VISHNU INSTITUTE OF TECHNOLOGY:: BHIMAVARAM
(Autonomous)
Approved by AICTE, Accredited by NBA, NAAC & Affiliated to JNTUK, Kakinada

MECHANICAL ENGINEERING DEPARTMENT

HONORS COURSES OF MECHANICAL ENGINEERING		
S.No	**Course Title**	**Pre- requisites**
POOL 1 (II-II)		
1	Composite Materials Manufacturing	Materials Science and Metallurgy
2	Advanced Welding Processes	Manufacturing Processes
3	Advanced Mechanics of Solids	Mechanics of Solids
4	Advanced Thermodynamics	Thermodynamics
POOL 2 (III-I)		
1	Tribology	NIL
2	Micro Electro Mechanical Systems	NIL
3	Mechanics of Composites	Engineering Mechanics
4	Fuel Cell Technology	Thermodynamics and Chemistry
POOL 3 (III-II)		
1	CNC Machines	Manufacturing Processes
2	Material Characterization Techniques	Materials Science and Metallurgy
3	Experimental Stress Analysis	Mechanics of Solids
4	Electric & Hybrid Vehicles	Applied Thermodynamics
POOL 4 (IV-I)		
1	Micro Manufacturing	NIL
2	Advanced Metrology and Sensing Systems	Metrology
3	Product Design	NIL
4	Vehicle Dynamics	Kinematics of Machines, Dynamics of Machines

B.Tech HONOR
in
Mechanical Engineering
Syllabus

II B.Tech. II - Semester

COMPOSITE MATERIALS MANUFACTURING

(Honors)

L	T	P	C
4	0	0	4

COURSE OBJECTIVES:

- To introduce various types of reinforcements and matrices for composites.
- To impart knowledge on the fundamentals of design of composites and structure property relations.
- To familiarize with suitable tools and methods for manufacturing of composites.
- To understand advance composite materials and processes.

UNIT I

Introduction to Composite Materials: Definition, classification of composite materials based on matrix and reinforcement, functional requirements of matrix and reinforcement, advantages of composites.

Applications of Composites in: aircraft, space, transportation, energy, electronics, sports and medical industries.

UNIT II

Reinforcements: Types of reinforcements, their mechanical properties and functions - ceramics, glass, carbon, boron. silicon carbide, alumina, metal, aramid. Forms of reinforcements - particulate, fibre, filaments, whiskers, flakes. Pre-fabricated forms - preforms, prepegs, fabrics, honeycomb.

Matrix: Type of matrix, its mechanical properties and functions- polymers (thermosets and thermoplastics), metals, ceramics, glass and carbon. Basic principles in the design of composites and selection of matrix and reinforcement.

UNIT III

Polymer Matrix Composites: Polymer Matrix Composites: Types of thermoset and thermoplastic resins. Principles in the selection of matrix and the reinforcements. Process selection criteria. Mould and tool making. Basic manufacturing steps - impregnation, lay-up, consolidation and solidification.

Manufacturing Processes for Polymer Composites: Hand lay-up, compression moulding, extrusion, injection moulding, sheet forming, pultrusion, hot press & autoclave techniques and filament winding.

UNIT IV

Manufacturing Processes for Metal Matrix Composites: Casting methods - gravity & low pressure die, investment, squeeze, spray forming, compression moulding and thixo-moulding.

Manufacturing Processes for Ceramic Matrix Composites: Reaction sintering, electro-deposition, spray forming, infiltration.

UNIT V

Testing of Composites: Mechanical testing of composites, tensile testing, compressive testing, intra-laminar shear testing, inter-laminar shear testing, fracture testing.

Non-Destructive Testing of Composites: Visual inspection, ultrasonic testing, radiography, Thermography, liquid penetrant test, eddy current test.

COURSE OUTCOMES:

, Upon successful completion of this course, the students will be able to:

1. Select appropriate composite materials for real time applications.
2. Select the mould, tool, matrix and reinforcements for composites.
3. Choose suitable processes and parameters for the manufacture of polymer matrix composites.
4. Identify suitable processes and parameters for the manufacture of metal matrix and ceramic matrix composites.
5. Understand the various methods of testing of composites.

TEXT BOOKS:

1. Composite Materials: Engineering and Science, F L Matthews and R D Rawlings, Chapman & Hall, London, 1994.
2. An Introduction to Metal Matrix Composites, T W Clyne and P J Withers, Cambridge University Press, 1993.

REFERENCE BOOKS:

1. Fundamentals of Metal Matrix Composites, S. Suresh, A. Martensen and A. Needleman, Butterworth, Heinemann, 1993.
2. Fibre-reinforced Composites: Materials, Manufacturing & Design, P K Mallick, Marcel Dekker, 1993.
3. Composites Manufacturing-Materials, Product, & Process Engineering, CRC Press, 2002.

II B.Tech. II - Semester

ADVANCED WELDING PROCESSES

(Honors)

L	T	P	C
4	0	0	4

COURSE OBJECTIVES:

- To acquire fundamental knowledge on principles of solid state welding processes.
- To understand the effect of welding parameters on weld quality.
- To study the importance of advanced welding processes.

UNIT I

Electrical Resistance Welding: General principle - heat generation in resistance welding-Electrical Characteristics of Resistance welding; Thermal Characteristics of Resistance Welding, Heat Balance.

Spot Welding: Principle, welding sequence - Solidification in Resistance Spot Welding-applications of spot welding.

UNIT II

Friction Based Processes: Introduction, working principle, difference between friction welding and inertia welding, Operation steps, Metallurgy of friction welded joints, Fibre flow in friction welding, Defect formation, Process parameters, Applications;

Friction Stir Welding: Introduction-working principle, Operation steps, Metallurgy of FSW joints, Defect formation - Process parameters, Tool design, tool geometry and tool materials, Heat generation in FSW process, Variants of FSW process.

UNIT III

Ultrasonic Welding: Principle of operation, welding equipment, welding variables, types of ultrasonic welds, materials ultrasonically welded, advantages, disadvantages and applications of ultrasonic welding.

Diffusion Welding: Principle, types, parameters, materials welded, advantages, limitations and applications of diffusion welding.

UNIT IV

Laser Beam Welding Processes: Basics of Laser, types of Lasers, Gaseous systems: - CO_2 Laser welding; Solid state Laser welding; Laser beam characteristics – Continuous Wave lasers, Pulsed Laser, High power diode lasers (HPDL) and Fibre Lasers; Principles of operation, effect of parameters on weld quality, advantages limitations and applications.

Electron Beam Welding Processes: Fundamentals; Beam characteristics; Different degrees of vacuum, Heat generation and regulation, equipment details in typical set-up, Parameters and its effects on weld quality, advantages and disadvantages, applications, characteristics of electron beam welded joints.

UNIT V

Allied Processes:

Principle and concept of narrow gap welding, under water welding, thermit welding. Process characteristics, advantages and applications of above techniques.

Principles and concepts of Induction brazing, Dip brazing, Resistance brazing, Vacuum brazing; Adhesive Bonding; High Frequency Welding; MIAB welding; Microwave joining.

COURSE OUTCOMES:

Upon successful completion of this course, the students will be able to:

1. Understand the concepts of resistance and spot-welding processes.
2. Acquire knowledge on friction-based processes.
3. Utilize advanced joining techniques for critical applications.
4. Select an appropriate welding process for a specific application.
5. Acquire knowledge of brazing processes.

TEXT BOOKS:

1. John Norrish, Advanced welding processes Technologies and process control, Wood
   head Publishing and Maney Publishing, 2006.
2. Hongyan Zhang and Jacek Senkara, Resistance welding: Fundamentals and Applications, CRC Press, 2nd Edition, 2011.

REFERENCE BOOKS:

1. Christopher Davis, Laser Welding- Practical Guide, Jaico Publishing House, 1994.
2. Rajiv S. Mishra, Murray W. Mahoney, Friction Stir Welding and Processing, ASM International, 2007.

II B.Tech. II - Semester

ADVANCED MECHANICS OF SOLIDS

(Honor)

L	T	P	C
4	0	0	4

Prerequisites: Mechanics of Solids

COURSE OBJECTIVES:

1) To gain knowledge about deflection of beams.

2) To understand the principles of failure criteria.

3) To determine the stresses and deflection in unsymmetrical bending of beams.

4) To understand concept about torsion.

5) To analyze the contact stresses.

UNIT I

DEFLECTION OF BEAMS: Bending into a circular arc – slope, deflection and radius of curvature – Differential equation for the elastic line of a beam – Double integration and Macaulay's methods – Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, – U.D.L uniformly varying load. Mohr's theorems – Moment area method – application to simple cases including overhanging beams, statically indeterminate Beams and solution methods.

UNIT II:

FAILURE CRITERIA: Modes of failure, Excessive deflections, Yield initiation, fracture, Progressive fracture, High Cycle fatigue for number of cycles N > 10%, buckling. Concept of Creep. Application of energy methods: Elastic deflections and statically indeterminate members and structures: Principle of stationary potential energy, Castiglione's theorem on deflections, Castiglione's theorem on deflections for linear load deflection relations, deflections of statically determinate structures.

UNIT III:

UNSYMMETRICAL BENDING: Bending stresses in Beams subjected to non-symmetrical bending; Deflection of straight beams due to non-symmetrical bending.

UNIT IV:

TORSION: Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section; Hollow thin wall torsion members, multiply connected Cross Section.

UNIT V:

CONTACT STRESSES: Introduction; problem of determining contact stresses; Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Method of computing contact stresses; Deflection of bodies in point contact; Stresses for two bodies in contact over narrow rectangular area (Line contact), Loads normal to area; Stresses for two bodies in line contact, Normal and Tangent to contact area.

COURSE OUTCOMES:

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

1. Calculate the deflection and slope curves for beams.
2. Explain the principles of failure criteria.
3. Determine the stresses and deflection in unsymmetrical bending of beams.
4. Interpret the concept of torsion.
5. Analyze the contact stresses.

TEXT BOOKS:

1) Richard J. Schmidt Arthur P. Boresi, Advanced Mechanics of materials, Wiley International, 2009.
2) Timoshenko S.P. and Goodlier J.N., Theory of elasticity, McGraw-Hill Publishers 3rd Edition, 2017.
3) L.S Srinath, Advanced Mechanics of Solids, McGraw Hill Education, 2017.

REFERENCE BOOKS:

1. Timoshenko, Theory of plates & Shells, McGraw Hill Education, 2017.
2. Strength of materials & Theory of structures (Vol I & II) by B.C Punmia, Lakshmi publications Pvt. Ltd, New Delhi.
3. Sadhu Singh, Strength of materials, Khanna Book Publishing Company, 2016.

II B.Tech. II - Semester

ADVANCED THERMODYNAMICS
(Honors)

L	T	P	C
4	0	0	4

PRE-REQUISITES: Thermodynamics

COURSE OBJECTIVE: To provide the insights on the laws of thermodynamics and its relations, Kinetic theory of ideal gases, non-reactive gas and liquid reactive mixtures, exergy and irreversibility of thermal systems and advanced power cycles.

UNIT I

BASIC CONCEPTS: Thermodynamics - Temperature and Zeroth law of thermodynamics - First law of thermodynamics-Applications - Limitations of first law - Concept of internal energy - Second law of thermodynamics-Applications - concept of entropy-Third law of Thermodynamics.

THERMODYNAMIC RELATIONS: Introduction – Reciprocity and cyclic relations – The Maxwell's relations – The Gibbs and Helmholtz relations - The Clapeyron Equation –Applications, General relations for du, dh, ds - Fugacity Coefficient and Residual Gibbs Function, Thomson Coefficient and Inversion Curve, Thermodynamic similarity.

UNIT II

KINETIC THEORY OF AN IDEAL GAS: Kinetic theory of gases-introduction, basic assumption, molecular flux, equation of state for an ideal gas, collisions with a moving wall, principle of equipartition of energy, classical theory of specific heat capacity. Transport phenomena-intermolecular forces, The Van der Waals equation of state, collision cross section, mean free path.

UNIT III

NON-REACTIVE GAS AND LIQUID MIXTURES: Introduction - Basic definitions for gas mixtures - PVT relationship for mixtures of ideal gases - Properties of mixtures of ideal gases - Gas-Vapor Mixtures, Application of First Law to Psychometric Processes, Real Gas Mixtures.

LIQUID MIXTURES/SOLUTIONS: Ideal Solutions, Real Solutions.

THERMODYNAMIC RELATIONS FOR REAL MIXTURES: Partial Properties, Relations for Activity and Activity Coefficient in Real Liquid Mixtures/Solutions.

UNIT IV

EXERGY: Introduction - Quality of Energy - Available and Unavailable energy - Availability, Surroundings work- Reversible work -Availability function of the closed & open system - availability in a SSSF process in an open system - Applications.

IRREVERSIBILITY: Introduction - Irreversibility for closed and open system - Steady flow process – Effectiveness-Applications.

UNIT V

ADVANCED POWER CYCLES:

VAPOR POWER CYCLES: - Second law analysis of vapor power cycles, Cogeneration, Binary vapor cycles, combined gas vapor power cycles-Applications.

GAS POWER CYCLES: - Second law analysis of gas power cycles-Applications, Atkinson cycle, Lenoir cycle.

COURSE OUTCOMES:

After the completion of the course, students should be able to:

1. Apply the laws of thermodynamics and thermodynamic relations of gas mixtures.
2. Describe the concepts of kinetic theory applicable for ideal gases.
3. Analyse non-reactive gas and liquid mixtures using thermodynamic relations.
4. Apply energy balances to reacting systems for both closed and open system.
5. Analyse vapour and gas power cycles.

TEXT BOOKS:

1. PK Nag, Engineering Thermodynamics, Tata Mcgraw Hill, 6th Edition, 2017.
2. Rolf Haase, Thermodynamics of Irreversible Processes, Dover Publications, Rev. Edition, 2010.

REFERENCE BOOKS:

1. Moran, Shapiro, Boettner, Bailey, Principles of Engineering Thermodynamics, Wiley and sons, 8th Edition, 2015.
2. J. P .Holman, Thermodynamics, McGraw-Hill, 4th Edition, 1987.

III B.Tech. I - Semester

TRIBOLOGY

(Honors)

L	T	P	C
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COURSE OBJECTIVES:

- To explain the contact of solid surfaces and types of lubrication.
- To understand the genesis of friction, the theories/laws of sliding and rolling friction.
- To apply the principles and design procedures for hydrostatic bearings.
- To understand and analyze the principles of hydrodynamic and mixed/ boundary lubrication.
- To gain knowledge about the types of seals and failure of tribological components.

UNIT I

Introduction: Nature of surfaces and contact-Surface topography-friction and wear mechanisms, wear maps, effect of lubricants- methods of fluid film formation.

Lubrication: Choice of lubricants, types of oil, Grease and solid lubricants-additives- lubrication systems and their selection.

UNIT II

Selection of rolling element bearings: Nominal life, static and dynamic capacity-Equivalent load, probabilities of survival- cubic mean load- bearing mounting details, pre loading of bearings, conditioning monitoring using shock pulse method.

UNIT III

Hydrostatic Bearings: Thrust bearings – pad coefficients- restriction- optimum film thickness - journal bearings – design procedure –Aerostatic bearings; Thrust bearings and Journal bearings –design procedure.

UNIT IV

Hydrodynamic bearings: Fundamentals of fluid formation – Reynold's equation; Hydrodynamic journal bearings – Sommerfield number- performance parameters – optimum bearing with maximum load capacity – Friction – Heat generated and Heat dissipated. Hydrodynamic thrust bearings; Raimondi and Boyd solution for hydrodynamic thrust bearings- fixed tilting pads, single and multiple pad bearings-optimum condition with largest minimum film thickness.

UNIT V

Seals: Different type-mechanical seals, lip seals, packed glands, soft piston seals, Mechanical piston rod packing, labyrinth seals and throttling bushes, oil flinger rings and drain grooves – selection of mechanical seals.

Failure of Tribological components: Failure analysis of plain bearings, rolling bearings, gears and seals, wear analysis using soap and Ferrography.

Dry rubbing Bearings: porous metal bearings and oscillatory journal bearings – qualitative approach only.

COURSE OUTCOMES:

Students will be able to:

1. Learn the concepts of surface topography and types of lubrication.
2. Learn the genesis of friction, the theories/laws of sliding and rolling friction.
3. Apply the principles and design procedures for hydrostatic bearings.
4. Analyze the principles of hydrodynamic and mixed/ boundary lubrication.
5. Gain knowledge about the types of seals and failure of tribological components.

TEXT BOOKS:

1. Rowe WW& O' Dionoghue, Hydrostatic and Hybrid bearing design, Butterworths & Co.Publishers Ltd, 1983.
2. Collacott R. A, Mechanical Fault diagnosis and condition monitoring, Chapman and Hall, 1977.
3. Bernard J. Hamrock, Fundamentals of fluid film lubricant, McGraw-Hill Co., 1994.

REFERENCE BOOKS:

1. Neale MJ, Tribology hand Book, Neumann Butterworths, 1975.
2. Connor and Boyd JJO, Standard hand book of lubrication engineers, ASLE, McGraw Hill Book & Co.,1968.
3. Shigley J, E Charles, Mechanical Engineering Design, McGraw Hill Co., 1989.

III B.Tech. I - Semester

MICRO ELECTRO MECHANICAL SYSTEMS
(Honors)

L	T	P	C
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COURSE OBJECTIVES:

- To understand basics of Micro Electro Mechanical Systems (MEMS), mechanical sensors and actuators.
- To illustrate thermal sensors and actuators used in MEMS.
- To apply the principle and various devices of Micro-Opto-Electro Mechanical Systems (MOEMS), magnetic sensors and actuators.
- To analyze applications and considerations on micro fluidic systems.
- To illustrate the principles of chemical and bio medical micro systems.

UNIT I

INTRODUCTION: Definition of MEMS, MEMS history and development, micro machining, lithography principles & methods, structural and sacrificial materials, thin film deposition, impurity doping, etching, surface micro machining, wafer bonding, LIGA.

MECHANICAL SENSORS AND ACTUATORS: Principles of sensing and actuation: beam and cantilever, capacitive, piezo-electric, strain, pressure, flow, pressure measurement by micro phone, MEMS gyroscopes, shear mode piezo actuator, gripping piezo actuator, Inchworm technology.

UNIT II

THERMAL SENSORS AND ACTUATORS: Thermal energy basics and heat transfer processes, thermistors, thermo devices, thermo couple, micro machined thermo couple probe, Peltier effect heat pumps, thermal flow sensors, micro hot plate gas sensors, MEMS thermo vessels, pyro electricity, shape memory alloys (SMA), U-shaped horizontal and vertical electro thermal actuator, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever.

UNIT III

MICRO-OPTO-ELECTRO MECHANICAL SYSTEMS: Principle of MOEMS technology, properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device (DMD), light detectors, grating light valve (GLV), optical switch, wave guide and tuning, shear stress measurement.

MAGNETIC SENSORS AND ACTUATORS: Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive sensor, more on hall effect, magneto diodes, magneto transistor, MEMS magnetic sensor, pressure sensor utilizing MOKE, mag MEMS actuators, by directional micro actuator, feedback circuit integrated magnetic actuator, large force reluctance actuator, magnetic probe based storage device.

UNIT IV

MICRO FLUIDIC SYSTEMS: Applications, considerations on micro scale fluid, fluid actuation methods, dielectro-phoresis (DEP), electro wetting, electro thermal flow, thermo capillary effect, electro osmosis flow, opto electro wetting (OEW), tuning using micro fluidics, typical micro fluidic channel, micro fluid dispenser, micro needle, molecular gate, micro pumps.

RADIO FREQUENCY (RF) MEMS: RF — based communication systems, RF MEMS, MEMS inductors, tuner/filter, resonator, clarification of tuner, filter, resonator, MEMS switches, phase shifter.

UNIT V

CHEMICAL AND BIO MEDICAL MICRO SYSTEMS: Sensing mechanism & principle, membrane-transducer materials, chem.-lab-on-a-chip (CLOC) chemo-resistors, chemo-capacitors, chemo-transistors, electronic nose (E-nose), mass sensitive chemo-sensors, fluorescence detection, calorimetric spectroscopy.

COURSE OUTCOMES:

Upon successful completion of this course, the students will be able to:

1. To understand basics of Micro Electro Mechanical Systems (MEMS), mechanical sensors and actuators.
2. Illustrate thermal sensors and actuators used in MEMS.
3. To apply the principle and various devices of Micro-Opto-Electro Mechanical Systems (MOEMS), magnetic sensors and actuators.
4. Analyze applications and considerations on micro fluidic systems.
5. Illustrate the principles of chemical and bio medical micro systems.

TEXT BOOKS:

1. Nitaigour Premchand Mahalik, MEMS, TMH, 1st Edition, 2009.
2. Chang Liu, Foundation of MEMS, Prentice Hall Ltd., 2nd Edition, 2011.

REFERENCE BOOKS:

1. Tai-Ran Hsu, MEMS and Micro Systems: Design and Manufacture, TMH Publishers, 1st Edition, 2017.
2. Thomas M Adams, Richard A Layton, Introductory MEMS, Springer International Publishers, Rev. Edition, 2010.

III B. Tech. I - Semester

MECHANICS OF COMPOSITES

(Honor)

L	T	P	C
4	0	0	4

PREREQUISITES: Mechanics of Solids

COURSE OBJECTIVES:

- To understand about the composite materials and their classification.
- To illustrate micro mechanical analysis of a lamina.
- To gain knowledge about the two-dimensional angle lamina.
- To illustrate macro mechanical analysis of a lamina.
- To gain knowledge in designing the laminates.

UNIT I

INTRODUCTION TO COMPOSITES: Composites, materials- matrix and reinforcement, Particulate composites, rule of mixtures, classification of composites, Applications.

UNIT II

MICRO MECHANICAL ANALYSIS OF A LAMINA: Introduction, Volume and Mass Fractions, Density, and Void Content, Evaluation of the Four Elastic Moduli, Strength of Materials Approach, Semi-Empirical Models Elasticity Approach, Elastic Moduli of Lamina with Transversely Isotropic Fibers, Ultimate Strengths of a Unidirectional Lamina, Coefficients of Thermal Expansion, Coefficients of Moisture Expansion.

UNIT III

HOOKE'S LAW FOR A TWO-DIMENSIONAL ANGLE LAMINA: Engineering Constants of an Angle Lamina, Invariant form of Stiffness and Compliance Matrices for an Angle Lamina Strength Hygro-thermal Stresses and Strains in a Lamina: Hygro-thermal Stress-Strain relationships for a Unidirectional Lamina, Hygro-thermal Stress-Strain Relationships for an Angle Lamina.

UNIT IV

MACRO MECHANICAL ANALYSIS OF A LAMINA: Introduction, Definitions: Stress, Strain, Elastic Moduli, Strain Energy. Hooke's Law for Different Types of Materials, Hooke's Law for a Two-Dimensional Unidirectional Lamina, Plane Stress Assumption, Reduction of Hooke's Law in Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina, Laminate Code, Stress-Strain Relations for a Laminate.

UNIT V

DESIGN OF LAMINATES: Introduction, thin plate theory, especially orthotropic plate, cross and angle ply laminated plates, problems using thin plate theory, Failure theories, Design of Laminated Composites.

COURSE OUTCOMES:

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

1) Discuss the composite materials and their classification.
2) Apply the micro mechanical analysis of a lamina.
3) Learn about two-dimensional angle lamina.
4) Apply the macro mechanical analysis of a lamina.
5) Utilize knowledge in designing the laminates.

TEXT BOOKS:

1) Isaac and M Daniel, Engineering Mechanics of Composite Materials, Oxford University Press, 2nd Edition, 2005.
2) Madhujit Mukhop, Mechanics of Composite Materials & Structures, Universities Press, 2004.
3) Autar K. Kaw, Mechanics of Composite Materials, Second Edition, CRC press, 2005.

REFERENCES:

1) R. M. Jones, Mechanics of Composite Materials, Mc Graw Hill Company, New York, 1998.
2) L. R. Calcote, Analysis of Laminated Composite Structures, Van Nostrand Rainfold, New York, 1970.
3) B. D. Agarwal and L. J. Broutman, Analysis and performance of fiber Composites, Wiley Inter science, New York, 3rd Edition, 2006.

III B.Tech. I - Semester

FUEL CELL TECHNOLOGY
(Honors)

L	T	P	C
4	0	0	4

PRE-REQUISITES: Thermodynamics and Chemistry

COURSE OBJECTIVE:

To know details of fuel cell technology, in particular the opportunities for using hydrogen.

UNIT I

HYDROGEN ENERGY ECONOMY: Hydrogen Energy Economy – Conception, Present status and a vision – Applications of Hydrogen - Transport application-cars, light trucks, buses - Stationary and Portable Electronic gadgets.

UNIT II

HYDROGEN PRODUCTION TECHNIQUES: Hydrogen – Physical and chemical properties, salient characteristics - Production of hydrogen – Steam reforming – Water electrolysis –Gasification and woody biomass conversion – Biological hydrogen production – Photo dissociation – Direct thermal or catalytic splitting of water.

UNIT III

HYDROGEN STORAGE: Hydrogen storage options – Compressed gas – Liquid hydrogen method– Hydride storage method– Chemical Storage – Comparisons.

HYDROGEN TRANSPORT: Introduction basic Components, Types of transport system, Applications, Transport of Hydrogen - Pipelines, gaseous, liquid and compound materials.

UNIT IV

FUEL CELLS: History – Principle - Working - Thermodynamics and kinetics of fuel cell process – Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – Relative merits and demerits - Performance evaluation of fuel cell – Comparison of battery Vs fuel cell – Flow Battery.

UNIT V

APPLICATION OF FUEL CELL: Fuel cell usage for domestic power systems - Large scale power generation – Automobile - Space - Environmental analysis of usage of Hydrogen in Fuel cell - Future trends in fuel cells.

COURSE OUTCOMES: After the completion of the course students are able to:

1. Describe the hydrogen energy storage system and its applications.
2. Understand the production techniques of hydrogen.
3. Comprehend the hydrogen storage and transport systems.
4. Compare the performance characteristics of different fuel cells.
5. Compute the power generation capacity of a fuel cell.

TEXT BOOKS:

1. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma, 2005.
2. Viswanathan, B and M Aulice Scibioh, Fuel Cells – Principles and Applications, Universities Press, 2006.

REFERENCE BOOKS:

1. Bent Sorensen, Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier, 2005.

III B.Tech. II - Semester

CNC MACHINES

(Honors)

L	T	P	C
4	0	0	4

COURSE OBJECTIVES:

The main objective of the course is

- Understand the construction and working of the modern CNC machine tools.
- Know the various drives and positional transducers used in CNC machines.
- should be able to develop the complex programs using either manual or computer aided part programming methods.
- Gain the knowledge on different tool & work holding devices used in CNC machines.

UNIT I

INTRODUCTION TO CNC MACHINE TOOLS:

Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines - turning centre, machining centre, grinding machine, EDM, types of control systems, CNC controllers, characteristics, interpolators- Computer Aided Inspection.

UNIT II

STRUCTURE OF CNC MACHINE TOOL:

CNC Machine building, structural details, configuration and design, guide ways- Friction, Anti friction and other types of guide ways, elements used to convert the rotary motion to a linear motion - Screw and nut, recirculating ball screw, planetary roller screw, recirculating roller screw, rack and pinion, spindle assembly, torque transmission elements - gears, timing belts, flexible couplings, Bearings.

UNIT III

DRIVES AND CONTROLS:

Spindle drives - DC shunt motor, 3 phase AC induction motor, feed drives - stepper motor, servo principle, DC and AC servomotors. Open loop and closed loop control, Axis measuring system - synchrony, synchrony-resolver, gratings, moiré fringe gratings. encoders, inductosysn. laser interferometer.

UNIT IV

CNC PROGRAMMING:

Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming, machining cycles, programming for machining centre and turning centre for well-known controllers such as Fanuc, Heidenhain, Sinumerik etc.. generation of CNC codes from CAM packages.

UNIT V

TOOLING AND WORK HOLDING DEVICES:

Introduction to cutting tool materials Carbides, Ceramics, CBN, PCD-inserts classification PMK, NSH, qualified, semi qualified and preset tooling, tooling system for Machining centre and Turning centre, work holding devices for rotating and fixed work parts, economics of CNC. maintenance of CNC machines.

COURSE OUTCOMES:

After completion of this course the students are expected to be able to:

1. Understand evolution and principle of CNC machine tools.
2. Describe constructional features of CNC machine tools.
3. Explain drives and positional transducers used in CNC machine.
4. Write simple programs for CNC turning and machining centers tools.
5. Describe tooling and work holding devices for CNC machine tools.

TEXT BOOKS:

1. Radhakrishnan P, Computer Numerical Control Machines, New Central Book Agency, 2nd Edition, 2014.
2. Rao P. N, CAD/CAM, Tata McGraw-Hill Publishing Company Limited, 1st Edition, 2002.
3. Warren Seamers, Computer Numeric Control, Thomson Delmar, 4th Edition, 2002.

REFERENCE BOOKS:

1. Ken Evans, John Polywka & Stanley Gabrel, Programming of CNC Machines, Industrial Press Inc, 2nd Edition, 2002.
2. Berry Leathan-Jones, "Introduction to Computer Numerical Control, Pitman, London, 1987.
3. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Limited, New Delhi.

III B.Tech. II - Semester

MATERIALS CHARACTERIZATION TECHNIQUES

(Honors)

L	T	P	C
4	0	0	4

COURSE OBJECTIVES:

- To understand the various structure analysis tools like X-ray diffraction.
- To apply the microscopy techniques for materials characterization.
- To understand the concepts of thermal analysis techniques.
- To learn about the magnetic characterization techniques.
- To illustrate optical and electronic characterization techniques.

UNIT I

INTRODUCTION TO MATERIALS AND TECHNIQUES: Structure analysis tools: X-ray diffraction: phase identification, indexing and lattice parameter determination, Analytical line profile fitting using various models, Neutron diffraction, Reflection High Energy Electron Diffraction, and Low Energy Electron Diffraction.

UNIT II

MICROSCOPY TECHNIQUES: Optical microscopy, analysis transmission electron microscopy (TEM), energy dispersive X-ray microanalysis (EDS), scanning electron microscopy (SEM), atomic force microscopy (AFM) and scanning probe microscopy (SPM), quantitative metallography.

UNIT III

THERMAL ANALYSIS TECHNIQUES: Differential thermal analysis (DTA), Differential Scanning Calorimeter (DSC), Thermo gravimetric analysis (TGA); Electrical characterization techniques: Electrical resistivity, Hall effect, Magneto resistance.

UNIT IV

MAGNETIC CHARACTERIZATION TECHNIQUES: Introduction to Magnetism, Measurement Methods, Measuring Magnetization by Force, Measuring Magnetization by Induction method, Types of measurements using magnetometers: M-H loop, temperature dependent magnetization, time dependent magnetization, Measurements using AC susceptibility, Magneto-optical Kerr effect, Nuclear Magnetic Resonance, Electron Spin Resonance.

UNIT V

OPTICAL AND ELECTRONIC CHARACTERIZATION TECHNIQUES: UV-VIS spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy, X-ray photoelectron spectroscopy.

COURSE OUTCOMES:

Upon successful completion of this course, the students will be able to:

1. Understand the various structure analysis tools.
2. Apply microscopic techniques for material characterization.
3. Learn about thermal analysis techniques.
4. Understand magnetic characterization techniques.
5. Learn about optical and electronic characterization techniques.

TEXT BOOKS:

1. R.W. Cahn, P. Haasen and E.J. Kramer, Characterization of Materials (Materials Science and Technology: A Comprehensive Treatment, Vol 2A & 2B, Wiley – VCH, 1994.
2. D. K. Schroder, Semiconductor Material and Device Characterization, Wiley, 3rd Edition, 2006.
3. S Zhang, L. Li and Ashok Kumar, Materials Characterization Techniques, CRC Press, 1st Edition, 2008.

REFERENCE BOOKS:

1. P. E. J.Flewitt and R K Wild, Physical methods for Materials Characterization, IOP publishing, 3rd Edition, 2003.
2. Ed. Z L Wang, Characterization of nano-phase materials, Willet-VCH, 1st Edition, 2000.

III B.Tech. II - Semester

EXPERIMENTAL STRESS ANALYSIS

(Honors)

L	T	P	C
4	0	0	4

COURSE OBJECTIVES:

To expose the students to the following:

- Demonstrates principles of experimental approach.
- Measure displacement and perform stress strain analysis of mechanical systems using electrical resistance strain gauges.
- Describe the photo elastic method to study and characterize the elastic behavior of solid bodies.
- Determine stress strain behavior of solid bodies using methods of coating.

UNIT I

PRINCIPLES OF EXPERIMENTAL APPROACH: Merits of Experimental Analysis Introduction, uses of experimental stress analysis advantages of experimental stress analysis, Different methods –Simplification of problems.

UNIT II

STRAIN MEASUREMENT USING STRAIN GAUGES: Definition of strain and its relation of experimental Determinations Properties of Strain Gauge Systems-Types of Strain Gauges –Mechanical, Acoustic and Optical Strain Gauges. Introduction to Electrical strain gauges -Inductance strain gauges –LVDT –Resistance strain gauges –various types –Gauge factor –Materials of adhesion base.

UNIT III

THEORY OF PHOTOELASTICITY: Introduction –Temporary Double refraction –The stress Optic Law –Effects of stressed model in a polariscope for various arrangements –Fringe Sharpening. Brewster‟s Stress Optic law.

UNIT IV

TWO-DIMENSIONAL PHOTOELASTICITY: Introduction –Iso-chromatic Fringe Patterns-Isoclinic Fringe patterns passage of light through plane Polariscope and Circular polariscope Isoclinic Fringe patterns –Compensation techniques –Calibration methods –Separation methods –Scaling Model to prototype Stresses –Materials for photo –Elasticity Properties of Photo elastic Materials.

UNIT V

BRITTLE COATINGS: Introduction, coating stresses, failure theories, brittle coating crack patterns, crack detection, ceramic based brittle coatings, resin based brittle coatings, test procedures for brittle coatings analysis, calibration procedures, analysis of brittle coating data. Moire Methods: Introduction, mechanism of formation of Moire fringes, the geometrical approach to Moire-Fringe analysis, the displacement field approach to Moire-Fringe analysis, out of plane displacement measurements, out of plane slope measurements, sharpening and multiplication of Moire-Fringes, experimental procedure and techniques.

COURSE OUTCOMES:

After successful completion of course the student should be able to

1. Understand different methods of experimental stress analysis.
2. Understand the use of strain gauges for measurement of strain.
3. Understand the theory of photo elasticity and its applications in analysis of structures.
4. Describe various coating techniques.

TEXT BOOK:

1. JW Dally and WF Riley, Experimental Stress Analysis, McGrawHill Publications, 3rd Edition, 1991.
2. CC Perry and HR Lissner, The Strain Gage Primer, McGrawHill, 2000.

REFERENCES:

1. Abdul Mubeen, Experimental Stress Analysis, DhanpatRai and Sons, 2001.
2. PS Theocaris, Moire Fringes in Strain Analysis, Pergammon Press, 2002.

III B.Tech. II - Semester

ELECTRIC & HYBRID VEHICLES

(Honors)

L	T	P	C
4	0	0	4

COURSE OBJECTIVES:

- Understand electric vehicle & HEV for various applications.
- Have knowledge about the electric vehicle system and its parameters.
- Learn about EV motor drives.
- Understand the concepts of HEV.
- Learn about the energy sources, battery chargers and charging infrastructure.

UNIT I

Introduction to EV & HEV: Past, Present & Feature of EV, Current Major Issues, Recent

Development Trends, EV Concept, Key EV Technology, State-of-the Art EVs & HEVs,

Comparison of EV Vs IC Engine.

UNIT II

EV System: EV Configuration: Fixed & variable gearing, single & multiple motor drives, In-wheel drives.

EV Parameters: Weight, size, force, energy & performance parameters.

UNIT III

EV Motor Drive:

DC Motor: Type of wound-field DC Motor, Torque speed characteristics, DC-DC Converter, Two quadrant DC Chopper, two quadrant zero voltage transition converter-fed dc motor drive, speed control of DC Motor.

Induction Motor Drive: Three Phase Inverter Based Induction Motor Drive, Equal Area PWM, Three Phase Auxiliary resonant snubber (ARS) Inverter Type (ZVC & ZCS), Single Phase ARS Inverter Topology, Speed Control of Induction Motor, FOC, Adaptive Control, Model Reference Adaptive Control (MARS), Sliding mode Control.

UNIT IV

HEV: HEV, Energy Sources & Charging HEV: Configuration of HEV (Series, Parallel, Seriesparallel &Complex), Power Flow control, Examples. Power flow control in all HEV configurations, Examples of HEV system performance.

UNIT V

Energy Sources: Different Batteries, Battery characteristics (Discharging & Charging).

Battery Chargers: Conductive (Basic charger circuits, Microprocessor based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods.

Charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.

COURSE OUTCOMES:

1. Understand electric vehicle & HEV for various applications.
2. Have knowledge about the electric vehicle system and its parameters.
3. Learn about EV motor drives.
4. Understand the concepts of HEV.
5. Learn about the energy sources, battery chargers and charging infrastructure.

TEXT BOOKS:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2nd Edition, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology, Wiley publications, 1st Edition, 2003.

REFERENCE BOOKS:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. Seth Leitman, Build Your Own Electric Vehicle, MC Graw Hill, 1st Edition, 2013.

IV B.Tech. I - Semester

MICRO MANUFACTURING

(Honor)

L	T	P	C
4	0	0	4

COURSE OBJECTIVE:

Principle of mechanics of manufacturing in macro and micro are entirely different. Materials change behaviour if processed at micro level. The present course based on the mechanical/chemical behaviour changes during micromachining/manufacturing. Therefore, tool based micro machining and unconventional micromachining processes have been explored.

UNIT I

Introduction and classification of micromachining; Mechanical type micro machining processes: Abrasive jet micromachining (AJMM), Ultrasonic micromachining, abrasive water jet micro machining (AWJMM).

UNIT II

Chemical and electrochemical type advanced machining processes: Electrochemical micromachining (EDMM), electrochemical micro deburring, Chemical and photochemical micromachining.

UNIT III

Thermo electric type micro-machining process: Electric discharge micromachining (EDMM), wire EDM, EDDG, ELID, Laser beam micro machining (LBMM), Electron beam micromachining (EBMM).

UNIT IV

Micro Forming; Micro and Nano structured surface development by Nano plastic forming and Roller Imprinting, Micro Extrusion. Micro bending with LASER. LASER micro welding, Electron beam for micro welding.

UNIT V

Magnetorheological finishing (MRF), Magnetorheological abrasive flow finishing (MRAFF), Magnetic float polishing (MFP), Chemo-mechanical polishing (CMP), Applications of micromachining in industry.

COURSE OUTCOMES:

Upon successful completion of this course, students will:

1. Acquired knowledge about different micro-machining processes.
2. Select and apply various advanced micro-manufacturing processes as per the desired quality of the product.
3. Understand the process of Micro-fabrication, forming and micro welding.
4. Acquired knowledge about super finishing processes and Applications of Micromachining.

TEXT BOOKS:

1. VK Jain, Introduction to micromachining, Narosa Publisher, 2nd Edition, 2019.
2. J. Paulo Davim and Mark J. Jackson, Nano and Micromachining, Wiley Publication, 1st Edition, 2008.

REFERENCE BOOKS:

1. JA Mc Geough, Micromachining of Engineering Materials, CRC Pres, 1st Edition, 2002.
2. VK Jain, Micro manufacturing processes, CRC Press, 1st Edition, 2017.
3. VK Jain, Advanced machining processes, Allied Publisher, 2nd Edition, 2009.

IV B.Tech. I - Semester

ADVANCE METROLOGY AND SENSING SYSTEMS

(Honors)

L	T	P	C
4	0	0	4

COURSE OBJECTIVES:

- Understanding Basic Measurement Systems in real time engineering applications.
- Enables students to work in Quality Control and assurance industries.
- To make the students capable of learning to operate and use advanced metrological devices with ease in industrial environments.

UNIT I

Computer Aided Metrology

High precision measurements – interfacing – software metrology – Automated visual inspection in manufacturing, contact and non – contact type inspection methods, Electrical field techniques, radiation techniques, ultrasonic – Atomic Force Microscopes (AFM), Talysurf instruments.

Measurement Of Surface Roughness

Definitions – Types of Surface Texture: Surface Roughness Measurement Methods Comparison, Contact and Non Contact type roughness measuring devices, 3D Surface Roughness Measurement, Nano Level Surface Roughness Measurement – Instruments.

UNIT II

Image Processing For Metrology

Overview, Computer imaging systems, Image Analysis, Preprocessing, Human vision system, Image model, Image enhancement, gray scale models, histogram models, Image Transforms - Examples.

UNIT III

MEASURING MACHINES AND LASER METROLOGY

Tool Makers Microscope – Coordinate Measuring Machines – Applications – Laser Metrology: Laser Interferometer, Alignment Telescope, laser scanners. On-line and in – process measurements – diameter, surface roughness, Micro holes, surface topography measurements, straightness and flatness measurement, speckle measurements.

UNIT IV

Sensing Systems

Edge detection techniques, Normalization, Grey scale correlation – Reflectance map concepts; surface roughness and texture characterization – photogrammetric. Application of Machine Vision in inspection – Measurement of length, diameters, and Surface roughness – automated visual inspection – 3D and dynamic feature extraction.

UNIT V

Machine Vision: Image Acquisition and Processing – Binary and gray level images, image segmentation and labeling, representation and interpretation of colours.

On-line Quality control: On-line feedback quality control, variable characteristics – control with measurement interval, one unit, and multiple units control systems for lot and batch production.

COURSE OUTCOMES:

Students will be able to:

1. Illustrate the fundamentals of computer aided metrology.
2. Understand the fundamentals of various methods for the image processing for metrology.
3. Learn the methods of measuring machines and laser metrology.
4. Understand the fundamentals of various sensing systems and measurements.
5. Analyze the process machine vision systems and quality control techniques for manufacturing field.

TEXT BOOKS:

1. Nello Zuech, Understanding and Applying Machine Vision, Marcel Dekker Inc., 2nd Edition, 2000.
2. Marshall A. D. and Martin R. R, Computer Vision, Models and Inspection, World Scientific, 1998.
3. John A. Bosch, Giddings, and Lewis Dayton, Coordinate Measuring Machines and Systems, Marcel Dekker Inc., 1st Edition, 1995.

REFERENCE BOOKS:

1. Gupta, I C, A Text Book of Engineering Metrology, Dhanpat Rai Publication, 8th Edition, 2016.
2. Narayana, K L, Engineering Metrology, Scitech Publication(India) Privet Limited, 3rd Edition, 2014.

IV B.Tech. I - Semester

PRODUCT DESIGN

(Honors)

L	T	P	C
4	0	0	4

COURSE OBJECTIVES:

Course Objectives:

- To understand the basic concepts of product design process.
- To interpret the operations of product management and impact of manufacturing processes.
- on product decisions.
- To understand concepts of risks and reliability.
- To interpret the various testing procedure of the product design.
- To understand the concepts of maintainability.

UNIT I

Product Design Process: Design Process Steps, Morphology of Design. Problem Solving and Decision Making: Problem-Solving Process, Creative Problem Solving, Invention, Brainstorming, Morphological Analysis, Behavioral Aspects of Decision Making, Decision Theory, Decision Matrix, Decision Trees. Modelling and Simulation: Triz, Role of Models in Engineering Design, Mathematical Modelling, Similitude and Scale Models, Computer Simulation, Geometric Modelling on Computer, Finite-Element Analysis.

UNIT II

Product management: The operation of product management: Customer focus of product management, product planning process, Levels of strategic planning, Wedge analysis, Opportunity search, Product life cycle Life cycle theory and practice.

Product development: Managing new products, Generating ideas, Sources of product innovation, selecting the best ideas, the political dimension of product design, Managing the product launch and customer feedback.

Product managers and manufacturing: The need for effective relationships, The impact of manufacturing processes on product decisions, Prototype planning,, Productivity potentials, Management of product quality, Customer service levels.

UNIT III

Risk and Reliability: Risk and Society, Hazard Analysis, Fault Tree Analysis. Failure Analysis and Quality: Causes of Failures, Failure Modes, Failure Mode and Effect Analysis, FMEA Procedure, Classification of Severity, Computation of Criticality Index, Determination of Corrective Action, Sources of Information, Copyright and Copying. Patent Literature.

UNIT IV

Product Testing; Thermal, vibration, electrical, and combined environments, temperature testing, vibration testing, test effectiveness. Accelerated testing and data analysis, accelerated factors. Weibull probability plotting, testing with censored data.

UNIT V

Design For Maintainability: Maintenance Concepts and Procedures, Component Reliability, Maintainability and Availability, Fault Isolation in design and Self-Diagnostics. Product Design for Safety, Product Safety and User Safety Concepts, Examples of Safe Designs. Design Standardization and Cost Reduction: Standardization Methodology, Benefits of Product Standardization; International, National, Association and Company Level Standards; Parts Modularization.

COURSE OUTCOMES: At the end of the course, student will be able to

1. Understand the basic concepts of product design process.
2. Identify the operations of product management and impact of manufacturing processes on product decisions.
3. Understand concepts of risks and reliability of the products design.
4. Interpret the various testing procedure of the product design.
5. Illustrate the concepts of maintainability.

TEXT BOOKS:

1. George E. Dieter, Linda C. Schmidt, Engineering Design, McGraw-Hill, 5th Edition, 2012.
2. John W. Evans and Jillian Y. Evans, Product Integrity and Reliability in Design, Springer, 2001.

REFERENCE BOOKS:

1. Richard S. Handscombe, The Product Management Handbook, McGraw-Hill, 1988.
2. Kevin Otto, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson, 1st Edition, 2001.

IV B.Tech. I - Semester

VEHICLE DYNAMICS

(Honors)

L	T	P	C
4	0	0	4

COURSE OBJECTIVES:

- Understand the dynamics of the automotive systems and its performance parameters.
- Identify the driving/ braking resistances and their influences on vehicle dynamics.
- To analyze dynamics systems such as suspension systems, body vibrations, steering
  mechanisms.
- To Understand the vehicle aerodynamics and its effects on vehicle performance.
- To identify, formulate, and solve engineering problems related to vehicle dynamics.

UNIT I

INTRODUCTION: History of road and off road vehicle system dynamics - dynamics of the motor vehicle, coordinate systems- vehicle fixed coordinates system, details of vehicle systems, wheel angles, typical data of vehicles. Fundamental approaches to vehicle dynamics modeling lumped mass, vehicle fixed coordinate system, motion variables, earth fixed coordinate system, SAE coordinate system, Euler angles, forces, Newton's second law. Definitions-modeling and simulation of dynamic behaviour of vehicle., motion analysis, force analysis, and energy analysis.

UNIT II

LONGITUDINAL DYNAMICS: Introduction to longitudinal dynamics - Performance of road vehicles: forces and moments on vehicle, equation of motion, tire forces, rolling resistance, weight distribution, tractive effort/tractive resistance and power available from the engine/ power required for propulsion, road performance curves- acceleration, grade ability, drawbar pull and the problems related to these terms. Calculation of maximum acceleration braking torque, braking force, brake proportioning, braking efficiency, stopping distance, load distribution (three wheeled and four wheeled vehicles), calculation of acceleration, tractive effort and reactions for different drives, Stability of a vehicle on slope, (Problems related to these).

UNIT III

LATERAL DYNAMICS: Introduction to lateral dynamics - Steering geometry, types of steering systems, fundamental condition for true rolling, development of lateral forces. slip angle, cornering force, cornering stiffness, pneumatic trail, self aligning torque, power consumed by tire, tire stiffness, hysteresis effect in tires, steady state handling characteristics. yaw velocity, lateral acceleration, curvature response & directional stability.

Stability of a vehicle on a curved track and a banked road. gyroscopic effects, weight transfer during acceleration, cornering and braking, stability of a rigid vehicle and equations of motion of a rigid vehicle, cross wind handling, the problems related to these terms.

UNIT IV

VERTICAL DYNAMICS: Introduction to vertical dynamics - Human response to vibrations, classification of vibration, specification and vibration, sources of vibration, suspension systems, Modal Analysis, One DOF, two DOF, free and forced vibration, damped vibration, magnification and transmissibility, vibration absorber, functions of suspension system. body vibrations: bouncing and pitching. doubly conjugate points (only basic idea). body rolling. roll center and roll axis, roll axis and the vehicle under the action of side forces, stability against body rolling.

Vehicle dynamics and suspension design for stability, choice of suspension spring rate, chassis springs and theory of chassis springs, gas & hydraulic dampers and choice of damper, damper characteristics, mechanics of an independent suspension system. Design and analysis of passive, semi-active and active suspension using quarter car, half car and full car model.

UNIT V

VEHICLE AERODYNAMIC AND DYNAMIC CONTROL SYSTEM: Road Loads: Air resistance-Mechanics of air flow around a vehicle, pressure distribution on a vehicle, factors affecting rolling resistance, aerodynamic forces – aerodynamic drag, drag components, drag coefficient, aerodynamic aids, aerodynamic side force, lift force, pitching moment, yawing moment, rolling moment, cross wind sensitivity.

Vehicle dynamic Control, modelling of actuators, sensors for automobile control, sensors for detecting vehicle environment, central tyre inflation system. Prediction of vehicle performance. ABS, stability control, traction control.

COURSE OUTCOMES:

Student able to

1. Understand the vehicle system dynamics.
2. Evaluate the driving/ braking resistances and their influences on vehicle dynamics.
3. Identify and analyse the dynamics systems such as suspension systems, body vibrations, steering mechanisms.
4. Analyse and solve engineering problems related to vehicle dynamics.
5. Comparing and identifying the different types of control systems in automobiles.

TEXT BOOKS:

1. Rajesh Rajamani, Vehicle Dynamics and Control, Springer, 1st Edition, 2005.
2. Singiresu S. Rao, Mechanical Vibrations, Prentice Hall, 5th Edition, 2010.

REFERENCE BOOKS:

1. J. Y. Woung, Theory of Ground Vehicles, John Willey & Sons, 4th Edition, 2008.
2. Rajesh Rajamani, Vehicle dynamics and control, Springer, 2nd Edition, 2012.