **PREREQUISITES** | - | | | | |
| OBJECTIVES | 1. The objective of the course is to make the student understand the various aspects of vehicle body and steering, braking and suspension systems of the vehicle. | | | | |
| Expected Outcome | By the end of this course the student will be able to design a car for safety, identify and develop suitable chassis, design and select suitable subsystems for the vehicle. | | | | |
| Module 1 | **VEHICLE BODY** | | | | |
| General consideration relating to chassis layout, power plant location, types of automobiles, layout of an automobile with reference to power plant, weight distribution, stability, Terms used in body building construction, Angle of approach, Angle of departure, Ground clearance, Cross bearers, Floor longitudes, posts, seat rail, waist rail, cant rail, Roof stick, Roof longitude, Rub rail, skirt rail, truss panel, wheel arch structure, wheel arch, post diagonals, gussets. Car Body: Types, Regulations, drivers visibility, tests for visibility, methods for improving visibility and space in cars, safety design, safety requirements for car, car body construction. Bus Body Details: Types, Mini bus, single-decker, double-decker, two level, split level and articulated bus, bus body layout, floor height, engine location, entrance and exit locations, seating dimensions, constructional details, frame construction, double skin construction, types of metal sections used, regulations, conventional and integral type construction. | | | | | |
| Module 2 | **FRONT AXLE , BRAKES & STREERING SYSTEMS** | | | | |

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| Axle parts and materials, loads and stresses, centre sections, section near steering head, spring pads, front axle loads, steering heads, factors of wheel alignment, wheel balancing, centre point steering, correct steering angle, steering mechanisms, cornering force, self righting torque, under steer and over steer, Steering linkages, steering gears, special steering columns, power steering, trouble shooting, Numerical problems. Necessity, stopping distance and time, brake efficiency, weight transfer, brake shoe theory, determination of braking torque, classification of brakes, types, construction, function, operation, braking systems - mechanical, hydraulic, disc, drum, details of hydraulic system, mechanical system and components, types of master & wheel cylinders, bleeding of brakes, brake drums, brake linings, brake fluid, factors influencing operation of brakes such as operating temperature, lining, brake clearance, pedal pressure, linkages etc, Numerical problems. Brake compensation, Parking and emergency brakes, hill holder, automatic adjustment, servo brakes, Power brakes-Air brakes, Wagner air brake, vacuum brakes and electric brakes and components brake valve, un-loader valve, diaphragm, air-hydraulic brakes, vacuum boosted hydraulic brakes, trouble shooting, Numerical problems. | |
| Module 3 | **SUSPENSION, WHEELS & TYRES** |
| Objects, basic considerations, Types of suspension springs, construction , operation & materials, leaf springs, coil springs, torsion bar, rubber springs, plastic springs, air bellows or pneumatic suspension, hydraulic suspension, constructional details of telescopic shock absorbers, independent suspension, front wheel independent suspension, rear wheel independent suspension, types, stabilizer, trouble shooting, Numerical problems. Wheels And Tyres: Types of wheels, construction, structure and function, wheel dimensions, structure and function of tyres, static and dynamic properties of pneumatic tyres, types of tyres, materials, tyre section & designation, factors affecting tyre life, quick change wheels, special wheels, trouble shooting' | |
| Text Books | 1. Kirpal Singh, "Automobile Engineering Vol. I", Standard publications, New Delhi, 2011. |
| Reference | 1. James E Duffy, "Modern Automotive Technology", Goodheart-Willcox; Seventh Edition, 2011<br>2. Jack Erjavec, "Automotive Techology – A systems approach",` |

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| | **APPLIED THERMODYNAMICS** | 2 | 1 | 0 | 3 |
| **PREREQUISITES** | - | | | | |
| OBJECTIVES | 1. To teach students the basic principles of classical thermodynamics and prepare them to apply basic conversion principles of mass and energy to closed and open systems.<br>2. To enable the students to understand second law of thermodynamics and apply it to various systems, note the significance of the results and to know about availability, entropy and second law aspects of daily life.<br>3. To teach students about properties of pure substances and to analyze the performance of thermodynamic air and vapour power cycles.<br>4. To help the students understand various gas laws and equations of state and apply them to solve problems of gas mixtures in estimating enthalpy, entropy, specific heat and internal energy.<br>5. To teach students about fuels and combustion phenomenon, solve problems on stoichiometry, complete combustion, gravimetric and volumetric analysis. | | | | |
| Expected Outcome | Student will be able to<br>1. Demonstrate an understanding of the concepts such as conservation of mass, conservation of energy, work interaction, heat transfer and first law of thermodynamics.<br>2. Identify closed and open systems and analyze related problems.<br>3. Apply the concept of second law to design simple systems.<br>4. Analyze the performance of gas and vapor power cycles and identify methods to improve thermodynamic performance.<br>5. Demonstrate the importance of phase change diagrams of various pure substances.<br>6. Apply gas laws to mixtures. | | | | |

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| | 7. Analyze problems of combustion and stoichiometry. |
| Module 1 | **BASIC CONCEPTS AND LAW'S OF THERMODYNAMICS** |
| Basic concepts of Thermodynamics - Thermodynamics and Energy - Closed and open systems - Properties of a system - State and equilibrium - Processes and cycles - Forms of energy - Work and heat transfer - Temperature and Zeroth law of thermodynamics – First law of thermodynamics - Energy balance for closed systems - First law applied to steady – flow engineering devices Limitations of the first law of Thermodynamics - Thermal energy reservoirs - Kelvin- Planck statement of the second law of thermodynamics - Clausius statement - Equivalence of Kelvin-Planck and Clausius statements - Refrigerators, Heat Pump and Air-Conditioners –COP - Perpetual Motion Machines - Reversible and Irreversible process - Carnot cycle – Entropy - The Clausius inequality - Availability and irreversibility - Second law efficiency. | |
| Module 2 | **VAPOUR & GAS POWER CYCLES** |
| Properties of pure substance-Property diagram for phase - change processes - Carnot vapour cycle - Rankine cycle - Methods for improving the efficiency of Rankine cycle – Ideal Reheat and Regenerative cycles - Binary vapour cycles - Combined gas - vapour power cycles - Analysis of power cycles - Carnot cycle - Air standard assumptions - Otto cycle - Diesel and Dual cycles - Brayton cycle - Stirling and Ericsson cycles | |
| Module 3 | **IDEAL GAS MIXTURES, FUELS & COMBUSTION** |
| Ideal and real gases - Vander Waals equation - Principle of corresponding states - Ideal gas equation of state - Other equations of state - Compressibility factor - Compressibility charts - Composition of gas mixtures - Mass and mole fractions - Dalton's law of additive pressures - Amagat's law of additive volumes - Relating pressure, volume and temperature of ideal gas mixtures - Evaluating internal energy - enthalpy - entropy and specific heats. Types of fuels - Exothermic and endothermic reactions - Combustion equations – Stoichiometry - Combustion analysis by mass and volume - Conversion of gravimetric to volumetric analysis - Conversion of volumetric to gravimetric analysis - Analysis of exhaust gas - Excess air and air-fuel ratio - Combustion problem by mole method - Complete combustion of fuel - Calorific value – Definition - Types of calorimeter. | |
| Text Books | 1. P K Nag, (2013), Engineering Thermodynamics, Tata McGraw-Hill Publishing Company Ltd. |
| Reference | 1. Yunus A. Cengel Michael A. Boles, (2011), Thermodynamics: Engineering Approach, Tata McGraw-Hill Publishing Company Ltd.<br>2. M. Achuthan, (2013), Engineering Thermodynamics, Prentice Hall India Limited.<br>3. Eastop, (2013), Applied Thermodynamics for Engineering Technologies, Addison-Wesley Logman Limited |

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| | **COMPUTER AIDED MACHINE DRAWING** | 0 | 0 | 4 | 2 |
| **PREREQUISITES** | Engineering graphics | | | | |
| OBJECTIVES | 1. To introduce students to the basics and standards of engineering drawing related to machines and components.<br>2. To teach students technical skills regarding assembly, production and part drawings.<br>3. To familiarize students with various limits, fits and tolerances.<br>4. To help students gain knowledge about standard CAD packages on modeling and drafting. | | | | |

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| Expected Outcome | Student will be able to<br>1. Acquire the knowledge of various standards and specifications about standard machine components.<br>2. Make drawings of assemblies with the help of part drawings given.<br>3. Ability to select, configure and synthesize mechancial components into assemblies.<br>4. Apply the knowledge of fits and tolerances for various applciaitons.<br>5. Able to model components of their choice using CAD software.<br>6. Get exposure to advanced CAD packag |
| Module 1 | **DRAWING STANDARDS** |
| Code of Practice for Engineering Drawing - BIS specifications –Conventional representation – Welding symbols - riveted joints - keys - fasteners – Reference to hand book for the selection of standard components like bolts - nuts - screws - keys etc. | |
| Module 2 | **LIMITS, FITS & TOLERANCES** |
| Limits - Fits and tolerances – Allocation of fits for various mating parts – Tolerance data sheet – Tolerance table preparation –Geometric tolerance. | |
| Module 3 | **COMPUTER AIDED ASSEMBLY & DETAILED DRAWING** |
| Solid modeling of simple and intricate machine and automobile components – Surface modelling of automobile body and Appliances(electrical and domestic) - Preparation of assembled and detailed drawings of I.C.Engine components viz: Cylinder head - Piston - Connecting rod and Crankshaft assembly - Carburettor - Fuel pump etc., | |
| Text Books | 1. James Barclay, Brian Griffiths, (2003), Engineering Drawing for Manufacture. |
| Reference | 1. Cecil Jensen, Jay Helsel and Donald D. Voisinet (2000) Computer-aided engineering drawing, McGraw-Hill: New York<br>2. Sidheswar, N., Kanniah, P. and Sastry, V.V.S., (2005) Machine Drawing |

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| | **STRENGTH OF MATERIALS** | 2 | 1 | 2 | 4 |
| **PREREQUISITES** | ENGINEERING MECHANICS | | | | |
| OBJECTIVES | 1. To develop the relationship between the loads applied to a non-rigid body and the internal stresses and deformations induced in the body.<br>2. To study the general state of stresses and strains in a given loaded member and the magnitude and direction of the principal stresses<br>3. To understand the different approaches to calculate slope and deflection for various types of beams.<br>4. To analyze the columns with different edge conditions by using different theories. | | | | |
| Expected Outcome | Student will be able to<br>1. Apply concepts of strength of materials to obtain solutions to real time Engineering problems.<br>2. Able to analyze the different types of loading and the consequent deflection. | | | | |
| Module 1 | **STRESS , STRAIN AND BASIC CONCEPTS OF BENDING** | | | | |

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| Definition/derivation of normal stress, shear stress, and normal strain and shear strain – Stress-strain diagram- Elastic constants – Poisson's ratio – relationship between elastic constants and Poisson's ratio – Generalised Hook's law – Strain energy – Deformation of simple and compound bars – thermal stresses. Types of beams: Cantilever, Simply supported, Overhanging: Shear Force and Bending Moment Diagrams Theory of simple bending – bending stress and shear stress in beams. | |
| Module 2 | **DEFLECTION OF BEAMS & TORSIONAL LOAD APPLICATION** |
| Deflection of beams by Double integration method – Macaulay's method – Area moment theorems for computation of slopes and deflections in beams – Conjugate beam method. Introduction to Torsion – derivation of shear strain – Torsion formula – stresses and deformations in circular and hollow shafts – Stepped shafts – shafts fixed at the both ends – Stresses in helical springs. Theory of columns – Long column and short column - Euler's formula – Rankine's formula - Secant formula - beam column. | |
| Module 3 | **BIAXIAL STRES STATE SYSTEM** |
| Biaxial state of stress – Stress at a point – stresses on inclined planes – Principal stresses and Principal strains and Mohr's circle of stress, Theories of failure Thin cylinders and shells – deformation of thin cylinders and shells; Thick Cylinders, Shrink fits, Compounding. Fundamentals of theory of elasticity. | |
| Text Books | 1. S. Ramamrutham and R. Narayanan, (2011), Strength of Materials, Dhanpat Rai Publications, 16th edition. |
| Reference | 1. Rowland Richards, (2011), Principles of Solid Mechanics, CRC Press.<br>2. Timoshenko, S.P. and Young, D.H., (2011), Strength of Materials, East West Press Ltd. 5th edition<br>3. R.K. Bansal, (2012), Strength of Materials, Laxmi Publications, 4th edition |

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| | **ENGLISH FOR ENGINEERS-II** | 2 | 0 | 2 | 3 |
| **PREREQUISITES** | **ENGLISH FOR ENGINEERS-I** | | | | |
| OBJECTIVES | Students :<br>• Can write and prepare the necessary technical documents.<br>• Can face interview with confidence.<br>• Will be a better performer professionally | | | | |
| Expected Outcome | • Tune up writing skills and prepare technical documents without errors.<br>• Enhance the students with strong writing and presentation skills. | | | | |
| Module 1 | | | | | |
| Profiling readers – Context of Use<br>Revising and editing - Error detection (grammatical and vocabulary)<br>Drafts of Abstract and Executive Summary<br>Revising and editing –Proof reading symbols<br>Writing Instructions<br>Writing Memos. | | | | | |

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| Module 2 | |
| Preparing Questionnaires<br>Writing Statements of Purpose – Definitions, format and Sample<br>Technical - Report writing<br>Technical- Writing a Proposal<br>Graphic information/ Transcoding (Use of graphs, tables, charts)<br>Meeting – Agenda, Minutes | |
| Module 3 | |
| Resume (Archival and Functional)<br>Writing effective Applications (Emphasizing Education and Emphasizing Work Experience)<br>Thank You Letter and apology letters (after interviews or refusing a job offer) | |
| Text Books | |
| Reference | 1. Technical Communication Today –Richard Johnson and Sheehan 4th Edn 2011<br>2. Porter, Patricia A., and Margaret Grant. Communicating Effectively in English: Oral Communication for Non-Native Speakers. 2nd ed. Belmont, CA: Wadsworth, 1992. ISBN: 9780534172688.<br>3. Alley, Michael. The Craft of Scientific Presentations: Critical Steps to Succeed and Critical Errors to Avoid. New York, NY: Springer, 2007. ISBN: 9780387955551.<br>4. Writing Resumes-Kilmet, Stephen. "The Resume,"and "The Computerized Resume." In Writing for Design Professionals. New York, NY: W.W. Norton, 2006, pp. 127-129. ISBN: 0393731855.<br>5. Writing Cover Letters-Kilmet, Stephen. "Cover Letter," and "Enclosures and Attachments." In Writing for Design Professionals. New York, NY: W.W. Norton, 2006, pp. 128-129. ISBN: 0393731855.<br>6. Writing a Proposal "Standard Proposal for Funding." in Writing in the Disciplines. Fort Worth, TX: Harcourt Brace College Publisher, 1995. ISBN: 0155025384.<br>7. http://www.job-interview.net/ http://www.interviewmastery.com/ |

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| | **MATERIAL SCIENCE & METALLURGY LAB** | | | | |
| **PREREQUISITES** | - | | | | |
| OBJECTIVES | 1. To train students in the preparation of samples to perform characterization such as microstructure, volume fraction of phases, determination of porosity, film thickness, grain size and avoid measurement.<br>2. To help the students understand the microstructure of engineering materials, phase diagrams, various testing standards and acquire knowledge on the material behaviour by conducting tests.<br>3. To teach students how to improve the mechanical properties of materials by various methods.. | | | | |
| Expected Outcome | Student will be able to<br>1. Acquire experimentation skills in the field of metallurgy.<br>2. Develop theoretical understanding of the mechanical properties of materials by performing experiments.<br>3. Apply the knowledge of phase diagrams and testing methods in related areas.<br>4. Know how to improve structure of materials for various industrial applications. | | | | |
| | LIST OF EXPERIMENTS | | | | |

1. Metallographic sample preparation
2. Phase diagram determination
3. Microstructures of plain carbon steel
4. Microstructures of cast iron
5. Heat treatment of plain carbon steels
6. Hardness measurement
7. Phase analysis and porosity determination using image analysis soft ware
8. Microstructure of non-ferrous alloys
9. Determination of grain size
10. NDT testing – using ultrasonic flaw detector
11. Stress analysis using XRD pattern
12. Creep Test

Reference

| | **STRENGTH OF MATERIALS LAB** | | | | |
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| **PREREQUISITES** | - | | | | |
| OBJECTIVES | 1. To help the students gain experience in the determination of creep for various materials and understand how this property varies with time.<br>2. To provide students an opportunity to learn how to measure hardness of materials and analyze how heat treatment affects hardening.<br>3. To impart knowledge on phase development of two isomorphous metals.<br>4. To teach students determine phases present in a material using XRD graph. | | | | |
| Expected Outcome | Student will be able to<br>1. Interpret hardness curve measured after heat treatment.<br>2. Find correlation between material structure and its creep.<br>3. Index XRD plot and determine phases of a material.<br>4. Perform non destructive failure analysis. | | | | |
| | LIST OF EXPERIMENTS | | | | |

1. Evaluation of Engineering Stress / Strain Diagram on Steel rod, Thin and Twisted Bars under tension.
2. Compression test on Bricks, Concrete blocks.
3. Deflection test – Verification of Maxwell theorem.
4. Comparison of hardness values of Steel, Copper and Aluminium using Brinell and Rockwell hardness measuring machines.
5. Estimation of Spring Constant under Tension and Compression.
6. Estimation of Notch Toughness of Steel using Charpy Impact Testing Machine.
7. Double shear test in U.T.M.
8. Fatigue test on Steel
9. Load measurement using Load indicator, Load coils.
10. Strain measurement using Rosette Strain Gauge.

| LIST OF EXPERIMENTS | ENGLISH FOR ENGINEER-II LAB |
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| • Group Discussions - Process, Skills, Guidelines, Evaluation<br>• Oral Presentation Skills – Planning, Preparing, Organizing, Presenting<br>• Starting A Career –Making Goals And Setting Plans<br>• Interviews – Identifying Career Options, Preparing For An Interview , Facing An Interview |
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**3RD SEMESTER**

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| | **THERMAL ENGINEERING SYSTEMS** | 2 | 1 | 2 | 4 |
| **PREREQUISITES** | APPLIED THERMODYNAMICS | | | | |
| OBJECTIVES | 1. To enable the students understand the principles, working and performance of IC engines<br>2. To introduce students to the working of compressors, steam nozzles and various refrigeration and air-conditioning systems.<br>3. To teach students the principles of waste heat recovery and thermal storage systems | | | | |
| Expected Outcome | Student will be able to<br>1. Solve problems on internal combustion engines and prepare heat balance sheet.<br>2. Get an insight of various components and principles of engines, compressors etc.<br>3. Design refrigeration and air-conditioning system for a particular application.<br>4. Demonstrate the knowledge of waste heat recovery and thermal storage. | | | | |

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| Module 1 | **PERFORMANCE ANALYSIS OF IC ENGINES** |
| Review of construction and working of two stroke and four stroke engines – Types of carburetor – Wankel engines – SI engines – Fuel systems – Simple carburetor – Ignition systems – Combustion – Detonation factors and remedies – Rating of fuels – Introduction to multi point and microprocessor based fuel injection system CI engines – Fuel injection system – Fuel pump – Combustion – Knocking – Factors and remedies – Rating of fuels – Cooling and lubrication of IC engines. Supercharging and turbocharging of IC engines and their effect on various parameters – Stratified charged engines – Lean burn engines; Performance test- Measurement of brake power – Indicated power – Fuel consumption – Air consumption; Heat balance test – heat carried away by exhaust gases and Morse test on IC engines – Standard testing procedure of IC engines – Performance curves and effect of various parameters on the performance of the engines. | |
| Module 2 | **POSITIVE DISPLACEMENT COMPRESSORS & STEAM NOZZLES** |
| Reciprocating compressors – Construction – Working – Effect of clearance volume – Multi staging - Volumetric efficiency - Isothermal efficiency. Steam Nozzle – One-dimensional steady flow of steam through a convergent and divergent nozzle – Equilibrium and Meta stable flow. | |
| Module 3 | **REFRIDGERATION & AIR CONDITIONING** |
| Reverse Carnot cycle- Bell-Colman's cycle – Air craft refrigeration cycles – Vapor compression cycle – Components – Working – P-H and T-S diagrams – Calculation of COP – Effect of sub-cooling and super-heating – Vapour absorption system – Ideal and actual cycles – Cryogenic engineering- Introduction – Liquefaction of gases – Application. Psychometric - Processes – Chart – Summer and winter air conditioning – Cooling load calculations – SHF – RSHF – GSHF – ESHF components used in air conditioner – Types of air conditioning units. Sources of waste heat – Heat recovery for industrial application – Thermal storage principles and applications of hot and cold systems – Sensible heat and latent heat system – Phase change storage materials. | |
| Text Books | 1. Rajput R.K., (2013), Thermal Engineering, Ninth Edition, Laxmi Publications (P) Ltd. |
| Reference | 1. Manohar Prasad., (2010), Refrigeration and Air Conditioning, New Age International.<br>2. Soman.K, (2013), Thermal Engineering, PHI Learning Private Ltd.<br>3. Mathur.M.L & Sharma R.P, (2012), Internal Combustion Engine, Dhanpat Rai Publications. |

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| | **MACHINE DYNAMICS** | 2 | 1 | 2 | 4 |
| **PREREQUISITES** | ENGINEERING MECHANICS | | | | |
| OBJECTIVES | Understanding of different types of mechanisms. Analyze cam-follower motion and gear train configurations. Gyroscopic effect on vehicles, ships and planes. Familiarize balancing procedures for rotating and reciprocating masses, rotors and engines. Fundamentals of free and forced vibrations | | | | |
| Expected Outcome | By the end of the course, the students will be able to analyze and solve problems associated with mechanisms, cam-followers and gear trains. Further the students will be able to analyze and apply the concept of gyroscopic couple in real time problems | | | | |
| Module 1 | **INTRODUCTION TO MECHANISMS** | | | | |

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| Introduction to mechanisms – Links - Pairs - Chains - Mobility - Degree of freedom –Gruebler's and Kutzbach criterion – Kinematics inversions- Grashoff's Law. Determination of velocity and acceleration – simple mechanisms – Relative motion method. Introduction to synthesis of mechanism. Inertia force analysis of slider crack mechanism- Klein's construction. Friction in screw and nut – Pivot and collar – Thrust bearing – Plate and disc clutches – Belt (flat and V) and rope drives. Ratio of tensions – Effect of centrifugal and initial tension – Condition for maximum power transmission – Open and crossed belt drive. Gyroscopic forces and couple – Gyroscopic effects on the movement of air planes and ships - Stability of two wheel drive and fourwheel drive and space vehicles - Gyroscope stabilization. | |
| Module 2 | **CAMS & GEARS** |
| Types of Cams and Followers - Applications – Displacement - Velocity and Acceleration and construction of cam profiles for Uniform velocity - Uniform acceleration and retardation – Simple Harmonic Motion (SHM) - Cycloidal motions of followers Spur gear terminology and definitions - Types of gears- Fundamental law of toothed gearing– Interference and under cutting –Comparison of Involute and Cycloidal tooth forms, gear trains: Simple, compound gear trains and epicylic gear trains - Determination of speed and torque. | |
| Module 3 | **BALANCING VIBRATIONS** |
| Static and Dynamic balancing of rotating masses in different planes – Balancing of rotors - Balancing of machines - Partial balancing of reciprocating masses of inline. Free and damped vibrations of single degree of freedom systems – longitudinal, transverse and torsional –Forced vibration – harmonic excitation - Magnification factor - Vibration isolation and Transmissibility. Introduction to vibrations of multi-degree freedom systems. | |
| Text Books | 1. Robert L. Norton (2013) Kinematics and Dynamics of Machinery (SI units), McGraw-Hill, 1st Edition |
| Reference | 1. S. Graham Kelly, (2011), Mechanical Vibrations: Theory and Application, Cengage Learning, 1st Ed.<br>2. J.E. Shigley and J.J Unicker, (2010), Theory of Machines and Mechanism, Oxford University Press, USA; 4th Ed.<br>3. Thomson. W.T. (2008), Theory of Vibration with applications, Pearson.<br>4. Dukkipati, Srinivas, (2005), Theory of mechanical vibrations, Prentice Hall of India. |

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| | **MANUFACTURING PROCESS** | 3 | 0 | 2 | 4 |
| **PREREQUISITES** | - | | | | |
| OBJECTIVES | The objectives of the course are to make the students to understand the basic concepts of foundry and casting, metal forming and welding processes. Acquire knowledge about various plastic materials that are commonly used for various applications and their manufacturing process. | | | | |
| Expected Outcome | By the end of this course student will be able to get in-depth knowledge of various manufacturing processes and select appropriate manufacturing process for a particular engineering application. | | | | |

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| Module 1 | |
| Manufacturing - selecting manufacturing process, global competitiveness of manufacturing costs - Fundamentals of materials: Their behavior and manufacturing properties - Ferrous metals and alloys – Non-ferrous metals and alloys – Fundamentals of metal casting, fluidity of molten metal, solidification time, sand casting, shell mold casting, investment casting, plaster mold casting, ceramic mold casting, die-casting, centrifugal casting - Melting practice and furnaces defects in casting - Testing and inspection of casting, Metal fusion welding processes – Oxy-fuel gas welding, arc welding processes – Consumable electrode: SMAW, SAW, GMAW, FCAW, electro gas welding, and electro slag welding – Nonconsumable electrode: GTAW, AHW, PAW, EBM, LBM - Solid state welding processes: Ultrasonic welding, friction welding, and resistance welding. weld quality - Testing of welded Joints | |
| Module 2 | |
| Cold and hot working: Rolling, forging, extrusion, drawing, sheet metal forming processes – High energy rate forming processes: Explosive forming, electro-hydraulic forming, Electromagnetic forming | |
| Module 3 | |
| Production of metal powders: Compaction, sintering and finishing - Shaping of ceramics, forming and shaping of glass - Types of plastics, types of molding, reinforced plastics - Metal matrix composites, ceramic matrix composites ,Lathe and its operations - Drilling machine and its types – Shaper – Planner-milling machine | |
| Text Books | 1. S. Kalpakjian and S.R. Schmid, "Manufacturing Engineering and Technology", 7 th Edition, Prentice-Hall, 2013 |
| Reference | 1. S.K. Hajra Choudhury (2001), Elements of Workshop Technology, Vol. - I, Media Promoters Pvt Ltd., Mumbai.<br>2. P.N. Rao (1998), Manufacturing Technology – Foundry, Forging and Welding, Tata McGraw-Hill Publishing Co., New Delhi.<br>3. Roy A. Lindberg (2004), Processes and Materials of Manufacture, 4th Edition, Prentice-Hall of India, New Delhi. |

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| | **FLUID MECHANICS & MACHINERY** | 3 | 1 | 2 | 5 |
| **PREREQUISITES** | Multivariable calculus & partial differential equations, Engineering Thermodynamics | | | | |
| OBJECTIVES | The objective of this course is to introduce and explain basic fundamentals of fluid mechanics and its applications in aerodynamics, hydraulics, marine engineering, gas dynamics and electronics cooling. To understand the concept of advanced fluid mechanics in relation to Computational Fluid Dynamics. To understand the energy exchange process and complexities involved in fluid machinery and turbo machinery components. | | | | |

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| Expected Outcome | By the end of this course student will be able to understand and formulate the governing equations, apply boundary layer concepts for various practical industrial fluid problems. |
| Module 1 | **FLUID DYNAMICS & DIMENSIONAL ANALYSIS** |
| Density – Viscosity – Surface tension – compressibility – capillarity – Hydrostatic forces on plane – inclined and curved surfaces – Buoyant flow - Basic concept, Grashoff's number and its importance - Buoyancy driven flow in Industrial applications like Radiator cooling - Electronics cooling - Buoyancy driven Micro channel/ Micro cavity flow – Buoyant Nano- fluids for Power electronics cooling - Cavitation - Saturation pressure driven - Boundary layer detachment driven – Causes - Possibility of estimation with local boiling phenomena & its effect on solid structure - Noise induced by Cavitation at high pressure drop - Free surface flow - Layer between two-phases, two-species - Effect of hydrodynamic force due to layer of free surface - Effects on Ship sailing, Tidal energy generation - Wind effect on High raise buildings. Control volume – Fluid Kinematics - Types of flows; Steady flow, Unsteady flow, Uniform and Non Uniform flow, Rotational flow, Irrotational flow, 1-D, 2-D, 3-D flows– Streamline and Velocity potential lines- Euler and Bernoulli's equations and their applications – Momentum equation-Navier-Stokes Equations - Exact Solutions of Navier –Stokes Equations – Low Reynolds Number flow – Flow over flat plate – Hagen Poiseuille equation – Turbulent flow. Introduction to dimensional analysis – Raleigh and Buckingham · theorems. | |
| Module 2 | **HYDRAULIC PUMPS & TURBINES** |
| Fluid machines: definition and classification - Construction of velocity vector diagrams – head and specific work - components of energy transfer - degree of reaction. Hydro turbines: definition and classifications - Pelton turbine - Francis turbine – propeller turbine - Kaplan turbine - working principles - velocity triangles - work done - specific speed - efficiencies - performance curve for turbines. Pumps: definition and classifications - Centrifugal pump: classifications, working principles, velocity triangles, specific speed, efficiency and performance curves - Reciprocating pump: classification, working principles, indicator diagram, and work saved by air vessels and performance curves - cavitations in pumps - rotary pumps: working principles of gear and vane pumps. | |
| Module 3 | **TURBOMACHINERY** |
| Energy transfer between fluid and rotor, classification of fluid machinery, dimensionless parameters, specific speed, applications, stage velocity triangles, work and efficiency for compressors and turbines. Centrifugal Fan - Types, stage and design parameters, flow analysis in impeller blades, volute and diffusers, losses, characteristics curves and selection, fan drives and fan noise. Centrifugal Compressors - Construction details, types, impeller flow losses, slip factor, diffuser analysis, losses and performance curves. Axial Compressors - Stage Velocity Triangles, enthalphy – entrophy diagrams, stage losses and efficiency, work done factor, simple stage design problems and performance characteristics. | |
| Text Books | 1. R.W. Fox, P. J. Pritchard and A.T. McDonald's (2010), Introduction to Fluid Mechanics Wiley Publication, 8th edition.<br>2 Yahya, S.H., " Turbines, Compressor and Fans ", Tata Mc Graw Hill Publishing Company, 2013 |
| Reference | 1. B.R. Munson, D.F. Young, T. H. Okiishi, and W. W. Huebsch. (2011) Fundamentals of Fluid Mechanics, Wiley Publications.<br>2. S. K. Som and G. Biswas (2007), Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw-Hill Publishing company Ltd.<br>3. S.L. Dixon and C.A. Hall, (2010), Fluid Mechanics and Thermodynamics of Turbomachinery, Elsevier Inc. |

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| | **INDUSTRIAL ENGINEERING & MANAGEMENT** | 3 | 0 | 0 | 3 |
| **PREREQUISITES** | - | | | | |
| OBJECTIVES | 1. To enable the students understand the demand forecasting techniques and costing.<br>2. To provide students an insight into the concepts of industrial engineering and organization.<br>3. To familiarize the students with principles of work-study and Ergonomics.<br>4. To introduce students to various aspects of plant design and materials planning. | | | | |
| Expected Outcome | Student will be able to<br>1. Conduct market research, demand forecasting and costing<br>2. Demonstrate the knowledge of designing plants and controlling production.<br>3. Optimize the resources of an organization and improve productivity. | | | | |
| Module 1 | **DEMAND FORECAST AND ELEMENT OF COST** | | | | |
| Macro and micro economics - Demand and supply – Factors influencing demand – Elasticity of demand – Demand forecasting – Time series - Exponential smoothing casual forecast - Delphi method – Correlation and Regression - Barometric method – Long run and Short run forecast. Elements of cost – Determination of Material cost - Labour cost - Expenses – Types of cost – Cost of production - Over head expenses – Problems. Introduction to Industrial Engineering – Concepts - History and Development of Industrial engineering – Roles of Industrial Engineer – Applications – Productivity – Factors affecting productivity – Increasing productivity of resources – Kinds of productivity measures. | | | | | |
| Module 2 | **WORK DESIGN PLANT LAYOUT & GROUP TECHNOLOGY** | | | | |
| Introduction to work study – Method study – Time study – stopwatch time study – Standard data - Method Time Measurement (M-T-M) – Work sampling – Ergonomics.. Plant location - Factors - Plant layout - Types - Layout design process – Computerized Layout Planning – Construction and Improvement algorithms -ALDEP - CORELAP and CRAFT. Group technology-Problem definition - Production flow analysis - Heuristic methods of grouping by machine matrices – Flexible Manufacturing System - FMS work stations- Material handling and Storage system-Cellular Manufacturing System. | | | | | |
| Module 3 | **PRODUCTION PLANNING & CONTROL** | | | | |
| Types of productions, Production cycle-Process planning, Forecasting, Loading, Scheduling, Dispatching, Routing- Simple problems. Materials Planning – ABC analysis – Incoming materials control – Kanban system – Just in time. MRP systems- Master Production Schedule – Bill of Materials – MRP calculations - MRP II. | | | | | |
| Text Books | 1. Elwood S Buffa, Rakesh K Sarin (2009) Modern Production / Operations Management, John Wiley & Sons. | | | | |
| Reference | 1. R. Danried, Nada R.Sanders (2009) Operations Management, John Wiley & Sons.<br>2. R Panneerselvam, (2012) Production and Operations Management, PHI Learning Private Limited | | | | |

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| | **APPLIED NUMERICAL METHODS** | 3 | 1 | 0 | 4 |
| **PREREQUISITES** | COMPLEX VARIABLES AND PARTIAL DIFFERENTIAL EQUATIONS | | | | |
| OBJECTIVES | 1. This course is organized to expose students to some of the most important, basic computational methods likely to be of great use to engineers<br>2. The emphasis is mainly on computer oriented numerical methods for Solving ordinary and partial differential equations. The students are expected to develop MATLAB / FORTRAN / C programs for the numerical methods and obtain results including graphics | | | | |

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| Expected Outcome | On completion of this course, the student will be able to understand and solve Transcendental/Polynomial equations, system of Linear Algebraic equations, Interpolation and approximation, Differentiation and Integration and find solutions of differential equations by finite difference approximations. |
| Module 1 | **SYSTEM OF EQUATIONS , NUMERICAL DIFFERENTIATION & INTEGRATION** |
| General iterative method- secant method- Newton – Raphson method - non-linear equationssolution of system of equations- generalized Newton's method(roots of equation-solution of system of equations), - rate of convergence-Gauss –Seidel method for system of linear equations – convergence criterion- positive definiteness of a matrixspectral radius of a matrixtridiagonal system of equations – Thomas algorithm.. Interpolation- finite differences- Newton's formulae for interpolation- Langrage interpolation, interpolation with cubic splines, - numerical differentiation- maxima minima for tabulated values-numerical integration: Trapezoidal rule, Simpsons 1/3 rd and 3/8 th rules. –Romberg's method. | |
| Module 2 | **ORDINARY DIFFERENTIAL EQUATIONS** |
| Review: Taylor series method-Euler and modified Euler's methods) Runge Kutta methods - fourth order R.K method – systems of equations and higher order equations.- multi step methods: Adams-Bashforth method-boundary value problems- the shooting method, eigen value problems- finite difference method. Elliptic equation-Laplace equation- Liebmann's method –Jacobi's method- Gauss- Seidal method- parabolic equations - hyperbolic equations –-explicit methods – Crank – Nicholson implicit method -Von Neumann stability condition-CFL(Courant–Friedrichs–Lewy) stability condition. | |
| Module 3 | **CALCULUS OF VARIATION** |
| Functionals- - Euler- Lagrange equation- extremals- isoperimetric problems – The Rayleigh – Ritz method-Galerkin's method. | |
| Text Books | 1. M. K. Jain, S. R. K. Iyengar and R. K. Jain, "*Numerical methods for scientific and Engineering",* New Age International Ltd., 5th Edition (2010).The topics in the chapters 2,3,4,5,6,7<br>2. C. F. Gerald and P.V. Wheatley. *Applied Numerical analysis*, Addition-Wesley, 7th Edition (2009). |
| Reference | 1. S. S. Sastry, " Introductory Methods of Numerical Analysis", PHI Pvt Ltd ,New Delhi(2012)<br>2. W.Y. Yang, W. Cao, T.S. Chung and J. Morris, Applied Numerical Methods Using MATLAB Wiley India Edt (2007)<br>3. Steren C. Chapra and Ra P. Canale, "*Numerical methods for Engineers with programming and software applications"*, 4th Edition, Tata McGraw Hill (2005). |

| | ENGLISH FOR ENGINEER-II LAB |
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| OBJECTIVES | 1. To teach students how to apply the knowledge of Thermodynamics and Thermal Engineering Systems to conduct experiments.<br>2. To help the students measure thermal properties, temperature effect on other properties of processes and use various working fluids. |

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| EXPECTED OUTCOME | Student will be able to<br>1. Conduct the experiments on various thermal engineering systems and calculate performance oriented.<br>2. Analyze the performance of blowers, fan, internal combustion engines and refrigeration systems. |
| EXPERIMENTS | |
| 1. Performance and Heat balance test on S.I & C.I engines<br>2. Morse test<br>3. Measurement of Frictional power using retardation.<br>4. Determination of calorific value of fuels<br>5. Performance test on reciprocating air compressor<br>6. Performance test on air blower<br>7. Performance test on vapour compressor refrigeration system<br>8. Performance test on air-conditioning system<br>9. Test on Boiler<br>10. Test on Steam turbine. | |

| | **MANUFACTURING PROCESS LAB** |
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| Experiments<br>Foundry:<br>1. Preparation of green sand mould using wooden pattern<br>2. Determination of grain fineness number of moulding sand<br>3. Determination of permeability number of moulding sand<br>4. Determination of compressive strength of moulding sand<br>5. Demonstration of pouring non-ferrous metal using crucible tilting furnace<br>Welding:<br>1. Straight line bead and butt welding joints (ARC)<br>2. Preparation of MIG weld lap joint<br>3. Preparation of TIG weld ‘T’-joint<br>Lathe: (Simple operations only)<br>1. Facing and straight turning<br>2. Shoulder turning<br>3. Taper turning<br>4. Drilling, countersinking and tapping | |
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| | **FLUID MECHANICS & MACHINERY LAB** |
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| 1. Flow through Orifice<br>2. Constant Head Method<br>3. Variable Head Method<br>4. Flow through Triangular Notch<br>5. Flow through Venturimeter<br>6. Flow through Orifice Meter<br>7. Reynold's apparatus<br>8. Verification of Bernoulli's Apparatus<br>9. Measurement of lift and drag of an aerofoil<br>10. Measurement of static pressure distribution around an aerofoil using wind tunnel apparatus. |
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## 4TH Semester

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| | **Design of machine elements** | 2 | 1 | 0 | 3 |

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| **PREREQUISITES** | Strength of Materials , Machine Dynamics |
| OBJECTIVES | 1. To understand the design methodology for machine elements.<br>2. To analyse the forces acting on a machine element and apply the suitable design methodology.<br>3. To understand the various standards and methods of standardisation.<br>4. To apply the concept of parametric design and validation by strength analysis. |
| Expected Outcome | Student will be able to<br>1. Analyze and select machine elements/components.<br>2. Know the applications of the various elements, materials used to make them, and methods used<br>3. Integrate various machine elements and components into the design of a machine or mechanical system through a design project |
| Module 1 | **Design process for better Products** |
| Introduction to Design process – Factors – Materials selection direct - Bending and Torsional stress equation - Impact and Shock loading - Stress concentration factor – Size factor - Surface limits factor - Factor of safety - Design stress - Theories of failures – Problems, Variable and cyclic loads – Fatigue strength – S- N curve – Continued cyclic stress – Soderberg and Goodman equations – Design of Helical – Leaf - Disc springs under Constant and Varying loads. | |
| Module 2 | **Design of necessary Machine members** |
| Design of Shafts – Riveted joints, Welded joints and Screwed fasteners, Computer aided design of machine elements. Design and drawings of couplings – Rigid – Flexible – Design and Drawings of Cotter joints - Knuckle joints, Computer aided design of machine elements. | |
| Module 3 | **Design of Engine Components** |
| Design and Drawings of Piston – Connecting rod – Crankshaft – Flywheel, Design of Cams for parabolic – SHM and Cycloidal follower motions. Computer aided design of machine elements. | |
| Text Books | 1. Joseph Edward Shigley and Charles, R. Mischke, (2011), Mechanical Engineering Design, McGraw –Hill International Editions, 9th Edition |
| Reference | 1. V.B. Bhandari (2010) Design of Machine elements, Tata Mc Graw Hill, 3rd Edition<br>2. Design Data (2010) – PSG College of Technology, DPV Printers, Coimbatore.<br>3. R.S Khurmi, J. K Gupta (2008) Machine Design, Eurasia Publisher, 3rd Edition |

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| **PREREQUISITES** | |
| OBJECTIVES | The objective of the course is to make the student understand the need and working of automotive transmission system, and emphasize the need for maintenance of transmission equipments. |
| Expected Outcome | On completion of this course, the students will be able to select proper transmission system for a vehicle, identify and solve problems related to transmission system. |
| Module 1 | **CLUTCH , GEAR BOX & TRANSMISSION** |
| Necessity of clutch in an automobile, different types of clutches, friction clutches namely Single plate clutch, multi plate clutch, cone clutch, centrifugal clutch, electromagnetic clutch, hydraulic clutches, Clutch - adjustment, Clutch troubles and their causes, requirements of a clutch , Clutch materials, clutch lining Vacuum operated clutch. Fluid coupling. Various Resistances to Motion of the Automobile, Traction, tractive effort Performance curves, acceleration grade ability, drawbar pull. The need for transmissions, Necessity of gear box, Desirable ratios of 3-speed & 4-speed gear boxes, Constructional details of sliding-mesh gear box, constant-mesh gear box, synchromesh gear box, automatic and semi-automatic transmission, overdrive. Principal of torque conversion, single, multi stage and polyphase torque converters, performance characteristics, constructional and operational details of typical hydraulic transmission drives. Automatic transmission: relative merits and demerits when compared to conventional transmission – epicyclic and hydromatic transmission – continuously variable transmission. | |
| Module 2 | **SPECIAL TRANSMISSION SYSTEM** |
| Hydrostatic drives: advantages and disadvantages, principles of hydrostatic drive systems, construction and working of typical hydrostatic drives, Janney Hydrostatic drive. Electrical drives: advantages and limitations, principles of Ward Leonard system of control Modern electric drive for buses and performance characteristics. | |
| Module 3 | **DRIVELINE** |
| Effects of driving thrust and torque reaction. Hotchkiss drive. Torque tube drive, radius rods. Propeller shaft. Universal joints. Final drives – different types, double reaction final drive. Two speed rear axle. Rear axle construction – full floating, three quarter floating and semi-floating arrangements. Differential – conventional type, non-slip type. Differential locks. | |
| Text Books | 1. Fischer and Pollack, “The automotive transmission book”, Springer, 2014 |
| Reference | 1. Newton K and Steeds. W. “The Motor Vehicle”, Butter Worth’s & Co., Publishers Ltd, 2001<br>2. Automatic vehicle transmission, John Wiley Publications 1995<br>3. Crouse. W.H., Anglin., D.L., "Automotive Transmission and Power Trains construction ", McGraw-Hill 4. Heldt P.M - Torque converters- Chilton Book Co.-1992 |

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| | **VEHICLE DYNAMICS** | 2 | 1 | 0 | 3 |
| **PREREQUISITES** | | | | | |
| OBJECTIVES | Familiarize the students with the modal analysis of the vibrating systems and understand the characteristics of the tires. Understand the stability and handling characteristics of vehicles at different tracks. To introduce the dynamics of the chassis structures. | | | | |
| Expected Outcome | On completion of this course, the students will be able to simulate and analyze vibrations from vehicles. Analyze the stability and handling characteristics of vehicle at different operating conditions. Analyze and select suitable tires for a vehicle.. | | | | |
| Module 1 | **INTRODUCTION** | | | | |
| Classification of vibration, Specification and Vibration, Vibration System and human comforts, Modal Analysis, One DOF, Two DOF, Free and Forced Vibration, Random Vibration, Magnification and Transmissibility, Vibration Absorber. | | | | | |
| Module 2 | **TYRES AND SUSPENSION** | | | | |
| Tyres: Types designation and specifications, Relative merits and demerits, Ride characteristics, Behavior while Cornering, Slip angle, Cornering force, Power consumed by Tyre, Definition of Camber, Castor, King Pin Inclination, Scrub Radius, Toe-in Toe-out and Effect of Camber, Camber Thrust. Suspension: Types, Requirements wheel Hop, Wheel Wobble and Wheel Shimmy. Solid Axles, Independent Suspension Interconnected Suspension, Active Suspension, Latest Trends. | | | | | |
| Module 3 | **STABILITY OF VEHICLE AND HANDLING CHARACTERSTICS** | | | | |
| Load Distribution, Stability on Curved Track and on slope, Gyroscopic Effect, weight Transfer during Acceleration, Cornering and Braking, Overturning and Sliding. Cross wind stability, stability and Equations of motions, Latest Trends. Over steer, under steer, steady state cornering. Effect of braking, driving torques on steering. Effect of camber, transient effects in cornering. Directional stability of vehicles. | | | | | |
| Text Books | 1. Rao V. Dukkipati, Jian Pang, “Road Vehicle Dynamics problems and solution”,SAE,2010 | | | | |
| Reference | 1. Thomas D.Gillespie, Fundamentals of vehicle dynamics,SAE,1992<br>2. J.G. Giles, ‘Steering, Suspension and Tyres, Illiffe Books Ltd., 1968.<br>3. J. Y. Wong, ‘Theory of Ground Vehicles’, John Wiley and Sons Inc., New York, 2001.<br>4. David Corolla, ‘Automotive Engineering’, ‘Powertrain, chasis system and Vehiocle Body’, Butterworth Heinmann, 2009 | | | | |

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| | **CAD/CAM** | 2 | 0 | 4 | 4 |
| **PREREQUISITES** | DESIGN OF MACHIME ELEMENTS | | | | |
| OBJECTIVES | 1. To understand the basics of CAD/CAM.<br>2. To gain exposure over the concepts of computer graphics.<br>3. To learn about the geometric issues concerned to the manufacturing and its related areas.<br>4. To understand the latest advances in the manufacturing perspectives. | | | | |
| Expected Outcome | Student will be able to<br>1. Understand the importance of CAD/CAM principles in the Product development.<br>2. Develop programs related to manufacturing using codes.<br>3. Analyze the importance of networking in manufacturing environment. | | | | |
| Module 1 | **PRINCIPLES OF COMPUTER GRAPHICS** | | | | |
| Geometric Modeling – Wireframe, Surface and Solid – CSG and B-Rep- World/device coordinate representations, 2D and 3D geometric transformations, Matrix representationtranslation, scaling, shearing, rotation and reflection, composite transformations, concatenation – Graphics software, Graphics functions, output primitives- Bresenham's Algorithm and DDA | | | | | |
| Module 2 | **CNC MACHINE TOOLS** | | | | |
| Introduction to NC, CNC, DNC- Manual part Programming – Computer Assisted Part Programming – Examples using NC codes- Adaptive Control – Canned cycles and subroutines – CAD / CAM approach to NC part programming – APT language, machining from 3D models | | | | | |
| Module 3 | **CIM** | | | | |
| CIM wheel – CIM Database- CIM-OSI Model– Networking Standards in CIM Environment – Network structure – Network architecture –TCP/IP, MAP – Virtual Reality, Augmented Reality- Artificial Intelligence and Expert system in CIM. | | | | | |
| Text Books | 1. Ibrahim Zeid and R. Sivasubramaniam, (2010) CAD/CAM: Principles and Applications Tata McGraw Hill, India, 3rd Edition | | | | |
| Reference | 1. Mikell P. Groover, (2007) Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education<br>2. James A. Rehg, Henry W. Kraebber,(2007) Computer Integrated Manufacturing, Pearson Education.<br>3. Donald Hearn and M. Pauline Baker (2010) Computer Graphics with Open GL Prentice Hall, International | | | | |

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| | **AUTOMOTIVE AERODYNAMICS** | 2 | 1 | 0 | 3 |
| **PREREQUISITES** | NIL | | | | |
| OBJECTIVES | The objective of the course is to broaden the understanding of vehicle aerodynamics and to familiarize the students with the application of computational fluid dynamics in aerodynamics study. To introduce the use of wind tunnels in testing the vehicles. | | | | |
| Expected Outcome | Upon completion of this course the student will be able to appreciate the use of wind tunnels and the different testing techniques and apply CFD for aerodynamic design of vehicle. | | | | |
| Module 1 | **FUNDAMENTALS OF AERODYNAMICS** | | | | |
| Scope – Development trends – Flow phenomena related to vehicles – External and Internal flow problems – Performance of cars and light vans – Resistance to vehicle motion – Drag – Types of drag – Flow field around car – Aerodynamic development of cars – Optimization of car bodies for low drag. The origin of forces and moments – effects – vehicle dynamics under side wind – Force and Moment coefficients – Safety limit – dirt accumulation on vehicle – wind noise – Air flow around individual components – High performance vehicles – Very log drag cars – Design alternatives – High efficiency radiator arrangement – Development and simulation methods. | | | | | |
| Module 2 | **WIND TUNNEL AND TEST TECHNIQUES** | | | | |
| Principles of wind technology – Limitations of simulation – Scale models – Existing automobile wind tunnels – Climatic tunnels – Measuring equipment and transducers. Pressure measurement – velocity measurements – Flow visualization techniques – Road testing methods – Wind noise measurements. | | | | | |
| **Module 3** | **APPLICATION OF CFD** | | | | |
| Methods to solve Navier–Stokes equation – Forces acting in a fluid element – Compressibility effects in a flow field – Inviscid flow – Governing equations – Irrotation flow field and consequences – Potential flows – Boundary layer methods – Numerical modeling of fluid flow around vehicle body. Development and simulation methods –cars, buses, trucks | | | | | |
| Text Books | Yomi Obidi, 'Theory and Applications of Aerodynamics for Ground Vehicles', SAE Publications, 2014 | | | | |
| Reference | 1. W.H. Hucho, 'Aerodynamics of Road Vehicles', SAE Publications, 4th edition 1998.<br>2. R.McCallen, Browand, Ross, "The Aerodynamics of Heavy Vehicles", Springer, 2004<br>3. Smits, Lim, "Flow Visualization: Techniques and Examples", 2nd Edition, Imperial College, 2012<br>4. Schlichting, H, Kirsten K. 'Boundary Layer Theory', Springer, 2000. | | | | |

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| | **AUTOMOTIVE PLASTICS** | 2 | 1 | 0 | 3 |
| **PREREQUISITES** | NIL | | | | |
| OBJECTIVES | This course explains how and why plastics are different and cites several different types of polymers and processing considerations. Understanding Plastics emphasizes material handling, explains regrind, and covers the effects that moisture can have on molded part properties during processing.. | | | | |
| Expected Outcome | Student should understand processing of plastic , injection molding machine and design die cavity. | | | | |
| Module 1 | **UNDERSTANDING PLASTICS** | | | | |
| Plastic introduction, type of polymers, polymer classification, plastic processing and material hamdling. | | | | | |
| Module 2 | **INJECTION MOLDING BASICS** | | | | |
| Molding process intro, molding machine types, modes of operations, machine components, startup procedures, Shut down procedures, Machine safety, material preparation, Injection molding phases, General processing guidelines, common defects,Mold fuction , Mold construction,Mold configurations, Cold runner systems, gate types, General Mold Maintainace. | | | | | |
| Module 3 | **PLASTIC PART DESIGN ESSENTIALS** | | | | |
| Universal design considerations, Plastic part design basics, fastening & snap features, Texture and secoundary operations, technical details | | | | | |
| Text Books | | | | | |
| Reference | | | | | |

| | **CAD / CAM LAB** |
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**CAD EXPERIMENTS:**

1. Structural analysis of Trusses
2. Structural analysis of Beams
3. Structural analysis of Frames
4. Plane stress/Plane strain analysis
5. Model analysis of different structures
6. Steady state thermal analysis
7. Transient thermal analysis
8. Flow analysis
9. Thermo-mechanical analysis

CAM EXPERIMENTS:

1. Manual part programming using G and M codes for Turning, Step turning, Taper turning, multiple turning, Facing, Multiple facing, thread cutting and radius turning on cylindrical components.
2. CNC Milling program involving linear motion and circular interpolation.
3. CNC Milling program involving contour motion and canned cycles.
4. CNC Milling program involving Pocket milling
5. Diagnosis and trouble shooting in CNC machine
6. CNC code generation using any CAM software.
7. Simulation of machining operations using any CAM software.
8. Route sheet generation using CAM software.
9. Study and practical demonstration on Wire-Cut EDM,
10. Study and practical demonstration on Coordinate measuring machine,
11. Study and practical demonstration on Vertical Machining center and Horizontal Machining center
12. Study on Rapid Prototyping Technologies, Student shall submit team work in the form of project /assignments with neat documentation.

PIONEER DESIGN
Empowering Technology

**INDUSTRY LINKED B.TECH AUTOMOTIVE ENGINEERING**
**(With Automotive product design specialization)**

**5TH SEMESTER**

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| | **HEAT AND MASS TRANSFER** | 3 | 1 | 2 | 5 |
| **PREREQUISITES** | Applied Thermodynamics | | | | |
| OBJECTIVE | 1. To teach the students to comprehend and evaluate various modes of heat and mass transfer.<br>2. To help the students to design fin enhanced systems, evaporators, condensers and heat exchangers.<br>3. To enable the students understand boundary layer theory, condensation and boiling.<br>4. To expose students to heat exchangers and heat pipes. | | | | |
| Expected Outcome | **Student will be able to**<br>**1. Apply basic principles of fluid mechanics, thermodynamics, heat transfer for designing heat and mass transfer systems.**<br>**2. Model heat, mass and momentum transport systems and develop predictive correlation.**<br>**3. Assess and evaluate various designs for heat and mass transfer and optimize the solution** | | | | |
| Module 1 | **CONDUCTION AND CONVECTION** | | | | |
| Basic concepts – conduction - convection and radiation – Laws – General equation of heat conduction – Derivation in cartesian - cylindrical and spherical coordinates – One dimensional steady state heat conduction in simple geometries – plane wall - cylinder and sphere – Heat transfer composite walls - composite cylinders and composite spheres – Critical thickness of insulation – Thermal contact resistance – Overall heat transfer coefficient – Electrical analogy – Heat generation in plane wall - cylinder and sphere – Extended surfaces – general equations – types and applications of fins – Fin efficiency and effectiveness – Fin performance. Two and Three dimensional steady state heat conduction – Analytical - Graphical and Numerical methods – Conduction shape factor – Unsteady state heat conduction – Lumped parameter system – Non-dimensional numbers in conduction – Significance of Biot and Fourier numbers – Transient heat flow in semi-infinite solid – Use of Heisler and Grober charts, Boundary layer theory – Conservation equations of mass - momentum and energy for laminar flow over a flat plate – Turbulent flow over a flat plate – Flow over cylinders - spheres - tube bank – Internal flow through pipes – annular spaces – Analogy between momentum and heat transfer – Natural convection in vertical - inclined and horizontal surfaces – Mixed convection – Dimentional analysis. | | | | |
| Module 2 | **CONDENSATION , BOILING & RADIATION** | | | | |
| Condensation and Boiling – Filmwise and dropwise condensation – Film condensation on a vertical plate – Regimes of Boiling – Forced convection boiling – Radiation heat transfer – Thermal radiation – Laws of radiation – Black body concept – Emissive power – Radiation shape factor – Gray bodies – Radiation shields | | | | | |
| Module 3 | **HEAT AND MASS TRANSFER** | | | | |
| Heat Exchangers – Types and practical applications – Use of LMTD – Effectiveness – NTU method – Compact heat exchangers – Plate heat exchangers – Fouling factor – Heat pipes –Types and applications – Principle of Mass Transfer-Mass transfer by molecular diffusion – Fick's law of diffusion – Analogy of heat and mass transfer. | | | | | |
| Text Books | 1. R.C. Sachdeva, (2010) Fundamentals of Heat and Mass Transfer (SI Units), | | | | |
| Reference | 1. Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera and David P. Dewitt (2011) Fundamentals of Heat and Mass Transfer, John Wiley & Sons, 7th Edition<br>2. Sarit K. Das (2010) Fundamentals of Heat and Mass Transfer, Narosa Publishing House.<br>3. J.P. Holman (2009) Heat Transfer, McGraw Hill Publishing Co. Ltd. 10th Edition<br>**Data Book:**<br>1. C.P Kothadaraman and S. Subramanyan (2012) Heat and Mass Transfer Data Book New Age International Publishers, 7th Edition | | | | |

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| | **FINITE ELEMENT ANALYSIS** | 3 | 1 | 2 | 5 |
| **PREREQUISITES** | Numerical Methods, Strength of materials | | | | |
| OBJECTIVE | 1. To enable the students understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics and thermal analysis<br>2. Introduce students to the theory of elasticity<br>3. To teach students the characteristics of various elements in structural and thermal analysis and selection of suitable elements for the problemsbeing solved<br>4. To introduce students to various field problems and the discretization of the problem<br>5. To make the students derive finite element equations for simple and complex elements | | | | |
| Expected Outcome | Student will be able to<br>1. Apply the knowledge of Mathematics and Engineering to solve problems in structural and thermal engineering by approximate and numerical methods<br>2. Design a new component or improve the existing components using FEA<br>3. Solve the problems in solid mechanics and heat transfer using FEM<br>4. Use commercial FEA packages like ANSYS and modern CAD/CAE tools for solving real life problems | | | | |
| **MODULE 1** | **INTRODUCTION TO THEORY OF ELASTICITY** | | | | |
| **Introduction to Theory of Elasticity: Definition of stress and strain – plane stress – plane strain – stress strain relations in three dimensional elasticity. Introduction to Variational Calculus: Introduction –General field problems, discrete and continuous models, Variational formulation in finite elements – Ritz method - Weighted<br>residual methods – Galerkin – sub domain – method of least squares and collocation method - numerical problems. Discretization of the Problem: Introduction – Geometrical approximations – Simplification through symmetry – Element shapes and behaviour – Choice of element types – size and number of elements – Element shape and distortion – Location of nodes – Node and Element numbering. Interpolation Function: Simplex - complex and multiplex elements – Linear interpolation polynomials for various simplex elements – Convergence requirements – derivation of shape function equations.** | | | | |
| Module 2 | **STIFFNESS MATRIX FORMULATION** | | | | |
| One dimensional elasticity – Bar with constant and varying cross section - and Pin jointed truss member – Two dimensional elasticity – Plane stress - plane strain and axisymmetric simplex elements only - simple numerical problems, General field equation – Formulation of 1D and 2D – steady state heat transfer problems involving conduction and convection and torsion of prismatic members – simple numerical problems. | | | | | |
| Module 3 | **HIGHER ODER PROBLEMS** | | | | |
| Natural coordinate system and numerical integration – Higher order 1D and 2D elements – Derivation of shape function equations for Four node quadrilateral - six node triangle and eight node quadrilateral elements – formulation of element equation. | | | | | |
| Text Books | 1. Tirupathi R. Chandrupatla and Ashok D. Belugundu (2011) Introdution to Finite Elements in Engineering, Prentice Hall | | | | |
| Reference | 1. Daryl L. Logan (2011) A First Course in the Finite Element Method, Cengage Learning.<br>2. Rao S. S., (2011), The Finite Element Method in Engineering, Elsevier.<br>3. Zienkiewicz O.C., Taylor R.L., Zhu J.Z. (2011), The Finite Element Method: Its basis and fundamentals, Butterworth Heinmann.<br>4. Madenci Erdogan, Guven Ibrahim (2011), Finite Element Method and Applications In Engineering using ANSYS, Springer | | | | |

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| | **COMPUTATIONAL FLUID DYNAMICS** | 2 | 1 | 0 | 3 |
| **PREREQUISITES** | FLUID MECHANICS, NUMERICAL METHODS, HEAT & MASS TRANSFER | | | | |
| OBJECTIVE | 1. To provide the students with sufficient background to understand the mathematical representation of the governing equations of fluid flow and heat transfer.<br>2. To enable the students to solve one and two-dimensional ordinary and partial differential equations using traditional CFD tools.<br>3. To teach students how to express derivatives and differential equations through discretization techniques.<br>4. To help the students to understand the general transformation equations for grid generation.<br>5. To teach students how to apply explicit, implicit and semi-implicit methods of finite differencing.<br>6. To help the students solve fluid flow field using some popular CFD techniques. | | | | |
| Expected Outcome | Student will be able to<br>1. Possess the knowledge of CFD techniques, basic aspects of discretization and grid generation.<br>2. Solve fluid flow fields using CFD methods.<br>3. Model fluid flow problems and heat transfer | | | | |
| Module 1 | **INTRODCUTION & GOVERNING EQUATIONS** | | | | |
| Introduction - Impact and applications of CFD in diverse fields - Governing equations of fluid dynamics – Continuity - Momentum and energy - Generic integral form for governing equations - Initial and Boundary conditions - Classification of partial differential equations – Hyperbolic - Parabolic - Elliptic and Mixed types - Applications and relevance. Basic aspects of discretization - Discretization techniques – Finite difference - Finite volume and Finite Element Method– Comparison of discretization by the three methods - Introduction to Finite differences - Difference equations - Uniform and non-uniform grids - Numerical errors - Grid independence test - Optimum step size | | | | | |
| Module 2 | **GRID GENERATION & TRANSFORMATION** | | | | |
| Grid generation – Transformation of non-uniform grids to uniform grids – General transformation of the equations - Form of the governing equations suitable for CFD - Compressed grids - Boundary fitted co-ordinate systems – Elliptic grid generation - Adaptive grids - Modern developments in grid generation. Steady one-dimensional, two and three-dimensional conduction - Steady one-dimensional convection and diffusion - Transient one-dimensional and two-dimensional conduction – Explicit - Implicit - Crank-Nicolson - ADI scheme – Stability criterion. | | | | | |
| Module 3 | **CALUCATION OF FLOW FIELD** | | | | |
| Discretization of convection - Diffusion – Central difference, upwind, hybrid and power law schemes - Representation of the pressure - Gradient term and continuity equation – Staggered grid - Momentum equations - Pressure and velocity corrections – Pressure Correction equation - Numerical procedure for SIMPLE algorithm - Boundary conditions for the pressure correction method. Stream function – Vorticity method - Discussion of case studies. | | | | | |
| Text Books | 1. John, D. Anderson. J R. Computational Fluid Dynamics, McGraw Hill, 2011. | | | | |
| Reference | 1. Chung t.J., (2002) Computational Fluid Dynamics, Cambridge University press.<br>2. G.Biswas and K.Muralidhar (2003) Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi<br>3. Joel H. Ferziger, Milovan Peric. (2002) Computational Methods for Fluid Dynamics, Verlag Berlin Heidelberg<br>4. Vladimir D. Liseikin (2010) Grid generation methods, Springer, 2nd Edition<br>5. Veersteeg. H. K. & Malaseekara (2007) Introduction to CFD, The Finite Volume Method, Longman Scientific & Technical. | | | | |

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| | **PRODUCT DEVELOPMENT & LIFECYCLE** | 2 | 1 | 0 | 3 |
| **PREREQUISITES** | Nil | | | | |
| OBJECTIVE | | | | | |
| Expected Outcome | | | | | |
| Module 1 | PRODUCT LIFECYCLE ENVIRONMENT | | | | |
| Product Data and Product Workflow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, Change Management for PLM | | | | | |
| Module 2 | PROCESS & METHODOGIES | | | | |
| Integrated Product development process - Conceive – Specification, Concept design, Design - Detailed design, Validation and analysis (simulation), Tool design, Realize – Plan manufacturing , Manufacture, Build/Assemble , Test (quality check) , Service - Sell andDeliver , Use , Maintain and Support, Dispose. Bottom-up design, Top-down design, Front loading design workflow, Design in context, Modular design. Concurrent engineering - work structuring and team Deployment - Product and process systemization - problem, identification and solving methodologies. Product Reliability, Mortality Curve. Design for Manufacturing, Design for Assembly. Design for Six Sigma. | | | | | |
| Module 3 | DFMA | | | | |
| Product Modeling - Definition of concepts – FundamentaL issues - Role of Process chains and product models -Types of product models – model standardization efforts-types of process chains - Industrial demands. Design for manufacturing - machining - casting and metal forming - optimum design - Design for assembly and disassembly - probabilisticdesign concepts - FMEA - QFD - Taguchi Method for design of experiments -Design for product life cycle. Estimation of Manufacturing costs, Reducing the component costs and assembly costs, Minimize system complexity. | | | | | |
| Text Books | | | | | |
| Reference | 1. Grieves, Michael. Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303<br>2. Product Life Cycle Management - by Antti Saaksvuori, Anselmi Immonen, Springer, 1st Edition (Nov.5, 2003)<br>3. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, 2004. ISBN 1852338105<br>4. Product Design & Process Engineering, McGraw Hill – Kogalkusha Ltd., Tokyo, 1974.<br>5. Product Design & Development – by Kari Ulrich and Steven D. Eppinger, McGraw Hill International Edns, 1999 | | | | |

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| | **AUTOMOTIVE INTERIORS & EXTERIORS** | 2 | 1 | 0 | 3 |
| **PREREQUISITES** | nil | | | | |
| OBJECTIVE | | | | | |
| Expected Outcome | | | | | |
| Module 1 | **PRODUCT LIFECYCLE ENVIRONMENT** | | | | |
| **Product Data and Product Workflow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, Change Management for PLM** | | | | | |
| Module 2 | **PROCESS & METHODOGIES** | | | | |
| Integrated Product development process - Conceive – Specification, Concept design, Design - Detailed design, Validation and analysis (simulation), Tool design, Realize – Plan manufacturing , Manufacture, Build/Assemble , Test (quality check) , Service - Sell andDeliver , Use , Maintain and Support, Dispose. Bottom-up design, Top-down design, Front loading design workflow, Design in context, Modular design. Concurrent engineering - work structuring and team Deployment - Product and process systemization - problem, identification and solving methodologies. Product Reliability, Mortality Curve. Design for Manufacturing, Design for Assembly. Design for Six Sigma. | | | | | |
| Module 3 | **DFMA** | | | | |
| Product Modeling - Definition of concepts – FundamentaL issues - Role of Process chains and product models -Types of product models – model standardization efforts-types of process chains - Industrial demands. Design for manufacturing - machining - casting and metal forming - optimum design - Design for assembly and disassembly - probabilisticdesign concepts - FMEA - QFD - Taguchi Method for design of experiments -Design for product life cycle. Estimation of Manufacturing costs, Reducing the component costs and assembly costs, Minimize system complexity. | | | | | |
| Text Books | | | | | |
| Reference | 1. Grieves, Michael. Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303<br>2. Product Life Cycle Management - by Antti Saaksvuori, Anselmi Immonen, Springer, 1st Edition (Nov.5, 2003)<br>3. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, 2004. ISBN 1852338105<br>4. Product Design & Process Engineering, McGraw Hill – Kogalkusha Ltd., Tokyo, 1974.<br>5. Product Design & Development – by Kari Ulrich and Steven D. Eppinger, McGraw Hill International Edns, 1999 | | | | |

**6TH SEMESTER**

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| | **ERGONOMICS & STYLING** | 2 | 1 | 0 | 3 |
| **PREREQUISITES** | nil | | | | |
| OBJECTIVE | | | | | |
| Expected Outcome | | | | | |
| Module 1 | MOBILITY RELATED VEHICEL PLAN AND INTEGRATION | | | | |
| Understanding context related problems, User research customer's explicit needs and latent needs.<br>• Aesthetics, trend, style Analysis<br>• Product planning, development of product brief. Concept generation, creativity and innovation<br>• Evaluation techniques. Peer reviews.<br>• Understanding of the packaging concept and the problems connected with traveling space, technology, ergonomics and aesthetics/ styling.<br>• Readings and exercises in mobility related topics | | | | | |
| Module 2 | EXPLORATION OF FUTURE MOBILITY& SUSTAINABLE SOLUTIONS | | | | |
| • Understanding mobility issues at system level.<br>• Sustainable mobility – ecology / environment, culture, technology, legislation, safety,<br>• Mass transportation, Urban, semi-urban, rural transport systems & mobility needs<br>• Rapid and intelligent transport systems etc.<br>• Future technologies for mobility<br>• Tasks: Technology watch, Scenario creation for integrated systems, Strategic approach to mobility design | | | | | |
| Module 3 | ERGONOMICS OF PASSENGER DRIVERAND AMENITIES | | | | |
| • Introduction to human body.<br>• Anthropometrics and its application to vehicle ergonomics and cockpit design.<br>• Driver comfort – seating, visibility, man-machine system.<br>• Psychological factors – stress, attention<br>• Passenger comfort - Ingress and egress, spaciousness, ventilation, temperature control, dust and fume prevention and vibration.<br>• Interior features and conveniences—Use of modern technology for the same.<br>• Safety issues- active and passive safety features in vehicles.<br>• Ergonomic research methods / ergonomic audit<br>• Task: Practical work aimed at integrating design and ergonomics.<br>• Readings and seminaR | | | | | |
| Text Books | | | | | |

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| Reference | • **B.Peacock, Waldemar Karwowski;** Automobile ergonomics. Publisher: CRC; 1 edition, 1993<br>• **S.P. Taylor C.M. Haslegrave;** Vision in Vehicles VI. Publisher: North Holland; 1 edition, 1998<br>• **Cristy ho, Charles Spenser;** The multi- sensory drives: Implication for ergonomics car interface design. Publisher CRC press 1993.<br>• **Don Harris (Editor);** Engineering Psychology and Cognitive Ergonomics: 8th International conference. Publisher: Springer; 1 edition ( 20095. Product Design & Development – by Kari Ulrich and Steven D. Eppinger, McGraw Hill<br>International Edns, 1999 |

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| | **Vehicle Inspection & Maintenance** | 2 | 1 | 0 | 3 |
| **PREREQUISITES** | | | | | |
| OBJECTIVE | To make the student understand the need for vehicle maintenance and its importance and to familiarize the maintenance procedure for various components of an automobile | | | | |
| Expected Outcome | On completion of this course, the students will be able to inspect and diagnose the problems occurring in the various components of the vehicle. | | | | |
| Module 1 | **Inspection schedule and maintenance of records** | | | | |
| Need for maintenance, types of maintenance: preventive and breakdown maintenance, requirements of maintenance, preparation of check lists. Inspection schedule, maintenance of records, log sheets and other forms, safety precautions in maintenance: General safety, tool safety. Tools used for engine disassembly, dismantling of engine components: cylinder head, valve train, cylinder block, connecting rod, piston and crankshaft assembly; cleaning and inspection of engine components, reconditioning of components | | | | | |
| Module 2 | **Engine subsystem maintenance** | | | | |
| Servicing and maintenance of fuel system, Engine tune-up, cooling system: water pump, radiator, thermostat. Lubrication system maintenance, Anticorrosion and anti freeze additives. Servicing and maintenance of clutch, gear box, universal joints, propeller shaft, differential system. Service and maintenance of brake – disc and drum brakes, steering wheel and suspension systems, wheel alignment, vehicle body maintenance | | | | | |
| Module 3 | **Electrical system maintenance** | | | | |
| Servicing and maintenance of battery, starter motor, alternator and generator, ignition system, lighting system, electric horn, and wiper motor | | | | | |
| Text Books | 1. Knott and Phil Knott, "An Introductory Guide to Motor Vehicle Maintenance: Light Vehicles", EMS publishing, 2010 | | | | |
| Reference | 1. William H. Crouse and Donald L. Anglin, "Automotive Mechanics", 10th edition, 2007<br>2.Tim Giles, "Automotive service: Inspection, maintenance and repair", 3rd edition, 2007<br>3. Jack Erjavec, "Automotive technology: A systems approach", 5th edition, 2009<br>4. Service manuals of various OEMs | | | | |

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| | **COMPUTER SIMULATION OF ENGINES** | 2 | 1 | 0 | 3 |
| **PREREQUISITES** | | | | | |
| OBJECTIVE | The objective of this course is to make the student understand the thermodynamics involved in various process of an engine and help them to mathematically model the processes. | | | | |
| Expected Outcome | By the end of the course student will be able to explain the physical process involved in an engine completely with mathematics and can develop code for simulating them. | | | | |
| Module 1 | **Ideal Cycle Simulation of SI Engines (ICS)** | | | | |
| Introduction – Heat of reaction – Measurement of URP – Measurement of HRP – Adiabatic Flame temperature – Calculations under constant Pressure and constant volume — Effect of change of pressure, temperature on Heat of reaction – Introduction to laminar flame speed – detonation – deflagration - Complete and Partial combustion . Basic approach – Assumptions of cycle with air as working medium – Ideal Otto cycle – Ideal cycle simulation – Deviation between actual and Ideal cycles – programmable exercises | | | | | |
| Module 2 | **Fuel – Air Cycle Simulation (FCS)** | | | | |
| Fuel and air – Working medium – Effect of temperature drop due to fuel vaporization – Full throttle operation – Adiabatic heat addition – work output and efficiency calculations – Part throttle operation – super charged operation – programmable exercises. | | | | | |
| Module 3 | **Progressive Combustion Simulation (PCS) and Actual Cycle Simulation (ACS)** | | | | |
| Actual combustion process simulation – progressive not instantaneous - Gas exchange process – reexamination of inlet and exhaust processes – Heat transfer process – Actual Cycle simulation – determination of heat transfer coefficients – Friction Calculations – Comparison of various simulation - Comparison of simulated values – Validation of engine performance like pressurecrank angle – brake power – brake thermal efficiency – Mechanical and Volumetric efficiency – Effect of speed on engine performance | | | | | |
| Text Books | 1. C.R. Ferguson, A.T. Kirkpatrick, “Internal Combustion Engines- Applied Thermosciences”, Wiley Publication, 2013 | | | | |
| Reference | 1. Ramoss A.L, “Modelling of Internal Combustion Engines Processes” McGraw Hill Publishing Co., 1992<br>2. Ashley Campbel, “Thermodynamic analysis of Combustion Engines”, John Wiley and Sons, New York, 1996<br>3. Benson R.S., Whitehouse N.D, “Internal Combustion Engines”, Pergamon Press, Oxford, 1979<br>4. V. Ganesan, “Computer Simulation of Spark – Ignition Engine Processes”. University Press (India) Limited, 1996 | | | | |

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| | **FUNDAMENTALS OF NOISE AND VIBRATION** | 2 | 1 | 0 | 3 |
| **PREREQUISITES** | | | | | |
| OBJECTIVE | The objective of the course is to broaden the understanding of the source of noise and vibration, to familiarize with the measurement, statistical and frequency analysis of noises | | | | |
| Expected Outcome | Upon completion of this course the student will be able to identify the sources of noise and vibration, measure sound intensity and human sensitivity and carryout statistical and frequency analysis. | | | | |
| Module 1 | **Introduction to Vibrations** | | | | |
| Oscillatory motion, Harmonic Motion Natural vibration, single DOF, two DOF and Multi DOF. Forced vibration, Damped, Undamped Vibrations, Modal Analysis, frequency response function, transient vibration, Laplace transformation formulation, Lagrange's Equation, Damped – Undamped Vibration, Forced vibration, Balancing of Reciprocating mass, Balancing of Rotary Mass, Transmissibility, Logarithmic decrement, Isolation Absorption. Car Model (2 DOF) Coupled System. | | | | | |
| Module 2 | **MULTI DOF** | | | | |
| Normal Mode of Vibrations-Flexibility and Stiffness Matrix, Eigen Values & Vectors, Orthogonal Modes, Modal Damping in forced Vibration, Forced Vibration by Matrix inversion, Numerical methods of fundamental frequencies, Continuous System Vibration of String, Euler's Equation of Beams. | | | | | |
| Module 3 | **Noise and Measuring Instruments** | | | | |
| What is Noise? Decibel, Various noise sources, Sound Quality, Sound Propagation, Sound Intensity, Sound Pressure level, Sound Intensity ratio, Sound power, Quantification of sound Machinery noise and Noise induced hearing loss. Noise Control. Vibration Instruments- Vibration Exciters, Analyzers, Principle, Free and Forced Vibration test, Frequency and Domain Analysis, Sound Intensity and mapping and introduction to array technique. Digital Signaling Process | | | | | |
| Text Books | 1. William T Thomson, Dahleh and C Padmanabhan, "Theory of Vibration with Applications", Pearson, 5th ed, 2011 | | | | |
| Reference | 1. Malcom J. croker, "Noise and Vibration Control", Wiley, 2007.<br>2. Norton MP "Fundamental of Noise and Vibration", Cambridge University Press, 2003.<br>3. Boris and Korney, "Dynamic Vibration Absorbers", John Wiley,1993.<br>4. Lewis L, "Industrial Noise Control", McGraw Hill Inc,1991. | | | | |

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| | **ENGINE DESIGN & DEVELOPMENT** | 2 | 1 | 0 | 3 |
| **PREREQUISITES** | | | | | |
| OBJECTIVE | The objective of this course is to make the student understand the functions and design aspects of various components of an engine and understand the mechanical limitations in obtaining ideal performance of an engine | | | | |
| Expected Outcome | By the end of this course the student will be able to design the various components of an engine. | | | | |
| Module 1 | **Engine Basic Theory** | | | | |
| Classification of I.C Engines, Customer & Functional requirements, Efficiency, Overall engine system parameters & configuration, General design considerations, Forces generated within engine, Duty cycle, Downsizing, Functional requirement, Block material like Gray Iron, Aluminum, Compacted Graphite Iron and Magnesium, Cylinder head alloys, Design layout, Basic block, Block head design, Cylinder liner design approach and Thermal loads, 2 Valve & 4 valve cylinder heads. Bolts loads and gasket design. | | | | | |
| Module 2 | **Crank & Valve train** | | | | |
| Function, Requirements, Materials – Piston and crankshaft. Recent trends in design of piston assembly – Piston, Piston rings, Piston pin, Connecting rod assembly and Crankshaft. | | | | | |
| Module 3 | **Intake & Exhaust System** | | | | |
| Functional requirement, Fuel Filter, Types of Injectors, Pump-line-injector injector system, Unit Injection, CRDI, Injection Pressure, Multiple Injections. Cooling system, Cooling Circuits, Water Pump and Thermostat and its types. Lubrication – Types & Layout, Requirement of Lubricants, Oil Filters, Oil Pan, Oil pump types. Functional Requirement, Air Induction, Swirl & Turbulence, Swirl Generation, Air Filter, Intake Manifold, Positive Crankcase Ventilation (PCV), Exhaust Manifold, Turbochargers, EGR, EGR Cooler, Silencer etc, Part design philosophy. | | | | | |
| Text Books | 1. John B Heywood, “Internal Combustion Engine Fundamentals”, Tata McGraw Hill, 2011 | | | | |
| Reference | 1. Design Of Automotives Engine, Kolchin A. & Demidov V; MIR Publishers,1984.<br>2. Goetze, “Piston Rings Manual”, 2008.<br>3. Kevin Hoag, “ Vehicular Engine Design”, Springer, 2006<br>4. Edward Fredric Obert, “Internal Combustion Engines”, International Text book co. (1968) | | | | |

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| | **AUTOMOTIVE STRUCTURES** | 2 | 1 | 0 | 3 |
| **PREREQUISITES** | | | | | |
| OBJECTIVE | The course explains how to create automotive structural parts within the body panels and assembly environment. We emphasize modeling parts to fit within a limited space using existing geometry as the boundaries, and to design the parts to accommodate subsystems. | | | | |
| Expected Outcome | | | | | |
| Module 1 | **Body in White Design Principles** | | | | |

1. BIW Design Overview
2. BIW Design Process
3. Parts in Body in White Design
4. BIW-Planning Stage
5. BIW-Starting the CAD Model

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| Module 2 | **Die design & Tooling** |

1. Die Design Overview (AS)
2. Die Design Structure (AS)
3. Die Design Advantages and Disadvantages (AS)
4. Die Tooling Design (AS

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| Module 3 | **Body in White Modelling** |

1. BIW-Clean Edge Modeling Technique
2. BIW-Clean Edge Application
3. BIW-Shaping the Part Overview
4. BIW-Rough Shape Envelope Cre
5. BIW-Front Hinge Pillar Envelope
6. BIW-Shaping the Part
7. BIW-Stamped Depressions
8. BIW-Complex Depression Creation Techniques
9. BIW-Complex Depressions on Contoured
10. BIW-Front Hinge Pillar Depressions
11. BIW-Flanges for Stamped Sheetmetal
12. BIW-Flange Creation

13. BIW-Offset Flange
14. BIW-Door Inner Flange
15. BIW-Front Hinge Pillar Flanges
16. BIW - Beads
17. BIW-Bead Creation
18. BIW-Front Hinge Pillar Bead
19. BIW-Dart Creation
20. BIW-Dart Creation Using Tool Solids
21. BIW-Front Hinge Pillar Completion

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| Text Books | |
| Reference | |