# Jabalpur Engineering College, Jabalpur

## Semester V Credit Based Grading System (CBGS) w.e.f. July 2017

## Scheme of Examination

## Bachelor of Engineering B.E. (Mechanical Engineering)

## Subject wise distribution of marks and corresponding credits

**Scheme of Examination w.e.f. July-2017 (Academic Session-2017-18)**

| S. No. | Subject Code | Subject Name & Title | Maximum Marks Allotted | | | | | | Hours / week. | | | Total Credits | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Theory | | | Practical | | Total Marks | | | | | |
| | | | End Sem | Mid Sem. MST | Quiz, Assign ment | End Sem. | Lab Work | | L | T | P | | |
| 1 | **ME5001** | Entrepreneurship & Management Concepts | 70 | 20 | 10 | - | - | 100 | 3 | 1 | - | 4 | |
| 2 | **ME5002** | Turbo Machines | 70 | 20 | 10 | 30 | 20 | 150 | 3 | 1 | 2 | 6 | |
| 3 | **ME5003** | Dynamics of Machines | 70 | 20 | 10 | 30 | 20 | 150 | 3 | 1 | 2 | 6 | |
| 4 | **ME5004** | Mechanical Measurement & Control | 70 | 20 | 10 | 30 | 20 | 150 | 3 | 1 | 2 | 6 | |
| 5 | **ME5005** | Elective-I | 70 | 20 | 10 | - | - | 100 | 3 | 1 | - | 4 | |
| 6 | **ME5006** | Departmental Lab-II (Departmental Choice/ Elective-I Lab) | - | - | - | 30 | 20 | 50 | - | - | 2 | 2 | |
| 7 | **ME5007** | Management Skill Development | - | - | - | - | 50 | 50 | - | - | 2 | 2 | |
| 8 | **ME5008** | Evaluation of Industrial Training (Internal Assessment) | - | - | - | - | 50 | 50 | - | - | 2 | 2 | |
| **Total** | | | **350** | **100** | **50** | **120** | **180** | **800** | **15** | **5** | **12** | **32** | **800** |

**MST:** Minimum of two mid semester tests to be conducted

**L: Lecture T: Tutorial P: Practical**

| **Elective-I** | |
|---|---|
| **Subject Code** | **Subject Name** |
| **ME5005A** | Internal Combustion Engine |
| **ME5005B** | Thermal Engineering & Gas Dynamics |
| **ME5005C** | Advanced Materials |
| **ME5005D** | Mechanical Behavior of Materials |

# B.E.CBGS V SEMESTER
## ENTREPRENEURSHIP AND MANAGEMENT CONCEPTS

| Course | Subject Title | Subject Code | Grade for End Sem. | | CGPA at the end of every even semester |
|---|---|---|---|---|---|
| | | | T | P | |
| B.E. | Entrepreneurship and Management Concepts | ME5001 | Min. "D" | Min. "D" | 5.0 |

**Course Objective:**

To familiarize the students with the concepts and applications of Management, Marketing, Productivity & Entrepreneurship in competitive world.

**Course Contents:**

**Unit-I: System Concepts:**

Types, definition & characteristics; supra & subsystems, key component; boundary & interface complexity; feedback (pull) & feed forward (push) controls, open flexible-adaptive system, computer as closed system, law of requisite variety; system coupling, stresses and entropy; functional & cross functional system; Steven Alter's nine element work system model and its comparison with IPO (input-processing-output) model, structure and performance of work systems leading to customer delight.

**Unit-II: Management:**

Importance, definition and functions; schools of theories, knowledge driven learning organization and e-business; environment, uncertainty and adaptability; corporate culture, difficulties and levels of planning, BCG matrix, SWOT analysis, steps in decision making, structured and unstructured decision; dimensions of organizations, size/specialization, behavior formalization, authority centralization, departmentalization, spam and line of control, technology and Minzberg organization typology, line, staff & matrix organization, coordination by task force, business process reengineering and process of change management, HR planning placement and training, MIS; attitudes and personality trait, overlap and differences between leader & manager, leadership grid, motivation, Maslow's need hierarchy and Herzberg two factor theory, expectation theory, learning process, team work and stress management.

**Unit-III: Marketing:**

Importance, definition, core concepts of need want and demand, exchange & relationships, product value, cost and satisfaction (goods and services ) marketing environment; selling, marketing and societal marketing concepts; four P's, product, price, placement, promotion; consumer, business and industrial market, market targeting, advertising, publicity, CRM and market research.

**Finance:** Nature and scope, forms of business ownerships, balance sheet, profit and loss account, fund flow and cash flow statements, breakeven point (BEP) and financial ratio analysis, pay-back period, NPV and capital budgeting.

**Unit-IV: Productivity and Operations:**

Productivity, standard of living and happiness, types of productivity, operations (goods and services) Vs project management, production processes and layouts, steps in method improvement, time measurement, rating and various allowances; standard time and its utility, predetermined motion and time method, product and process specification, TQM, cost of quality, introduction to lean manufacturing (JIT), QFD, TPM & six sigma quality.

**Unit-V:Entrepreneurship:**

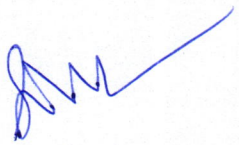
Definition and concepts, characteristics, comparison with manager, classification, theories of entrepreneur, socio, economic, cultural and psychological; entrepreneur traits and behavior, roles in economic growth, employment, social stability, export promotion and indigenization, creating a venture, opportunity analysis competitive and technical factors, sources of funds, entrepreneur development program.

**Evaluation:**

Evaluation will be continuous an integral part of the class followed by the final examination.

**Books References**:


1. Daft R; The new era of management; Cengage.
2. Bhat Anil, Arya kumar; Management: Principles,Processes and Practices; Oxford higheredu.
3. Davis & Olson; Management Information System; TMH.
4. Steven Alter; Information systems, Pearson, www.stevenalter.com
5. Kotler P; Marketing management; 6- Khan, Jain; Financial Management; 7- ILO; Work study;ILO.
6. Mohanty SK; Fundamental of Entrepreneurship; PHI.

# B.E.CBGS V SEMESTER
## TURBO MACHINES

| Course | Subject Title | Subject Code | Grade for End Sem. | | CGPA at the end of every even semester |
|---|---|---|---|---|---|
| | | | T | P | |
| B.E. | Turbo Machines | ME5002 | Min. "D" | Min. "D" | 5.0 |

**Course Objective:**

On the successful completion of this course student shall be able to learn about:

1. Steam turbines and its application in thermal power plants
2. Gas turbines and its application in Gas Turbine power plants
3. Hydraulic Turbines and its application in Hydel power plants
4. Pumps, compressors, blowers and fans and other equipments in power plants
5. Power Transmitting Turbo Machines and hydraulic systems

**Course Contents:**

**Unit -I:**

**Steam Turbines**: Classifications, principles of impulse and reaction machines.

**Impulse Turbine:** Impulse staging, velocity and pressure compounding, utilization factor, analysis for optimum utilization factor, Curtis and Rateau stage, velocity diagram, blade velocity coefficient, force, work done, blade efficiency, nozzle efficiency, gross stage efficiency, analysis for optimum efficiency, mass flow and blade height.

**Reaction Turbine:** Reactions staging, velocity diagram, Parson's stages, degree of reaction, nozzle efficiency, velocity coefficient, stator efficiency, carry over efficiency, stage efficiency, vane efficiency, conditions for optimum efficiency, speed ratio, axial thrust, reheat factor in turbines. Governing and performance characteristics of steam turbines.

**Unit -II:**

**Water Turbines**: Classification, Pelton, Francis and Kaplan turbines, vector diagrams and work-done,Hydraulic, volumetric, mechanical and overall efficiencies, draft tubes, governing of water turbines.

**Performance and Characteristics**: Application of dimensional analysis and similarity to water turbines, unit and specific quantities, selection of machines, Main and operating characteristics of the machines andcavitation.

**Unit -III:**

**Rotary Fans, Blowers and Compressors**: Classification based on pressure rise, centrifugal and axial flow machines.

**Centrifugal Blowers** Vane shape, velocity triangle, degree of reactions, slip coefficient, size and speed of machine, vane shape and stresses, efficiency, characteristics, fan laws and characteristics.

**Centrifugal Compressor** – Vector diagrams, work done, temp and pressure ratio, slip factor, work input factor, pressure coefficient, Dimensions of inlet eye, impeller and diffuser.

**Axial flow Compressors**- Vector diagrams, work done factor, temp and pressure ratio, degree of reaction, Dimensional Analysis for plotting compressor characteristics, surging and chocking, Polytrophic and isentropic efficiencies.

**Unit- IV:**

**Centrifugal Pumps**: Classification, advantage over reciprocating type, definition of manometric head, gross head, static head, velocity diagram and work done, slip factor, efficiency and sources of inefficiency, minimum starting speed of pump, net positive suction head, priming and cavitation, unit and specific quantities, performance characteristics.

**Power Transmitting Turbo Machines**: Fluid coupling and Torque converter,their torque ratio, speed ratio, slip and efficiency, velocity diagrams and characteristics.

**Hydrostatic Systems:**hydraulic intensifier, accumulator, press and crane.

**Unit V:**

**Gas Turbines:** Simple cycle, modification in simple cycle, simple cycle with heat exchanger, with reheat, with intercooler, closed cycle gas turbine, practical gas turbine cycle, optimum pressure ratio for maximum specific work output and thermal efficiency in actual gas turbine cycle, effect of operating variables on thermal efficiency.

**Jet Propulsion:** types, pulse jet, Ram jet, turbo jet, efficiency and horse power of propulsion, flying unit.

**Evaluation:**

Evaluation will be continuous an integral part of the class followed by the final examination as well as through external assessment.

**Books References:**


1. Venkanna BK; turbomachinery; PHI
2. Shepherd DG; Turbo machinery
3. Csanady; Turbo machines.
4. Kadambi V Manohar Prasad; An introduction to EC Vol. III-Turbo machinery; Wiley EasternDelhi
5. Bansal R. K; Fluid Mechanics & Fluid Machines;
6. Rogers Cohen & Sarvan Multo Gas Turbine Theory
7. Kearton W. J; Steam Turbine: Theory & Practice.
8. J. K. Jain; Gas turbine theory and jet propulsion.


## TURBO MACHINES

**List of Experiments:**

1. Performance analysis and plotting main characteristic curves of pelton turbine.
2. Performance analysis and plotting operating characteristic curves of pelton turbine.
3. Performance analysis and plotting main characteristic curves of reaction turbine.
4. Performance analysis and plotting operating characteristic curves of reaction turbine.
5. Performance analysis and plotting main characteristics curves of centrifugal pump.
6. Performance analysis and plotting operating characteristic curves of centrifugal pump.
7. Performance analysis of centrifugal blower.

# B.E.CBGS V SEMESTER
# DYNAMICS OF MACHINES

| Course | Subject Title | Subject Code | Grade for End Sem. | | CGPA at the end of every even semester |
|---|---|---|---|---|---|
| | | | T | P | |
| B.E. | Dynamics of Machines | ME5003 | Min. "D" | Min. "D" | 5.0 |

**Course Objective:**

At the completion of the course the students will be able:

1. To determine the velocity and acceleration of piston in a reciprocating engine mechanism and calculation of flywheel rim dimensions.
2. To understand the working of speed control mechanisms.
3. To understand the concepts of balancing of rotors of heavy machines.
4. To know the principles of clutches, brakes and dynamometers and calculation of brake power.

**Course Contents:**

**Unit-I: Dynamics of Engine Mechanism**:
Displacement, velocity and acceleration of piston; turning moment on crankshaft, turning moment diagram; fluctuation of crankshaft speed, analysis of flywheel.

**Unit-II: Governor Mechanisms**:
Types of governors, characteristics of centrifugal governors, gravity and spring controlled centrifugal governors, hunting of centrifugal governors, inertia governors.

**Unit-III: Balancing of Inertia Forces and Moments in Machines**:
Balancing of rotating masses, two plane balancing, determination of balancing masses (graphical and analytical methods), balancing of rotors, balancing of internal combustion engines (single cylinder engines, in-line engines, V-twin engines, radial engines.

**Unit-IV**: **Friction:**
Frictional torque in pivots and collars by uniform pressure and uniform wear rate criteria. Boundary and fluid film lubrication, friction in journal and thrust bearings, concept of friction circle and axis, rolling friction.
**Clutches:** Single plate and multi plate clutches, Cone clutches.

**Unit-V: Brakes**:
Band brake, block brakes, Internal expanding shoe brakes, braking of vehicles.
**Dynamometer:** Different types and their applications.

**Evaluation:**
Evaluation will be continuous an integral part of the class followed by the final examination as well as through external assessment.

**Books References:**


1. Ambekar, AG; Mechanism and Machine Theory; PHI
2. Rattan SS; Theory of machines; TMH
3. Sharma and Purohit; Design of Machine elements; PHI
4. Bevan; Theory of Machines;
5. Ghosh and Mallik; Theory of Mechanisms and Machines; Affiliated East-West Press, Delhi
6. Norton RL; kinematics and dynamics of machinery; TMH
7. Grover; Mechanical Vibrations
8. Balaney; Theory of Machines
9. Theory of Vibrations by Thomson
10. Theory of machines through solved problems by J.S.RAO.


# DYNAMICS OF MACHINES

**List of Experiments:**

1. Study of various models of governors.
2. To observe the jumping phenomenon in a cam and follower mechanism.
3. To study working of different types of brakes using models.
4. To study working of friction clutches using models.
5. To study working of different types of dynamometer.
6. To study static and dynamic balancing machines.

# B.E.CBGS V SEMESTER
## MECHANICAL MEASUREMENT & CONTROL

| Course | Subject Title | Subject Code | Grade for End Sem. | | CGPA at the end of every even semester |
|---|---|---|---|---|---|
| | | | T | P | |
| B.E. | Mechanical Measurement & Control | ME5004 | Min. "D" | Min. "D" | 5.0 |

**Course Objective:**

1. Develop ability to understand basic concept of measurement system.
2. Develop ability to understand the mathematical modeling of mechanical measurement system.
3. Develop ability to find out various types of errors in measurement and there uncertainty analysis.
4. Develop ability to setup measurement system with a control environment.
5. Develop an ability to design and utilize advanced control system.

**Course Contents:**

**Unit-I**:

Basic Concepts of Measurement:- General measurement system; Experimental test plan; variables, parameters, noise and interference, replication and repetition; Calibration; Static calibration, dynamic calibration, static sensitivity, range, accuracy, precision and bias errors, sequential and random tests; Presenting data; Rectangular coordinate format, semi-log, full-log formats. Measurement System Behavior: General model for a dynamic measurement system and its special cases; zero order, first order, and second order system, determination of time constant and settling time, phase linearity.

**Unit-II**:

Statistics: Least square regression analysis and data outlier detection; Normal distribution and concept of standard deviation of the mean in finite data set, Uncertainty Analysis: Measurement errors; error sources: calibration, data acquisition, data reduction; Design stage uncertainty analysis; combining elemental errors; Bias & Precision errors; Error propagation, Higher order uncertainty analysis.

**Unit-III**:

Temperature Measurement:- Temperature standards, Temperature scales;Thermometry based on thermal expansion: Liquid in glass thermometers, Bimetallic Thermometers; Electrical resistance thermometry; Resistance Temperature Detectors, Thermistors; Thermoelectric Temperature Measurement; Temperature measurement with thermocouples, thermocouple standards.

Pressure Measurement: - Relative pressure scales, pressure reference instruments, barometer, manometer, deadweight tester, pressure gauges and transducers, total and static pressure measurement in moving fluids Flow measurement; Pressure differential meters; Orifice meter, Venturi meter, Rota-meter.

**Unit-IV**:

Strain Measurement:- Stress and strain, resistance strain gauges, gauge factor, strain gauge electrical circuits, multiple Gauge Bridge, bridge constant, apparent strain and temperature compensation, bending compensation.

Motion, Force and Torque Measurement: - Displacement measurement: Potentiometers, Linear variable differential transformers, rotary variable differential transformer.

Velocity measurement: moving coil transducers; angular velocity measurement: electromagnetic

measurement: measurement of torque on rotating shafts, Power estimation from rotational speed and torque.

**Unit-V**:

Introduction to control systems: Examples of control systems. Open loop and closed loop control system, Mathematical modeling of dynamic systems: Transfer function, impulse response function, block diagram of closed loop control system, block diagram reduction, Transient and steady state response analyses: First order systems, unit step and unit impulse response of first order systems, second order systems, unit step and unit impulse response of second order systems, transient response specifications, modeling of mechanical systems, modeling of electrical systems, signal flow graphs, modeling of fluid systems, liquid level systems, hydraulic systems, modeling of thermal systems.

**Evaluation:**

Evaluation will be continuous an integral part of the class followed by the final examination as well as through external assessment.

**Books References:**


1. Nakra and Chaudhry; instrumentation, Measurement and analysis; TMH
2. Figiola RS & Beasley DE; Theory and Design for Mechanical Measurements; 3e John Wiley
3. Katsuhiko Ogata; Modern Control Engineering, 4e Pearson Education, New Delhi
4. Gopal; Control Systems Principles and Design; Tata McGraw Hill, New Delhi.
5. Backwith and Buck; Mechanical Measurements.
6. Swhney; Metrology and Instrumentation.
7. A. K.Sawhney; Mechanical measurement and control, Dhanpat Rai Publications.
8. D.S. KUMAR; Mechanical measurement and control, Metropolitan Book Co. Pvt. Ltd.


## MECHANICAL MEASUREMENT & CONTROL

**List of Experiments:**

1. Study of various temperature measuring devices; thermocouple, RTD, liquid in glass thermometers, ERT, Pyrometers.
2. Measuring velocity of fluid flow by Ventura meter/ orifice meter/ pitot-tube, rotameter.
3. Measuring torque and power generated by a prime mover by using pony brake dynamometer, LVDT, RVDT.
4. Study of various pressure measuring devices like manometers, mercury in glass pressure gauge, Bourdon tube pressure gauge.
5. To develop a measuring device for fluid level measurement.
6. Study of open loop and closed loop control system.

# B.E.CBGS V SEMESTER
# (ELECTIVE –I) INTERNAL COMBUSTION ENGINE

| Course | Subject Title | Subject Code | Grade for End Sem. | | CGPA at the end of every even semester |
|---|---|---|---|---|---|
| | | | T | P | |
| B.E. | (Elective –I) Internal Combustion Engine | ME5005A | Min. "D" | Min. "D" | 5.0 |

**Course Objective:**

1. To make students familiar with performance characteristics of I.C. engine.
2. To study the thermodynamics, combustion, heat transfer, friction and other factors affecting I.C. engine performance.
3. To study conventional and modern system being used in I.C. engines.
4. To study future fuels of engines.
5. To study different types of superchargers and supercharging methods.

**Course Contents:**

**Unit I**:

Internal Combustion Engine: S.I. and C.I. engines of two and four stroke cycles, real cycle analysis of SI and CI engines, determination of engine dimensions, speed, fuel consumption, output, mean effective pressure, efficiency, factors effecting volumetric efficiency, heat balance, performance characteristics of SI and CI engines, cylinder arrangement, firing order, power balance for multi-cylinder engines, valve timing.

**Unit II**:

Combustion in SI engines: Flame development and propagation, ignition lag, effect of air density, temperature, engine speed, turbulence and ignition timings, physical and chemical aspects of detonation, effect of engine and fuel variables on knocking tendency, knock rating of volatile fuels, octane number, H.U.C.R., action of dopes, pre-ignition, its causes and remedy, salient features of various type combustion chambers, valve timing and firing order.

**Unit III**:

Combustion in C.I. Engines: Times base indicator diagrams and their study, various stages of combustion, delay period, diesel knock, octane number, knock inhibitors, salient features of various types of combustion chambers, fuel, ignition, cooling, exhaust and lubrication systems; Simple problems on fuel injection, various types of engines, their classification and salient features. Rotary I. C. engines, their principles of working.

**Unit IV**:

I.C. Engine System: Fuels, ignition systems, cooling, exhaust/scavenging and lubrication system. Fuel metering in SI engine: Fuel injection in SI engine (MPFI & TBI), Theory of carburetion, simple problems on carburetion. Fuel metering in CI engines: Fuel injection in CI engine and simple problems, various types of engines, their classification and salient features. Fuels: Conventional fuels and alternate fuels, engine exhaust emission, carbon monoxide, unburnt hydro carbon, oxides of nitrogen, smoke, density, measurement and control, hydrogen as alternate fuel.

**Unit V**:

Supercharging: Effect of attitude on mixture strength and output of S.I. engines, low and high pressure super charging, exhaust, gas turbo-charging, supercharging of two stroke engines.

**Evaluation:**

Evaluation will be continuous an integral part of the class followed by the final examination as well as through external assessment.

**References**:


1. Ganeshan V; Internal Combusion engines; TMH
2. Mathur ML & Sharma RP; A. Course in IC engines; DhanpatRai
3. Gupta HN; Fundamentals of IC Engines; PHI
4. Srinivasan S; Automotive Engines; TMH
5. Halderman JD and Mitchell CD; Automotive Engines theory and servicing; Pearson
6. DomKundwar; Internal Combustion Engines ; Dhanpat Rai Publications
7. Taylor GF; Internal Combustion Engines Theory & Practice; MIT Press
8. Richard Stone; Introduction to IC Engines; Society of Automotive Engr (Palgrave Mc Millan)


**List of Experiments:**

1. Determination of Valve timing diagram for S.I. and C.I. four stroke engines.
2. To study the performance parameters of I.C. engines and draw Heat Balance sheet.
3. Study of Battery Ignition system and magneto Ignition System.
4. Study of lubricating system in CI Engines.
5. Study of Fuel Injection system in SI Engine.
6. Study of Fuel Injection system in CI Engine.
7. Study of Carburetors.
8. Study of Diesel fuel pump and fuel injectors.
9. To find the indicated power (IP) on multi-cylinder petrol engine by Morse test.
10. Study of kirloskar diesel engine.

# B.E.CBGS V SEMESTER
# (ELECTIVE -I ) THERMAL ENGINEERING & GAS DYNAMICS

| Course | Subject Title | Subject Code | Grade for End Sem. | | CGPA at the end of every even semester |
|---|---|---|---|---|---|
| | | | T | P | |
| B.E. | ( Elective-I ) Thermal Engineering & Gas Dynamics | ME5005B | Min. "D" | Min. "D" | 5.0 |

**Course Objectives:**

The purpose of this course is to introduce the undergraduate students with

1. To learn applications of energy conversion device to thermal power plant.
2. To provide an overview of steam boilers, condensers, steam nozzles their applications.
3. To perform calculations on related to designing of energy conversion devices.
4. Importance and components of cooling towers and heat exchangers.

**Course Contents:**

**Unit-I :Steam Generators (Boilers):**

Classification of boilers, Requirements of a good boiler, Conventional boilers, High-pressure boilers-Lamont, Benson, Loeffler and Velox steam generators, Fluidized bed boilers (FBB), Selection of boilers, Performance and rating of boilers, Equivalent evaporation, Boiler efficiency, Heat balance sheet, Heat losses in boiler plant, Combustion in boilers, Stoker firing system, Pulverized fuel firing system, Super critical boilers, Fuel and ash handling in power plants, Ash handling plant and challenges in India. Boiler draught, overview of boiler codes, ASME-BPVL 2007, Numerical problems on boiler performance and boiler draught.

**Unit- II: Phase Change Cycles:**

Introduction, Classifications of vapour power cycles, Basic elements of steam power plant, Vapor Carnot cycle, its efficiency and limitations, Rankin cycle, its efficiency and assumptions, effect of boiler andCondenser pressure and superheat on efficiency, Modified Rankin cycle, Comparison of Rankine and Carnot cycle, Reheat cycle, Perfect regenerative cycle, its expression of efficiency, Ideal and actual regenerative cycle with single and multiple heaters, Regenerative-reheat cycle, Binary-vapor cycle, properties of binary working fluid, work done and efficiency calculations. Simple numerical problems on Phase change cycles.

**Unit –III: Gas Dynamics:**

Introduction and Applications of Gas Dynamics, Concept from fluid mechanics, Continuity equation, Momentum equation, One dimensional gas dynamics, Isentropic condition, Speed of sound in fluid, One dimensional wave motion, Elastic waves, Mach number and its significance, Mach cone, Zone of action, Zone of silence, Stagnation state andproperties, One-dimensional isentropic flow through variable area duct, Condition for maximum fluid flow, Effect of area ratio as a function of Mach number, Simple numerical problems on Gas Dynamics.

# B.E.CBGS V SEMESTER
## (ELECTIVE -I) ADVANCED MATERIALS

| Course | Subject Title | Subject Code | Grade for End Sem. | | CGPA at the end of every even semester |
|---|---|---|---|---|---|
| | | | T | P | |
| B.E. | ( Elective-I ) Advanced Materials | ME5005C | Min. "D" | Min. "D" | 5.0 |

**Course Objectives:**

The purpose of this course is to introduce the undergraduate students with

1. To understand characteristics and behaviour of ferrous and non-ferrous alloys.
2. Knowledge of high temperature materials and nuclear materials.
3. To provide an overview of advanced materials and their applications.
4. To perform selection of materials for various applications.

**Unit -I: Ferrous Metals and Alloys:**

**Developments in Iron Making and Steel Making:** Overview of iron making, steel making, refining and continuous casting processes; indicative process calculations; environmental considerations; quality issues in steel plant operations.

**Steel Making:** Modifications of steel making converter operations; developments such as sub lance and dynamic control of steel making, secondary treatment including ladle metallurgy and injection metallurgy; continuous steel making; illustrative numerical problems.

**Specifications of Steels:** Types of steels, alloy steels, tool steels; stainless steels, HSLA, TRIP steels, TWIP steels. Types of cast irons – compositions, properties and applications, specific heat treatment.

**Unit -II: Non-ferrous Alloys:**

**Aluminum and its alloys:** Physical chemical and mechanical properties, classifications, heat treatable and non-heat treatable types - structural features corrosion behavior; cladding and other methods of corrosion protection.

**Titanium and its alloys:** physical, chemical and mechanical properties of titanium, effect of other elements on its properties, types of titanium alloys, micro structural features, properties and applications.

**Magnesium and its alloys:** structure, properties and applications of magnesium and some of its alloys; metallurgy of magnesium castings; Lead, tin, zinc, antimony, silver, gold and platinum alloys, properties and applications.

**Unit -III: High Temperature Materials and Nuclear Materials:**

**High Temperature Materials:** Iron base, nickel base and cobalt base super alloys, composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening, TCP phase - embrittlement, solidification of single crystals.

**Nuclear Materials:** Overview of nuclear scenario in India, nuclear scenario at international level.Material requirements – structural materials, coolants, shielding materials and fuel rods – fabrication requirements. Nuclear irradiation effects on structural materials – safe guards, safety and health protection.

**Unit-IV:Air Compressors:**

Introduction, applications, and Classification of Air Compressors,Reciprocating Air Compressor; working, work done, power required, efficiency, for single and multistage stagecompression, Comparison of single stage and multi stage compression, Two stage with intercooler, Condition for minimum work done in two stage. Rotary Compressors; working, classifications. Comparison of reciprocating and rotary compressors. Simple numerical problems on Air Compressors.

**Unit -V :**

**(A) Steam Nozzles:** Introduction and types, Flow of steam through nozzles, Effect of friction in nozzle efficiency, Condition for maximum discharge, Physical significance of critical pressure ratio, Super-saturated flow.

**(B) Steam Condensers:** Introduction, Objective, Classification of condensers,Comparison of jet and surface condensers, Air leakage and its effect on performance, back pressure and its effect on plant performance, Condenser efficiency and factors affecting, Thermal analysis of condenser, Simple numerical problems on Steam Condensers.

**(C) Cooling Towers:** Introduction, Function, Components and applications, Cooling tower materials, Classifications of cooling towers, Performance assessment of cooling towers, Energy efficiency opportunities, Best design practices for cooling tower.

**(D) Heat Exchangers:** Introduction and applications, Classification of heat exchangers.

**Evaluation:**

Evaluation will be continuous an integral part of the class followed by the final examination as well as through external assessment

**Books References:**


1. Nag PK; Power plant Engineering; TMH
2. Thermodynamics by Gordon J. Van Wylen
3. P.K.Nag; Basic and applied Thermodynamics; TMH
4. Ganesan; Gas turbines; TMH
5. Heat Engines by V.P. Vasandani& D. S. Kumar
6. R. Yadav Steam and Gas Turbines
7. R.Yadav Thermal Engg.
8. Kadambi& Manohar; An Introduction to Energy Conversion – Vol II. Energy conversion cycles.


**List of Experiments:**

1. Study of Separating & Throttling Calorimeter for measurement of dryness fraction.
2. Study of Benson Boiler.
3. Study of Lamont Boiler.
4. Study of Loeffler Boiler.
5. Study of Velox Boiler.
6. Study of Boiler Draught.
7. Study of Boiler Trial.
8. Study of Cooling Towers.
9. Study of Heat Exchangers
10. Study of Air Compressor.

**Unit -IV: Polymers, Plastics and Composites:**

**Polymers:** Structure of polymers, characterization and applications of polymers: mechanical behavior of polymers, strengthening of polymers, crystallization and glass transition phenomenon and types of polymers.

**Plastics:** Design and selection of plastics, structure property correlation, mechanical properties, degradation, wear and friction, thermal, electrical and optical properties, flammability of plastics and processing of plastics and FRP.

**Composites:** Particle reinforced composites, fiber reinforced composites – influence of fiber length, orientation and concentration. Fiber phase, matrix phase, metal matrix composites, polymer matrix composites, ceramic matrix composites, carbon – carbon composites, hybrid composites and structural composites.

**Unit -V: Ceramics and Bio materials**

**Ceramics:** Ceramics as a class of material, classification of ceramics, bonding and structure of various ceramic materials; crystal structure and defects; chronological developments, structure of silicates; polymorphic transformations, raw materials.

**Bio Materials:** Introduction to biomaterials; need for biomaterials; Salient properties of important material classes; Property requirement of biomaterials; Metallic implant materials, ceramic implant materials, polymeric implant materials, composites as biomaterials; Orthopedic, dental and other applications. Biomaterials worldwide market, technology transfer and ethical issues; Standards for biomaterials and devices.

**Books References:**


1. Avner S. H., 'Introduction to Physical Metallurgy', 2nd Edition, McGraw Hill, 1974.
2. Leslie W. C., 'The Physical Metallurgy of Steels', McGraw Hill, 1982.
3. Pickering P. B., 'Physical Metallurgy and the Design of Steels', Applied Science Publishers, 1983.
4. Brick R. M., Gorden R. B, Phillips A., 'Structure and Properties of Alloys', McGraw Hill, 1965.
5. Polmear I. J., 'Light Alloys -Metallurgy of the Light Metals', 3rd Edition, Arnold, 1995.
6. Thomas H. Courtney, "Mechanical Behavior of Materials", 2nd Edition, 2013, Overseas Press India Private Limited.
7. Rose R. M., Shepard L. A., Wulff J., 'Structure and Properties of Materials', Volume III, John Wiley, 1984.
8. M.F. Ashby, "Materials Selection in Mechanical Design' – Third edition, Elsevier publishers, Oxford, 2005.
9. Tupkary R.H., 'Introduction to Modern Steel Making', Khanna Publishers, 2004 (primary text).


**Evaluation**

Evaluation will be continuous an integral part of the class as well through external assessment.

## (ELECTIVE -I) ADVANCED MATERIALS

## List of Experiments:

1. Make a selection of steels available in the market as per given application.
2. Study of properties and applications of High Temperature Materials.
3. Study of properties and applications of Nuclear Materials.
4. Study of properties and applications of Polymers, Plastics and Composites.
5. Processing of Composites.
6. Properties,selection and applications of biomaterials in engineering.

# B.E.CBGS V SEMESTER
# (ELECTIVE -I) MECHANICAL BEHAVIOR OF MATERIALS

| Course | Subject Title | Subject Code | Grade for End Sem. | | CGPA at the end of every even semester |
|---|---|---|---|---|---|
| | | | T | P | |
| B.E. | ( Elective-I ) Mechanical Behavior of Materials | ME5005D | Min. "D" | Min. "D" | 5.0 |

**Course Objectives:**

The purpose of this course is to introduce the undergraduate students with

1. To understand deformation behaviour of ferrous and non-ferrous alloys.
2. Knowledge of elastic behaviour of metals, ceramics and polymers.
3. To provide an overview of microscopic view of plastic deformation.
4. To perform selection of materials for various applications.
5. Able to predict deformation at high temperature.

**Unit 1: Introduction to Deformation Behavior:** Concept of stresses and strains, engineering stresses and strains, Different types of loading and temperature encountered in applications, Tensile Test - stress - strain response for metal, elastic region, yield point, plastic deformation, necking and fracture, Bonding and Material Behaviour, theoretical estimates of strength of materials.

**Elasticity Theory:** The State of Stress and strain, stress and strain tensor, tensor transformation, principal stress and strain, elastic stress-strain relation, anisotropy, elastic behaviour of metals, ceramics and polymers.

**Unit 2: Yielding and Plastic Deformation:** Hydrostatic and Deviatoric stress, Octahedral stress, yield criteria and yield surface, texture and distortion of yield surface, Limitation of engineering strain at large deformation, true stress and true strain, effective stress, effective strain, flow rules, strain hardening, Ramberg-Osgood equation, stress - strain relation in plasticity, plastic deformation of metals

**Unit 3: Microscopic view of plastic deformation:** crystals and defects, classification of defects, thermodynamics of defects, geometry of dislocations, slip and glide, dislocation generation - Frank Read and grain boundary sources, stress and strain field around dislocations, force on dislocation - self-stress, dislocation interactions, partial dislocations, twinning, dislocation movement and strain rate, deformation behavior of single crystal, critical resolved shear stress (CRSS), deformation of poly-crystals - Hall-Petch and other hardening mechanisms, grain size effect - source limited plasticity, Hall-Petch breakdown, dislocations in ceramics and glasses.

**Unit 4: Fracture:** fracture in ceramics, polymers and metals, different types of fractures in metals, fracture mechanics - Linear fracture mechanics -KIC, elasto-plastic fracture mechanics - JIC, Measurement and ASTM standards, Design based on fracture mechanics, effect of environment, effect of microstructure on KIC and JIC, application of fracture mechanics in the design of metals, ceramics and polymers.

**Deformation under cyclic load - Fatigue:** S-N curves, Low and high cycle fatigue, Life cycle prediction, Fatigue in metals, ceramics and polymers.

**Unit 5: Deformation at High temperature:** Time dependent deformation - creep, different stages of creep, creep and stress rupture, creep mechanisms and creep mechanism maps, creep under multi-axial loading, microstructural aspects of creep and design of creep resistant alloys, high temperature deformation of ceramics and polymers.

**Books References**


1. Mechanical Metallurgy – George E. Dieter
2. Mechanical Behavior of materials – Thomas H. Courtney
3. Strond solid – A.Kelly
4. Materials Science and Engineering – William D. Callister, Jr.
5. Mechanics of composite materials – Autar K. Kaw Wallace – Thermodynamics of Crystals.


**Evaluation**

Evaluation will be continuous an integral part of the class as well through external assessment.

## (ELECTIVE -I) MECHANICAL BEHAVIOR OF MATERIALS

**List of Experiments (may be expanded):**

1. Study of stress strain curve for various materials using UTM.
2. Study of properties of High Temperature Materials.
3. Study of properties and applications of Nuclear Materials.
4. Study of deformation under cyclic load (draw S-N curve).
5. Study of fatigue in metals, ceramics and polymers.
6. Study of various crystals defects in materials.