MATERIAL SCIENCE AND METALLURGY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	15AU32	Exam Marks	80
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Credits	04
IA Marks	20		

Course objectives:

The objectives of this course are to make students:

1. To gain knowledge of different material crystal structures, arrangement of atoms and mechanical properties.
2. To know different types of fractures and their importance.
3. To draw TTT curves and Iron carbon diagrams
4. To select various non-ferrous metals and alloys based on composition and properties for a given application
5. To describe various types of composite materials, explain various manufacturing methods of composites and identify the engineering application.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Crystal Structure: BCC, FCC and HCP Structures, coordination number and atomic packing factors, crystal imperfections –point, line and surface imperfections. Atomic Diffusion: Phenomenon, Flick's laws of diffusion, factors affecting diffusion. **Mechanical Behavior**: Stress-strain diagram for ductile and brittle materials, True stress and true strain, linear and non linear elastic behavior and properties, mechanical properties in plastic range, yield strength, offset yield strength, ductility, ultimate tensile strength, and toughness. Plastic deformation of single crystal by slip and twinning.	10 Hours	L1, L2
Module -2		
Fracture: Type I, Type II and Type III. **Creep:** Description of the phenomenon with examples, three stages of creep, creep properties, stress relaxation. **Fatigue:** Types of fatigue loading with examples, Mechanism of fatigue,	10 Hours	L1, L2

fatigue properties, fatigue testing and S-N diagram.		
Module -3		
Solidification and Solid Solutions: Mechanism of solidification, Homogenous and Heterogeneous nucleation, crystal growth, cast metal structures, solid solutions- types and rules governing the formation of solid solutions. **Phase Diagram:** Basic terms, phase rule, lever rule, cooling curves, construction and interpretation of different phase diagrams (eutectic, eutectoid, peritectic and peritectoid)	10 Hours	L1, L2, L3
Module -4		
Heat Treatment of Metals: TTT curves, continuous cooling curves, annealing and its types. normalizing, hardening, tempering, martempering, austempering, hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flarne hardening and induction hardening, age hardening of Aluminium-copper alloys. **Ferrous Materials**: Properties, Composition and uses of Grey cast iron, malleable iron, S.G iron and steel **Non Ferrous Metals:** Copper alloys-brasses and bronzes. Aluminum alloys-Al-Cu, Al-Si, Al-Zn alloys.	10 Hours	L1, L2, L3, L4
Module -5		
Composite Materials: Definition, classification, types of matrix materials & reinforcements, fundamentals of production of FRP' and MMC's advantages and application of composites. **Other Materials:** Brief description of other materials such as optical and thermal materials Smart materials – fiber optic materials, piezo-electrics, shape memory alloys Shape Memory Alloys – Nitinol, superelasticity, Biological applications of smart materials - materials used as implants in human Body, Selection of Materials, Performance of materials in service Residual life assessment – use of non-destructive testing, Economics, Environment and Sustainability.	10 Hours	L2, L3

Course outcomes:

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

1. Explain different types of material crystal structures and arrangement of atoms.
2. Describe various mechanical properties of materials.
3. Describe about different types of fractures and their importance in engineering applications.
4. Explain the concept of equilibrium diagram.
5. Plot cooling curves and phase diagrams for pure metals and alloys.
6. Draw and Interpret TTT curves and Iron carbon diagram.
7. Explain various heat treatment processes and their importance in engineering field.
8. Identify various ferrous metals and alloys based on composition and properties for prescribed application .
9. Select various nonferrous metals and alloys based on composition and properties for given application.

10. Describe about different types of composite materials and their production and application in engineering field.

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).

Question paper pattern:

- The question paper will have ten questions.
- Each full question carries 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. Smith, **Foundations of Materials Science and Engineering**, 3rd Edition McGraw Hill, 2009
2. Shackleford., & M. K. Muralidhara, **Materials Science**, Pearson Publication – 2007.

Reference Books:

1. Alan Cottrell, **An introduction to Metallurg**y, University Press India Oriental Longman Pvt. Ltd., 1974.
2. V.Raghavan, **Materials Science and Engineering**, PHI, 2002
3. H. VanVlack, **Elements of Materials Science and Engineering,** Addison- Wesley Edn., 1998
4. William D. Callister Jr., **Materials Science and Engineering**, John Wiley & Sons. Inc, 5th Edition, 2001.
5. Donald R. Askland and Pradeep.P. Phule, **The Science and Engineering of Materials**, Thompson Learning, 4lh Ed., 2003.

ENGINEERING THERMODYNAMICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	15AU33	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Number of Tutorial Hours/Week	02	Exam Hours	03
Total Number of Lecture Hours	50	Credits	04

Course objectives:

The objectives of this course are to make students:

1. To define work, heat, and laws of thermodynamics.
2. To explain the concept of entropy
3. To calculate load and IHP, BHP of IC engines
4. To evaluate thermal performance of refrigeration cycles
5. To demonstrate the calculation of efficiency of gas power and vapor power cycles
6. To design cost effective thermodynamic systems

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Fundamentals of Thermodynamics: Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Thermodynamic properties; definition and units, intensive, extensive properties, specific properties, pressure, specific volume, Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics, Temperature; concepts, scales, international fixed points and measurement of temperature. Constant volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer **Work and Heat:** Thermodynamic definition of work; examples, sign convention, Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention.	10 Hours	L1, L2
Module -2		
Laws of Thermodynamics and Entropy Joules experiments, Statement of the First law of thermodynamics, steady state-steady flow energy equation, important applications, analysis of unsteady processes such as filling and evacuation of vessels	10 Hours	L1, L2

with and without heat transfer. Keivin –Planck & Clasius statement of Second law of Thermodynamics, PMM II and PMM I. Clasius Theorem & inequality, Entropy; definition, a property, Available and unavailable energy, Numericals.		
Module -3		
Combustion Thermodynamics, Gas power cycles and Testing of IC Engines: Air Fuel (A/F) ratio, Excess air, Theoretical (Stoichiometeric) air for combustion of fuels, Exhaust gas analysis , Otto, Diesel, Dual Cycles, efficiencies and mean effective pressures, Testing of two stroke and four stroke SI and CI engines for performance Related numerical problems, heat balance sheet, Morse test, Willian line test and Motoring Test.	10 Hours	L1, L2, L3
Module -4		
Refrigeration and Psychrometry Vapor absorption refrigeration system, steam jet refrigeration, vapor compression refrigeration system; description, analysis, refrigerating effect, capacity, power required, units of refrigeration, COP, Refrigerants and their desirable properties. Dry bulb temperature, wet bulb temperature, dew point temperature; specific and relative humidifies Construction and use of psychrometric chart Analysis of various processes; heating, cooling, dehumidifying and humidifying. Adiabatic mixing of moist air. Summer and winter air conditioning. Numericals.	10 Hours	L1, L2, L3, L4
Module -5		
Reciprocating Air Compressors, Gas Turbine and Jet Propulsion: Operation of a single stage reciprocating compressor, work input through P-V diagram, steady state and steady flow analysis, adiabatic, isothermal and mechanical efficiencies minimum work for compression, multistage compressor. Classification of Gas turbines, Analysis of open cycle gas turbine cycle. Advantages and disadvantages of closed cycle, numericals. Principle of Jet propulsion and Rocket propulsion	10 Hours	L2, L3
Course outcomes: At the end of this course student will be able to: 1. Define and explain fundamental thermodynamic laws and concepts, work, various types of works and heat and its applications, entropy and its relations 2. Explain Zeroth, First & Second law of thermodynamics and its applications. 3. Explain various thermodynamic relations, constants of gas and basics of ideal gas & its mixtures. 4. Calculate load and IHP, BHP of IC engines. 5. Explain the selection of air conditioning system; evaluate thermal performance of refrigeration		

cycles.

6. Calculate efficiency and MEP of various gas power & vapor power cycles.
7. Explain the principles of gas turbine & jet propulsion system and their fuels.
8. Design cost effective thermodynamic systems

NOTE:

1. **Thermodynamics data hand book,** B. T. Nijaguna (to be supplied in the examination)
2. A copy of **Psychrometry chart** to be given along with answer book to the candidates (if needed)

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. P. K. Nag, **Basic and Applied Thermodynamics**, Tata McGraw Hul Pub. 2002
2. B.K. Venkanna , **Applied Thermodynamics**, , PHI New Delhi

REFERENCE BOOKS

1. Yunus, A. Cenegal and Michael A.Boies ,**Thermodynamics, An engineering approach**, Tata Mac-Graw Hill publishing company, 2002,
2. G.J. Van Wylen and R.E. Sontang, **Fundamental of Classical Thermodynamics**, Wiley eastern.

MECHANICS OF MATERIALS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	15AU34	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Number of Tutorial Hours/Week	02	Exam Hours	03
Total Number of Lecture Hours	50	Credits	04

Course objectives:

The objectives of this course are to make students:

1. To explain the basic concepts of stress, strain
2. To explain the behavior of different engineering materials subjected to different types of loading
3. To demonstrate calculation of principal stresses using analytical and graphical methods
4. To calculate and plot shear force and bending moment diagrams for beams carrying different types of loads, and various support conditions
5. To determine deflection and slope of beams subjected to various type of loads
6. To determine the diameter of solid and hollow shafts subjected to torques
7. To demonstrate the calculation of critical loads for different type of columns using Euler's, Rankine's equations

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-I		
Stress and Strain: Introduction, Hooke's law, Calculation of stresses in straight, Stepped and tapered sections, Composite sections, Stresses due to temperature change, Shear stress and strain, Lateral strain and Poisson's ratio, Generalized Hooke's law, Bulk modulus, Relationship between elastic constants.	10 Hours	L1, L2, L4
Module -2		
Analysis of Stress and Strain: Plane stress, Stresses on inclined planes, Principal stresses and maximum shear stress, Principal angles, Shear stresses on principal planes, Maximum shear tress, Mohr circle for plane stress conditions. **Cylinders:** Thin cylinder: Hoop's stress, maximum shear stress, circumferential and longitudinal strains, Thick cylinders: Lames equations.	10 Hours	L1, L2, L3, L4
Module -3		
Shear Forces and Bending Moments: Type of beams, Loads and reactions, Relationship between loads, shear forces and bending moments, Shear force and bending moments of cantilever beams, Pin	10 Hours	

support and roller supported beams subjected to concentrated loads and uniformly distributed constant / varying loads. **Stress in Beams:** Pure bending, Curvature of a beam, Longitudinal strains in beams, Normal stresses in Beams with rectangular, circular,'I' and 'T' cross sections, Flexure Formula, Bending Stresses, Deflection of beams (Curvature). .		L1, L3, L4
Module -4		
Torsion: Circular solid and hallow shafts, Torsional moment of resistance, Power transmission of straight and stepped shafts, Twist in shaft sections, Thin tubular sections, Thin walled sections. **Columns:** Buckling and stability, Critical load, Columns with pinned ends, Columns with other support conditions, Effective length of columns and Secant formula for columns.	10 Hours	L1, L2, L4
Module -5		
Strain Energy: Castigliano's theorem I and II, Load deformation diagram, Strain energy due to normal stresses, Shear stresses, Modulus of resilience, Strain energy due to bending and torsion. **Theories of Failure:** Maximum Principal stress theory, Maximum shear stress theory.	10 Hours	L1, L4

Course outcomes:

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

1. Explain the concepts of stress, strain; material properties.
2. Explain the behavior of materials under different loading conditions such as tensile, compression, shear, bending etc.
3. Calculate principal stresses using analytical and graphical methods; estimate the stresses in thick and thin cylinders.
4. Calculate bending moment (BM) and shear forces (SF) and draw the BM and SF diagrams types of beams carrying different types loads such as point load, UDL,UVL and extend the same to real life situations.
5. Calculate the deflection & slope of beams under subjected to various types of loads
6. Explain the concepts of torque and calculate the diameter of hollow and solid shafts subjected to twisting moment.
7. Stresses & angle of twist induced in to the shaft due to twisting.
8. Calculate Critical load for different types columns using Euler's, Rankine's equations & limitations of these equations and explain the applications.

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. James M Gere, Barry J Goodno, **Strength of Materials**, Indian Edition, Cengage Learning, 2009.
2. S. S. Bhavikatti, **Strength of Materials,** Vikas publications House -1 Pvt. Ltd., 2nd Ed., 2006.

REFERENCE BOOKS

1. S.S. Rattan, **Strength of Materials**, Tata McGraw Hill, 2009
2. K.V. Rao, G.C. Raju, **Mechanics of Materials**, First Edition, 2007
3. Egor. P. Popov, **Engineering Mechanics of Solids**, Pearson Edu. India, 2nd, Edison, 1998.
4. W.A. Nash, Shaum's Outline Series, **Strength of Materials**, Fourth Edition-2007.
5. R Subramanian, **Strength of Materials**, Oxford, 2005.

MECHANICAL MEASUREMENTS AND METROLOGY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	15AU35	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives:

The objectives of this course are to make students:

1. To explain significance of mechanical measurements, elements of a generalized measuring system
2. To explain the theory and working principle of measuring instruments for the measurement of force, torque, flow, temperature, pressure and strain
3. To define Metrology, appreciate the objectives of Metrology, and explain the importance of standards.
4. To interpret the limits specified, identify fits and explain the concept of tolerance
5. To provide the knowledge of working principle of comparators, screw and gear metrology

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-I		
Measurements, Measurement Systems and Standards of Measurement: Definition, significance of measurement, generalized measurement system, definition and concept of accuracy, precision, sensitivity, Calibration, threshold, hysteresis, repeatability, linearity, loading effect, system response, time delay, errors in measurement, classification of errors. Definition and objectives of metrology, Standard of length- International prototype meter, Imperial standard yard, Wave length standard, Subdivision of standards, line and end standard, comparison, Transfer from line standard to end standard, calibration of end bars (Numerical)	10 Hours	L1, L2, L3, L5
Module -2		
Comparators and Angular Measurements: Introduction to Comparator, Characteristics, Classification of Comparators, Sigma comparators, dial indicators, optical comparators, principles, ziess ultra optimeter, Electric and electronic comparators –principles, LVDT, pneumatic comparators, back pressure gauges, solex comparators. Bevel protractor. Sine principle, use of sine bars, sine centre, angle gauges (numerical on building of angles)	10 Hours	L1, L2, L3, L6

Module -3		
Transducers, Intermediate Modifying Devices and Interferometer: Transfer efficiency, primary and secondary transducers, Mechanical, electrical, electronic transducers, advantages of each type of transducers. Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, signal transmission (hydraulic transmission, magnetic transmission, electrical transmission) Clinometers. Principle of inter-ferometry, autocollimator, optical flats. .	10 Hours	L1, L2, L3, L6
Module -4		
Measurement of Force, Torque, and Display Devices: Principle, analytical balance, platform balance proving ring, torque measurement, types of dynamometers prony brake, Hydraulic dynamometer, Eddy current dynamometer. Mechanical, digital read out devices, ultra-violet recorders, servo-recorders cathode ray oscilloscope, Oscillographs, X-Y plotters.	10 Hours	L1, L2, L3
Module -5		
System of Limits, Fits, Tolerance and Gauging: Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, definition of fits, hole basis system, shaft basis system, types of fits and their designation (IS 919-1963), geometric tolerance, position-tolerances. **Strain Measurement, Pressure Measurement and Temperature Measurement:** Strain gauge, preparation and mounting of strain gauges, gauge factor, Methods of strain measurement Principle, use of elastic members, bridge man gauge, Mc leod gauge, thermal conductivity gauge, (pirani gauge and thermocouple vacuum gauge) ionization gauge, Resistance thermometers, thermocouple, law of thermocouple, thermocouple circuits, thermocouple materials, pyrometers, optical pyrometer.	10 Hours	L1, L2, L3, L6

Course outcomes:

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

1. Explain the significance of mechanical measurements and components of a generalized measurement system.
2. Classify and explain principles of various types of transducers, modifying devices and terminating devices.
3. Explain the working principle of instruments used for measurement of Force, Torque, Pressure, Temperature, Strain and Vibration.
4. Explain the objectives of metrology and explain various standards of length such as line and end standards.
5. Demonstrate the skills of interpreting various types of limits, fits and tolerances.
6. Classify the comparators and explain their working principles.

7. Explain the usage of instruments used for the measurement of screw thread and gear parameters.

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. R.K. Jain, **Engineering Metrology** - Khanna Publishers, New Delhi.
2. D. S. Kumar, **Mechanical Measurements and Control** - Metropolitan Book Co. Pvt. Ltd, New Delhi.

REFERENCE BOOKS

1. ASTME- **Hand book of Industrial Metrology** - PHI
2. K.J. HUME, **Engineering Metrology** - Third (metric) Edition - Kalyani publishers.
3. BECKWITH, BUCK & MARAN-GONI, **Mechanical Measurements** - Narosa Publishing House.
4. DOEBELIN, **Measurement systems - Application a Design**, (4th Edition) - McGraw Hill.
5. R.C. Gupta, **Engineering Precision Metrology** - Khanna Publishers, New Delhi.

MANUFACTURING PROCESS – I
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Subject Code	15AU36	Exam Marks	80
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Credits	03
IA Marks	20		

Course objectives:

The objectives of this course are to make students:

1. To define various terms associated with casting processes
2. To explain methods of construction of moulds
3. To select molding machine and molding process based on material type
4. To select appropriate joining process, type of joints
5. To appreciate the importance of non-destructive testing

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-I		
Introduction: Concept of Manufacturing process, its importance. Classification of Manufacturing processes. Introduction to Casting process & steps involved. Varieties of components produced by casting process. Advantages & Limitations of casting process. **Patterns:** Definition, functions, Materials used for pattern, various pattern allowances and their importance. Classification of patterns. **Binder**: Definition, Types of binder used in molding sand. **Additives**: Need, Types of additives used. Types of base sand, requirement of base sand. Molding sand mixture ingredients (base sand, binder & additives) for different sand mixtures. Method used for sand molding, such as Green sand, dry sand and skin dried moulds. **Cores:** Definition, Need, Types. Method of making cores, Binders used, core sand molding. **Gates & Risers.** Principle and types. **Fettling and cleaning of castings.** Basic steps, Casting defects, Causes, features and remedies.	10 Hours	L1, L2, L3

Module -2		
Special Moulding Process & Furnaces: **Moulding Machines** : Jolt type, Squeeze type, Jolt & Squeeze type and Sand slinger. **Process:** Study of important molding processes, No bake moulds, Flaskless moulds, Sweep mould, CO_2 mould, Shell mould, Investment mould. **Metal moulds**: Gravity die-casting, Pressure die casting, Centrifugal casting, Squeeze Casting, Slush casting, and Thixocasting processes. **Classification of furnaces:** Constructional features & working principle of coke fired, oil fired and Gas fired pit furnace, Resistance furnace, Electric Arc Furnace, Cupola furnace.	10 Hours	L1, L2, L3
Module -3		
Welding Process: Definition, Principles, Classification, Application, Advantages & limitations of welding. **Arc Welding**: Principle, Metal Arc welding **(MAW)**, Flux Shielded Metal Arc Welding **(FSMAW)**, **Gas Welding**: Principle, Oxy – Acetylene welding, Chemical Reaction in Gas welding, Flame characteristics. Gas torch construction & working. Forward and backward welding. Inert Gas Welding **(TIG & MIG)** Submerged Arc Welding **(SAW)** and Atomic Hydrogen Welding processes. **(AHW)**	10 Hours	L1, L2, L3
Module -4		
Resistance welding: principles, Seam welding, Butt welding, Spot welding and projection welding. Friction welding, Explosive welding, Thermit welding, Laser welding and Electron beam welding. Structure of welds, Formation of different zones during welding. Heat affected zone **(HAZ).** Parameters affecting **HAZ**. Effect of carbon content on structure and properties of steel. Shrinkage in welds & Residual stresses. Concept of electrodes, Filler rod and fluxes. Welding defects – Detection causes & remedy.	10 Hours	L1, L2, L3
Module -5		
Soldering, Brazing: Parameters involved & Mechanism. Different Types of Soldering & Brazing Methods. **Inspection Methods**: Methods used for Inspection of casting and welding. Visual, Magnetic particle, Fluorescent particle, Ultrasonic, Radiography, Eddy current, Holography methods of Inspection.	10 Hours	L1, L2, L3
Course outcomes: At the end of this course student will be able to: 1. Define various terminologies used in casting process. 2. Explain basic concepts used in construction of various moulds. 3. Analyze the working of various moulding machines. 4. Select the appropriate moulding machine and moulding process depending on the type of raw		

material required to produce the desired product.

5. Select the appropriate joining process depending on the type of joint required to produce the desired product.
6. Realize the significance of Non-Destructive Testing's (NDT's).

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. Dr. K. Radhakrishna, **Manufacturing Process-**I, Sapna Book House, 5th Revised Edition 2009.
2. P. N. Rao, **Manufacturing & Technology: Foundry, Forming and Welding**, 2nd Ed., Tata McGraw Hill, 2003.

REFERENCE BOOKS

1. Serope Kalpakjain, Steuen. R. Sechmid, **Manufacturing Technology**, Pearson Education Asia, 5th Ed. 2006.
2. Roy A Lindberg, **Process and Materials of Manufacturing**, 4th Ed. Pearson Edu. 2006.

METALLOGRAPHY AND MATERIAL TESTING LABORATORY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	15AUL 37	IA Marks	20
Number of Lecture Hours/Week	01	Exam Marks	80
Number of Practical Hours/Week	02	Exam Hours	03
Total Number of Hours	39	Credits	02

Course objectives:

The objectives of this course are to make students:

1. To demonstrate the conduct of experiments in Metallography and Material Testing Laboratory using the principles of material science and mechanics of materials
2. To explain the working of different material testing machines
3. To conduct experiments, tabulate the data, plot graphs and make thorough analysis of results

	Laboratory Experiments:	**Revised Bloom's Taxonomy (RBT) Level**
	PART-A	
1	Preparation of specimen for Metallographic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray CI, SG iron, Brass, Bronze & composites.	L1, L3
2	Heat treatment: Annealing, normalizing, hardening and tempering of steel. Hardness studies of heat treated samples.	L1, L3
3	To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.	L1
4	Non-destructive test experiments like, a. Ultrasonic flaw detection b. Magnetic crack detection c. Dye penetration testing. To study the defects of Cast and Welded specimens	L1, L3
5	Brinell, Rockwell and Vickers's Hardness test.	L1
	PART-B	
1	Tensile, Shear and Compression tests of metallic and non metallic specimens using Universal Testing Machine	L1, L3, L4
2	Torsion Test	L1, L3, L4
3	Bending Test on metallic and nonmetallic specimens.	L1, L3, L4
4	Izod and Charpy Tests on M.S, and CI specimen.	L1, L4
5	Fatigue Test.	L1

Course outcomes:

At the end of this laboratory, students will be able to:

1. Apply the knowledge of Material Science and Mechanics of Materials to demonstrate the conduct of experiments in Metallography and Material Testing Laboratory
2. Explain the working principle of all the laboratory equipment
3. Explain the standard test procedures
4. Plot graphs (if any) and interpret the results.
5. Explain the significance of the various tests conducted in practice, research works etc.

Scheme of Examination:

ONE question from part -A	:**25 Marks**
ONE questions from part -B	**:45 Marks**
Viva -Voice	:**10 Marks**
Total:	:**80 Marks**

FOUNDRY AND FORGING LABORATORY

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Subject Code	15AUL 38	IA Marks	20
Number of Lecture Hours/Week	01	Exam Marks	80
Number of Practical Hours/Week	02	Exam Hours	03
Total Number of Lecture Hours	39	Credits	02

Course objectives:

The objectives of this course are to make students:

1. To apply knowledge of foundry and forging for the conduct of experiments in Foundry and Forging laboratory using standard test procedures
2. To explain various foundry and forging tools and demonstrate their usage

	Laboratory Experiments:	**Revised Bloom's Taxonomy (RBT) Level**
	PART-A	
1	**Testing of Moulding Sand and Core Sand:** Preparation of sand specimens and conduction of the following tests: a. Compression, Shear and Tensile tests on Universal Sand Testing Machine. b. Permeability test c. Core hardness & Mould hardness tests. d. Sieve Analysis to find Grain Finest number of Base Sand e. Clay content determination in Base Sand	L1, L2, L3
	PART-B	
2	**Foundry Practice:** a. Use of foundry tools and other equipments. b. Preparation of molds using two molding boxes using patterns or without patterns. (Split pattern, Match c. Preparation of one casting (Aluminum or cast iron-Demonstration only)	L1, L2, L3
	PART-C	
3	**Forging Operations:** a. Calculation of length of the raw material required to do the model. b. Preparing minimum three forged models involving upsetting, drawing and bending operations. c. Out of these three models, at least one model is to be prepared by using Power Hammer.	L1, L2, L3

Course outcomes:		
At the end of this laboratory, students will be able to: 1. Apply the basic knowledge of Foundry and Forging to demonstrate the conduct of experiments in Foundry and Forging Laboratory. 2. Explain the working principle of all the laboratory equipment and accessories/tools 3. Explain the standard test procedures 4. Plot graphs (if any) and interpret the results. 5. Explain the significance of the various tests conducted in practice, research works etc.		
Scheme of Examination:		
One question from Part – A	: 25 marks	
One question from either Part-B or Part-C	: 45 marks	
Viva-Voce	: 10 marks.	
Total	**: 80 marks.**	