GURU KASHI UNIVERSITY

Bachelor of Technology in Mechanical Engineering
(BME)

Session: 2022-23

Department of Mechanical Engineering

PROGRAMME LEARNING OUTCOMES

- The programme emphasizes to enable to develop Professional competencies and reflect on policies and practices of higher education.
- It also targets to develop the skills to apply technology in education and fortheir professionaldevelopment and to carry out researchon the issues of global community.

Course Structure

Semester: 1st (Physics Group)						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
BME101	Basic Electrical Engineering	Core Course	3	1	0	4
BME102	Physics –I (Electromagnetism)	Core Course	3	1	0	4
BME103	Mathematics-1 (Calculus & Linear Algebra)	Core Course	3	1	0	4
BME104	Engineering Graphics & Drawing	Skill Based	1	0	4	3
BME105	Physics –I (Electromagnetism) Lab	Skill Based	0	0	2	1
BME106	Basic Electrical Engineering Lab	Skill Based	0	0	2	1
BME107	Road Safety	Ability Enhancement	1	0	0	1
Discipline Elective-I (Anyone of the following)						
BME108	Introduction to Mechanical Engineering	Discipline Elective	3	0	0	3
BME109	Engineering Materials					
Total			14	3	8	21

Semester: 2nd (Chemistry Group)						
Course Code	**Course Name**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
BME201	Engineering Chemistry	Core Course	3	1	0	4
BME202	Mathematics–II (ODE & Complex Variables)	Core Course	3	1	0	4
BME203	Programming for Problem Solving	Skill Based	3	0	0	3
BME204	Communication Skills	Skill Based	3	0	0	3
BME205	Manufacturing Practices	Skill Based	1	0	4	3
BME206	Engineering Chemistry Lab	Skill Based	0	0	2	1
BME207	Programming for Problem Solving Lab	Skill Based	0	0	2	1
BME208	Communication Skills Lab	Skill Based	0	0	2	1
Value Added Course(Any one) For other disciplines also						
BME209	Numerical Aptitude & Reasoning Ability	VAC	1	0	0	1
BME210	Digital Marketing					
BME211	Stress Management					
Discipline Elective-II (Anyone of the following)						
BME212	Basic Thermodynamics	Discipline Elective	3	0	0	3
BME213	Non Conventional Energy Resources					
Total			17	2	10	24

Semester: 3rd						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
BME301	Fluid Mechanics	Core Course	3	1	0	4
BME302	Theory of Machines - I	Core Course	3	1	0	4

BME303	Machine Drawing	Skill Based	1	0	4	3
BME304	Strength of Materials-I	Core Course	3	1	0	4
BME305	Applied Thermodynamics-I	Core Course	3	1	0	4
BME306	Strength of Materials-I Lab	Skill Based	0	0	2	1
BME307	Theory of Machines-I Lab	Skill Based	0	0	2	1
BME308	Fluid Mechanics Lab	Skill Based	0	0	2	1
BME309	Summer/Institutional Training *	Skill Based	NA	NA	NA	2
Discipline Elective-III (Anyone of the Following)						
BME310	Internal Combustion Engine	Discipline Elective	3	0	0	3
BME311	Energy Conservation And Management					
BME312	Automobile Engineering					
BME399		MOOC	-	-	-	
Total			18	4	10	27

Note:
*-Instititional Training will be imparted in the Institute at the end of 2nd Semester for 6-weeks duration. However this Subject is not applicable to LEET Students

Semester: 4th						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
BME401	Applied Thermodynamics- II	Core Course	3	1	0	4
BME402	Strength of Materials-II	Core Course	3	1	0	4
BME403	Theory of Machines-II	Core Course	3	1	0	4
BME404	Material Engineering & Metallurgy	Core Course	4	0	0	4

BME405	Environmental Studies	Ability Enhancement	2	0	0	2
BME406	Applied Thermodynamics-II Lab	Skill Based	0	0	2	1
BME407	Material Engineering Lab	Skill Based	0	0	2	1
Discipline Elective-IV (Anyone of the following)						
BME408	Non Traditional Machining	Discipline Elective	3	0	0	3
BME409	Computer Aided Manufacturing					
BME410	Computer Aided Process Planning					
BCS415	Basics of Management	Value Added Course	2	0	0	2
Open Elective Course						
	Open Elective	OEC	2	0	0	2
Total			20	3	4	27
Open Elective Courses (For other Departments)						
	Industrial Safety and Environment	IDC	2	0	0	2
	Total Quality Management	IDC	2	0	0	2

Semester: 5th						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
BME501	Heat Transfer	Core Course	3	1	0	4
BME502	Numerical Methods	Ability Enhancement	3	1	0	4
BME503	Mechanical Measurement and Metrology	Core Course	4	0	0	4
BME504	Manufacturing Process	Skill Based	4	0	0	4
BME505	Engineering Mechanics	Skill Based	4	0	0	4
BME506	Project-I	Research Skill	0	0	2	1

BME507	Heat Transfer Lab	Skill Based	0	0	2	1
Discipline Elective-V (Anyone of the following)						
BME508	Modern Welding Formation Process	Discipline Elective	3	0	0	3
BME509	Machining Science					
BME510	Composite Material					
BME599	MOOC	MOOC	-	-	-	
Total			23	2	4	27

Semester: 6th						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
BME601	Refrigeration &Air-conditioning	Core Course	4	0	0	4
BME602	Mechanical Vibration	Core Course	3	1	0	4
BME603	Manufacturing Technology	Skill Based	4	0	0	4
BME604	Industrial Automation & Robotics	Skill Based	4	0	0	4
BME605	Mechanical Vibration Lab	Skill Based	0	0	2	1
BME606	Project-II*	Research Skill	0	0	2	1
BME607	Mechanical Measurement & Metrology Lab	Skill Based	0	0	2	1
Discipline Elective-VI (Anyone of the following)						
BME608	Casting Processes	Discipline Elective	3	0	0	3
BME609	Micromachining Technologies					
BME610	Plastic Technology					

Total	18	1	6	22

Semester: 7th						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
BME701	Design of Machine Elements	Core Course	4	0	0	4
BME702	Computer Aided Design	Core Course	4	0	0	4
BME703	Operation Research	Core Course	4	0	0	4
BME704	Research Methodology	Core Course	4	0	0	4
BME705	Computer Aided Design Lab	Skill Based	0	0	4	2
BME706	Project-III**	Research Skill	0	0	2	1
Discipline Elective-VIII (Anyone of the following)						
BME707	Heat Exchange Design	Discipline Elective	3	0	0	3
BME708	Gas Dynamics And Jet Propulsion					
BME709	Cryogenic Technologies					
Discipline Elective-IX (Opt any one)						
BME710	Computational Fluid Dynamics	Discipline Elective	3	0	0	3
BME711	Mechatronics					
BME712	Product Design And Development					
	MOOC	MOOC	-	-	-	
Total			**22**		**6**	**25**

Semester: 8th						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	Credits
BME801	Internship	Skill Based	NA	NA	NA	20
Total						20
Grand Total			**130**	**15**	**48**	**191**

Evaluation Criteria for Theory Courses

A. Continuous Assessment: [25 Marks]
   i. Continuous Assessment-I:[10 Marks]
   ii. Continuous Assessment-II:[10 Marks]
   iii. Continuous Assessment-III:[5 Marks]
B. Attendance : [5 marks]
C. Mid Semester Test-1: [30 Marks]
D. MST-2: [20Marks]
E. End-Term Exam: [20 Marks]

Evaluation Criteria for Practical Courses

A. Performance of Each Practical: [10Marks]
B. Report/File: [5 Marks]
C. Viva: [5Marks]

Evaluation of Training/Internship

A. SemesterTraining: [25 Marks each]Monthly Report
B. 6WeeksTraining: [25 Marks each] Weekly Report
C. 4 WeeksTraining: [25 Marks each] Weekly Report

SEMESTER: I

L	T	P	Credits
3	1	0	4

COURSE TITLE: BASIC ELECTRICAL ENGINEERING
COURSE CODE: BME101

Learning Outcomes:

On successful completion of this course, students would be able to:

1. Discuss the DC and AC electrical circuit elements with RLC in detail.
2. Analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems.
3. Analyze Single Phase AC Circuits and representation of alternating quantities and determining the power in these circuits.
4. Classify the different types of Electrical machines.
5. Understand the different type of electrical installation devices.

Course Content

UNIT I **10 Hours**

DC Circuits

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.

UNIT II **18 Hours**

AC Circuits

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three-phase balanced circuits, voltage and current relations in star and delta connections.

Transformers

Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

UNIT III **16 Hours**

Electrical Machines

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators.

UNIT IV **16 Hours**

Power Converters

DC-DC buck and boost converters, duty ratio control. Single-phase and three-phase voltage source inverters; sinusoidal modulation.

Electrical Installations

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Suggested Readings

1. Kothari, D. P. and Nagrath, I. J. (2010). *Basic Electrical Engineering*. Tata McGraw Hill.
2. Kulshreshtha, D. C. (2009). *Basic Electrical Engineering*. McGraw Hill.
3. Bobrow, L. S. (2011). *Fundamentals of Electrical Engineering*. Oxford University Press.
4. Hughes, E. (2010). *Electrical and Electronics Technology*. Pearson

SEMESTER: I

COURSE TITLE: PHYSICS (ELECTROMAGNETISM)

COURSE CODE: BME102

L	T	P	Credits
3	1	0	4

Learning Outcomes:

On successful completion of this course, students would be able to:

1. Apply knowledge of electricity and magnetism to explain natural physical processes and related technological advances
2. Use the knowledge regarding calculus along with physical principles to effectively solve problems encountered in everyday life, further study in science, and in the professional world
3. Design experiments and acquire data in order to explore physical principles, effectively communicate results, and critically evaluate related scientific studies.
4. Assess the contributions of physics to our evolving understanding of global change and sustainability while placing the development of physics in its historical and cultural context
5. Acknowledge the concepts of induction and self-induction, to solve problems using Faraday's and Lenz's laws and analyze and solve RL circuits

Course Content

UNIT I **16 Hours**

Electrostatics in vacuum

Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential and uniqueness of their solution and connection with steady state diffusion and thermal conduction; Practical examples like Farady's cage and coffee-ring effect; Boundary conditions of electric field and electrostatic potential; method of images; energy of a charge distribution and its expression in terms of electric field.

UNIT II **18 Hours**

Electrostatics in a linear dielectric medium

Electrostatic field and potential of a dipole. Bound charges due to electric polarization; Electric displacement; boundary conditions on displacement; Solving simple electrostatics problems in presence of dielectrics – Point charge at the centre of a dielectric sphere, charge in front of a dielectric slab, dielectric slab and dielectric sphere in uniform electric field.

Magnetostatics

Bio-Savart law, Divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; the equation for the vector potential and its solution for given current densities.

Magnetostatics in a linear magnetic medium

Magnetization and associated bound currents; auxiliary magnetic field; Boundary conditions on and solving for magnetic field due to simple magnets like a bar magnet; magnetic susceptibility and ferromagnetic, paramagnetic and diamagnetic materials; Qualitative discussion of magnetic field in presence of magnetic materials.

UNITIII **12 Hours**

Faraday's law

Faraday's law in terms of EMF produced by changing magnetic flux; equivalence of Faraday's law and motional EMF; Lenz's law; Electromagnetic breaking and its applications; Differential form of Faraday's law expressing curl of electric field in terms of time-derivative of magnetic field and calculating electric field due to changing magnetic fields in quasi-static approximation; energy stored in a magnetic field.

UNIT IV **12 Hours**

Displacement current, Magnetic field due to time-dependent electric field and Maxwell's equations

Continuity equation for current densities; Modifying equation for the curl of magnetic field to satisfy continuity equation; displace current and magnetic field arising from time-dependent electric field; calculating magnetic field due to changing electric fields in quasi-static approximation. Maxwell's equation in vacuum and non-conducting medium; Energy in an electromagnetic field; Flow of energy and Poynting vector with examples. Qualitative discussion of momentum in electromagnetic fields.

Electromagnetic waves

The wave equation; Plane electromagnetic waves in vacuum, their transverse nature and polarization; relation between electric and magnetic fields of an electromagnetic wave; energy carried by electromagnetic waves and examples. Momentum carried by electromagnetic waves and resultant pressure. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

Suggested Reading

1. David J Griffths. (1999). *Introduction to Electrodynamics*. PrenticeHall.
2. Walker, Jearl, David Halliday, and Robert Resnick. (2011). *Fundamentals of Physics*. Hoboken, N.J: Wiley.
3. Saslow, W. (2008). *Electricity, magnetism and light*. e-book.

SEMESTER: I

COURSE TITLE: MATHEMATICS –I (CALCULUS AND LINEAR ALGEBRA)
COURSE CODE: BME103

L	T	P	Credits
3	1	0	4

Learning Outcomes:

On successful completion of this course, students would be able to:

1. To apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.
2. The fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
3. The tool of power series and Fourier series for learning advanced Engineering Mathematics.
4. To deal with functions of several variables that is essential in most branches of engineering.
5. The essential tool of matrices and linear algebra in a comprehensive manner.

Course Content

UNIT I **28 Hours**

a. Calculus:

Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

Rolle's theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Indeterminate forms and L'Hospital's rule; Maxima and minima.

b. Advanced Calculus

Differentiation: Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.

Integration: Multiple Integration: double and triple integrals (Cartesian and polar), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes by (double integration) Center of mass and Gravity (constant and variable
densities). Theorems of Green, Gauss and Stokes, orthogonal curvilinear coordinates, Simple
applications involving cubes, sphere and rectangular parallelepipeds.

c. Trigonometry

Hyperbolic and circular functions, logarithms of complex number resolving real and imaginary parts of a complex quantity, De Moivre's Theorem.

Theory of equations:Relation between roots and coefficients, reciprocal Equations, transformation of equations and diminishing the roots.

UNIT II **10 Hours**

Matrices

Matrices: addition and scalar multiplication, matrix multiplication; Linear systems of equations, linear Independence, rank of a matrix, determinants, Cramer's Rule, inverse of a matrix, Eigen values & vectors.

UNIT III **10 Hours**

Sequences and series

Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

UNIT IV **12 Hours**

Algebra

Vector Space, linear dependence of vectors, basis, dimension; Linear transformations (maps), range and kernel of a linear map, rank and nullity, Inverse of a linear transformation, rank-nullity theorem, composition of linear maps, Matrix associated with a linear map. Eigenvalues, eigenvectors, symmetric, skew-symmetric, and orthogonal Matrices, eigenbases. Diagonalization; Inner product spaces, Gram-Schmidt orthogonalization.

Suggested Readings

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
3. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
4. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
5. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
6. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
7. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
8. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
9. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
10. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
    1. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
11. 2. V. Krishnamurthy, V.P. Mainra and J.L. Arora, An introduction to Linear Algebra, Affiliated East–West press, Reprint 2005.
12. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
13. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
14. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
15. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.

SEMESTER: I

COURSE TITLE: ENGINEERING GRAPHICS & DESIGN
COURSE CODE: BME104

L	T	P	Credits
1	0	4	3

Learning Outcomes:

On successful completion of this course, the students would be able to:

1. Understand about engineering drawing applications and its importance in society.
2. Learn about the visual aspects of engineering design
3. Understand the engineering graphics standards.
4. Understand the concept of solid modeling techniques.
5. Apply the computer-aided geometric design in engineering

Course Content

UNIT I **10 Hours**

1. Introduction to Engineering Drawing covering, Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales.
2. Orthographic Projections covering, Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes.

UNIT II **10 Hours**

1. Projections of Regular Solids covering, those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.
2. Sections and Sectional Views of Right Angular Solids covering, Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only)

UNIT III **12 Hours**

1. Isometric Projections covering, Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;
2. Overview of Computer Graphics covering, listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids];
3. Customization & CAD Drawing consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, Snap to objects

manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

UNIT IV **12 Hours**

1. Annotations, layering & other functions covering applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory including sketching of perspective, isometric, multi view, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerance techniques; dimensioning and scale multi views of dwelling;
2. Demonstration of a simple team design project that illustrates Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerance; Use of solid-modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying color coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modeling (BIM).

Suggested Readings

1. Gill, P.S.(2001).*Engineering Drawing*. S.K; Kataria and Sons, Ludhiana.
2. Bhatt, N.D.(2012). *Engineering Drawing*. Charotar Book Stall, TulsiSadan, Anand.
3. French, T.E. and Vierck. C.J.(1993).*Graphic Science*. McGraw-Hill, New York.
4. Zozzora, F.(1958). *Engineering Drawing*. McGraw Hill, NewYork.
(Corresponding set of) CAD Software Theory and User Manuals

SEMESTER: I

Course Title: PHYSICS (ELECTROMAGNETISM) LAB
Course Code: BME105

L	T	P	Credits
0	0	2	1

Learning Outcomes

On successful completion of this course, the students would be able to:

1. Apply knowledge Experiments on electromagnetic induction and electromagnetic breaking.
2. Predict use LC circuit and LCR circuit.
3. Design Resonance phenomena in LCR circuits
4. Assess Magnetic field from Helmholtz coil.
5. Understand Measurement of Lorentz force in a vacuum tube

Course Content

List of Experiments:

1. Experiments on electromagnetic induction and electromagnetic breaking;
2. LC circuit and LCR circuit;
3. Resonance phenomena in LCR circuits;
4. Magnetic field from Helmholtz coil;
5. Measurement of Lorentz force in a vacuum tube.

SEMESTER: I

Course Title: BASIC ELECTRICAL ENGINEERING LAB
Course Code: BME106

L	T	P	Credits
0	0	2	1

Course Content

List of Experiments:

1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
2. Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope). Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage. Resonance in R-L-C circuits.
3. Transformers: Observation of the no-load current waveform on an oscilloscope (non-sinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a discussion about harmonics). Loading of a transformer: measurement of primary and secondary voltages and currents, and power.
4. Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line-line voltage, phase-to-neutral voltage, line and phase currents). Phase-shifts between the primary and secondary side. Cumulative three-phase power in balanced three-phase circuits.

5. Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
6. Torque Speed Characteristic of separately excited dc motor.
7. Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections. Torque-Slip Characteristic of an induction motor. Generator operation of an induction machine driven at super-synchronous speed.
8. Synchronous Machine operating as a generator: stand-alone operation with a load. Control of voltage through field excitation.
9. Demonstration of (a) dc-dc converters (b) dc-ac converters – PWM waveform (c) the use of dc-ac converter for speed control of an induction motor and (d) Components of LT switchgear.

SEMESTER: I

Course Title: ROAD SAFETY
Course Code: BME107

L	T	P	Credits
1	0	0	1

Learning Outcomes:

On successful completion of this course, the students would be able to:

1. Demonstrate Schrodinger equation, Particle in a box solution and their applications
2. Conjugated molecules and Nanoparticles,
3. Evaluate band structure of solids and the role of doping on band structures.
4. Distinguish the ranges of Vibrational and rotational spectroscopy of diatomic molecules,
5. Applications, Nuclear magnetic resonance and magnetic resonance imaging

Course Content

Unit –I **3 Hours**
Importance of Road Safety

Unit –II **3 Hours**
Safe and Responsible Driving

Unit –III **3 Hours**
Road Signs

Unit –IV **3 Hours**
Driving Rules and Registration

Unit –V **3 Hours**
Driving License

SEMESTER: I

Course Title: INTRODUCTION TO MECHANICAL ENGINEERING

Course Code: BME108

L	T	P	Credits
3	0	0	3

Learning Outcomes:

On successful completion of this course, the students would be able to:

1. Comprehend the basic concepts of thermodynamics,
2. Understand the concepts of boilers, turbines and refrigeration.
3. Distinguish different metal joining techniques,
4. Enumerate the knowledge of engineering materials, their specifications

Course Content

UNIT I **12 Hours**

1. **Basic concepts of Thermodynamics**: Introduction, states, concept of work, heat, temperature; Zeroth, Ist, 2nd and 3rd laws of thermodynamics. Concept of internal energy, enthalpy and entropy (simple numericals)
2. **Boilers**: Introduction to boilers, classification, Lancashire boiler, Babcock and Wilcox boiler. Introduction to boiler mountings and accessories (no sketches).
3. **Turbines:** Hydraulic Turbines — Classification and specification, Principles and operation of Pelton wheel turbine, Francis turbine and Kaplan turbine (elementary treatment only). Hydraulic Pumps: Introduction, classification and specification of pumps, reciprocating pump and centrifugal pump, concept of cavitation and priming

UNIT II **12 Hours**

Properties, Composition and Industrial Applications of engineering materials Metals — Ferrous: cast iron, tool steels and stainless steels and nonferrous: aluminum, brass, bronze. Polymers - Thermoplastics and thermosetting polymers. Ceramics - Glass, optical fiber glass, cermets. Composites - Fiber reinforced composites, Metal Matrix Composites Smart materials — Piezoelectric materials, shape memory alloys, semiconductors and insulators.

UNIT III **8 Hours**

Joining Processes: Soldering, Brazing and Welding Definitions. Classification and methods of soldering, brazing and welding. Brief description of arc welding, oxy-acetylene welding, TIG welding, and MIG welding. Belt drives Open & crossed belt drives, Definitions - slip, creep, velocity ratio, derivations for length of belt in open and crossed belt drive, ratio of tension in flat belt drives, advantages and disadvantages of V belts and timing belts, simple numerical problems. Gear drives Types—spur, helical, bevel, worm and rack and pinion. Velocity ratio, advantages and disadvantages over belt drives, simple numerical problems on velocity ratio

UNIT IV **10 Hours**

Refrigeration and Air conditioning Refrigeration - Definitions - Refrigerating effect, Ton of Refrigeration, Ice making capacity, COP, relative COP, Unit of Refrigeration. Refrigerants, Properties of refrigerants, List of commonly used refrigerants. Principle and working of vapor compression refrigeration and vapor absorption refrigeration. Domestic refrigerator. Principles and applications of air conditioners, window and split air conditioners.

Suggested Readings

1. Dossat, R. J., *Principles of Refrigeration*, PHI
2. Heywood, J., *Internal Combustion Engine Fundamentals*, McGraw Hill Publishers
3. Holman, J. P., *Thermodynamics*, McGraw Hill Co.
4. Jain, K. K. and Asthana, R. B., *Automobile Engineering*, TTTI Bhopal
5. Jonathan Wickert, *Introduction to Mechanical Engineering*, Cengage Learning
6. Kalpakjian, S. and Schmid, S. R., *Manufacturing Processes for EngineeringMaterials*, Pearson education Maines,
7. R., *Landmarks in Mechanical Engineering*, ASME

SEMESTER: I

Course Title: ENGINEERING MATERIALS
Course Code: BME109

L	T	P	Credits
3	0	0	3

Learning Outcomes:

On successful completion of this course, the students would be able to:

1. Understand the behavior of materials for different loading conditions
2. Analyze different phase diagrams, related composition and microstructure
3. Understand heat treatment methods of steel and their properties
4. Understand solidification process in casting and material degradation
5. Discuss Non Destructive methods of testing materials

Course Content

UNIT I **10 Hours**

Properties, Composition and Industrial Applications of engineering materials Metals — Ferrous: cast iron, tool steels and stainless steels and nonferrous: aluminum, brass, bronze. Polymers - Thermoplastics and thermosetting polymers. Ceramics - Glass, optical fiber glass, cermets. Composites - Fiber reinforced composites, Metal Matrix Composites Smart materials — Piezoelectric materials, shape memory alloys, semiconductors and insulators

UNIT II **11 Hours**

Mechanical behavior of Materials: Plastic deformation of metals, Mechanism of plastic deformation, role of dislocation in plastic deformation and Work Hardening. Fracture-mechanism of Ductile and brittle fracture, Ductile to brittle transition, Fatigue- Types of loading, S-N curve

UNIT III **10 Hours**

Environmental Degradation of Materials: Different forms of environmental degradation, forms of corrosion- Galvanic, Intergranular, pitting, stress related corrosion. Corrosion control- Materials selection, protective coating

UNIT IV **10 Hours**

NON DESTRUCTIVE TESTING: Non Destructive Testing basic principles, Advantages and testing methods like Liquid penetrant inspections, Magnetic particle inspection, Ultrasonic testing, and Eddy current.

Suggested Readings

1. Avner, S. H.(1974*). Introduction to Physical Metallurgy*. Tata McGraw Hill BookCompany.
2. Raghavan, V.(2015*). Physical Metallurgy: Principles and Practice*. Prentice Hall ofIndia.
3. Wadhwa, A. S. & Dhaliwal, H. S.(2008).*Engineering Materials and Metallurgy*. Laxmi Publications Pvt. Ltd.
4. Callister, W. D.(2010). *Material Science and Engineering*.JohnWiley&Sons.

SEMESTER: II

Course Title: ENGINEERING CHEMISTRY
Course Code: BME201

L	T	P	Credits
3	1	0	4

Learning Outcomes:

On successful completion of this course, the students would be able to:

1. Demonstrate Schrodinger equation, Particle in a box solution and their applications
2. Conjugated molecules and Nanoparticles,
3. Evaluate band structure of solids and the role of doping on band structures.
4. Distinguish the ranges of Vibrational and rotational spectroscopy of diatomic molecules,
5. Applications, Nuclear magnetic resonance and magnetic resonance imaging
5. Rationalize periodic properties such as ionization potential, electro-negativity, Oxidation states and electro-negativity.
6. List the Thermodynamic functions: energy, entropy and free energy and also Estimations of entropy and free energies.

Course Content

UNIT I **14 Hours**

Atomic and molecular structure

Schrodinger equation, Particle in a box solution and their applications for conjugated molecules and Nanoparticles, Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations, Molecular orbitals of diatomic molecules and plots of the multicenter orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

UNIT II **14 Hours**

1. Spectroscopic techniques and applications

Principles of spectroscopy and selection rules, Electronic spectroscopy, Fluorescence and its applications in medicine, Vibrational and rotational spectroscopy of diatomic molecules, Applications, Nuclear magnetic resonance and magnetic resonance imaging, surface characterisation techniques, Diffraction and scattering.

2. **Intermolecular forces and potential energy surfaces**

Ionic, Dipolar and Vander Waals interactions, Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.

UNIT III **14 Hours**

1. Use of free energy in chemical equilibria

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria, Water chemistry, Corrosion,Use of free energy considerations in metallurgy through Ellingham diagrams.

2. Periodic properties

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries

UNIT IV **14 Hours**

1. Stereochemistry

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds

2. Organic reactions and synthesis of a drug molecule

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.

Suggested Readings

1. Mahan, B. H. (1987). University chemistry.
2. Sienko, M. J. & Plane, R. A. *Chemistry. (1979): Principles and* Applications. New York: McGraw-Hill.
3. Banwell, C. N. (1966). *Fundamentals of Molecular Spectroscop.* New York, McGraw-Hill.
4. Tembe, B. L., Kamaluddin& Krishnan, (2008). M. S. *Engineering Chemistry (NPTEL Web-book).*

SEMESTER: II

Course Title: MATHEMATICS –II (ODE & COMPLEX VARIABLES)
Course Code: BME202

L	T	P	Credits
3	1	0	4

Course Learning Outcomes

On successful completion of this course, the students would be able to:

1. Demonstrate the methods of forming and solving Ordinary differential equations and Solve linear differential equations with constant and variable coefficients
2. Explain the concept of differential equation and classifies the differential equations with respect to their order and linearity.
3. Solve first-order ordinary and exact differential equations and converts separable and homogeneous equations to exact differential equations by integrating factors.
4. Apply the method of undetermined coefficients to solve the non-homogeneous linear differential equations with constant coefficients.
5. Compare the Methods of Cauchy's Riemann Integral and Analytical methods.

Course Content

UNIT I **14 Hours**

Multivariable Calculus (Integration)

Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

UNIT II **12 Hours**

First order ordinary differential equations

Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

UNIT III **16 Hours**

1. Ordinary differential equations of higher orders:

Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

2. Complex Variable – Differentiation:

Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

UNIT IV **12 Hours**

Complex Variable – Integration:

Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula(without proof), Liouville's theorem and Maximum-Modulus theorem (without proof);Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, CauchyResidue theorem (without proof), Evaluation of definite integral involving sine and cosine,Evaluation of certain improper integrals using the Bromwich contour.

Suggested Reading

1. Thomes, G.B.and Finney, R.L.(2010)*Calculus and Analytic Geometry*; Ninth Edition; Pearson Education
2. Kreyszig, E. (1998) *Advanced Engineering Mathematics*; Eighth Edition, John wiley and sons.
3. Grewal, B.S. (1965) *Higher Engineering Mathematics*; Khanna Publishers, New Delhi.
4. BabuRam (2009) *Advance Engineering Mathematics*; First Edition; Pearson Education.
5. Richard Courant and Fritz John (2012).Introduction to Calculus and Analysis, Volume II, VSpringer Publication.
6. Harold M. Edwards (2013) *Advanced Calculus: A Differential Forms Approach*, Birkhauser.

SEMESTER: II

Course Title: PROGRAMMING FOR PROBLEM SOLVING
Course Code: BME203

L	T	P	Credits
3	0	0	3

Learning Outcomes:

On successful completion of this course, the students would able to:

1. Design the algorithms to write a programs.
2. Apply arrays, pointers and structures to formulate algorithms and programs
3. Apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration
4. To implement conditional branching, iteration and recursion
5. Test and execute the programs and correct syntax and logical errors

Course Content

UNIT I **8 Hours**

1. Introduction to Programming
2. Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.)
3. Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples.
4. From algorithms to programs; source code, variables (with data types) variables and memory
5. Locations, Syntax and Logical Errors in compilation, object and executable code

UNIT II **12 Hours**

1. Arithmetic expressions and precedence
2. Conditional Branching and Loops
3. Writing and evaluation of conditionals and consequent branching
4. Iteration and loops
5. Arrays: Arrays (1-D, 2-D), Character arrays and Strings

UNIT III **15 Hours**

1. Basic Algorithms
   Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of Equations, notion of order of complexity through example programs (no formal definition required)
2. Function
   Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference.
3. Recursion
   Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

UNIT IV **10 Hours**

1. Structure

Structures, Defining structures and Array of Structures

2. Pointers
   Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)
   File handling (only if time is available, otherwise should be done as part of the lab)

Suggested Readings

1. Byron Gottfried, Schaum's (1995), *Outline of Programming with C,* McGraw-Hill
2. E. Balaguruswamy (2005) Programming in ANSI C, Tata McGraw-Hill

SEMESTER: II

Course Title: COMMUNICATION SKILLS
Course Code: BME204

L	T	P	Credits
3	0	0	3

Learning Outcomes

On successful completion of this course, the students would be able to:
1. Develop vocabulary and improve the accuracy in Grammar.
2. Apply the concepts of accurate English while writing and become equally ease at using good vocabulary and language skills.
3. Develop and Expand writing skills through Controlled and guided activities
4. Compose articles and compositions in English
5. Become autonomous and self-directed English language learners.

Course Content

UNIT I **10 Hours**

Vocabulary Building

The concept of Word Formation, Root words from foreign languages and their use in English, Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives. Synonyms, antonyms, and standard abbreviations.

UNIT II **10 Hours**

Basic Writing Skills

Sentence Structures, Use of phrases and clauses in sentences, Importance of proper punctuation, Creating coherence, Organizing principles of paragraphs in documents, Techniques for writing precisely

UNIT III **10 Hours**

Identifying Common Errors in Writing

Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés

UNIT IV **12 Hours**

1. Nature and Style of sensible Writing)

Describing, Defining, Classifying, Providing examples or evidence, Writing introduction and conclusion

2. **Writing Practices):** Comprehension, Précis Writing, Essay Writing

Suggested Readings

1. Swan, Michael. (1995). *Practical English*. OUP.
2. Wood, F.T. (2007). *Remedial English Grammar*.Macmillan.
3. Zinsser, W. (2001). *On Writing Well*. Harper Resource Book.
4. Lyons, L. H.&Heasly, B.(2006). *Study Writing*. Cambridge University Press.
5. Kumar, S &Lata, P. (2011). *Communication Skills*. Oxford University Press.
6. CIEFL, Hyderabad. *Exercises in Spoken English. Parts. I-III*. Oxford University Press.

SEMESTER: II

Course Title: MANUFACTURING PRACTICES
Course Code: BME205

L	T	P	Credits
1	0	4	3

Learning Outcomes:

On successful completion of this course, the students would be able to:

1. Apply the various manufacturing methods in different fields of engineering.
2. Learn about the different fabrication techniques.
3. Learn about the practices in manufacturing of simple components using different materials.
4. Understand the advanced and latest manufacturing techniques being used in engineering industry.
5. Prepare different sand molds for various parts.

Course Content

UNIT I **4 Hours**

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods
2. CNC machining, Additive manufacturing

UNIT II **3 Hours**

1. Fitting operations & power tools
2. Electrical & Electronics
3. Carpentry

UNIT III **3 Hours**

1. Plastic moulding, glass cutting
2. Metal casting

UNIT IV **50 Hours**

Welding (arc welding & gas welding), brazing [More hours can be given to Welding for Civil Engineering students as they may have to deal with Steel structures fabrication and erection; 3D Printing is an evolving manufacturing technology and merits some lectures and hands-on training. (1 hour)

Workshop Practice:

1. Machine shop - 10 hours

2. Fitting shop - 8 hours
3. Carpentry - 6 hours
4. Electrical & Electronics - 8 hours
5. Welding shop - 8 hours (Arc welding 4 hours) + gas welding 4 hours))
6. Casting - 8 hours
7. Smithy - 6 hours
8. Plastic moulding& Glass Cutting -6 hours

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Suggested Readings

1. Raghuwanshi, B.S.(2009*). A Course in Workshop Technology, Vol 1 &II*.DhanpatRai &Sons.
2. Jain, R.K.(2010*).Production Technology*.Khanna Publishers.
3. Singh, S.(2003).*Manufacturing Practice*.S.K. Kataria&Sons.

SEMESTER: II

Course Title: ENGINEERING CHEMISTRY LAB
Course Code: BME206

L	T	P	Credits
0	0	2	1

Learning Outcomes:

On successful completion of this course, the students would be able to:

1. Estimate rate constants of reactions from concentration of reactants /products as a function of time
2. Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc
3. Apply the theoretical concepts for result analysis and interpret data obtained from experimentation
4. Identify the compound using a combination of qualitative test and analytical methods

Course Content

List of Experiments:

1. Determination of surface tension and viscosity
2. Thin layer chromatography
3. Ion exchange column for removal of hardness of water
4. Determination of chloride content of water
5. Colligative properties using freezing point depression
6. Determination of the rate constant of a reaction
7. Determination of cell constant and conductance of solutions

8. Potentiometry - determination of redox potentials and emfs
9. Synthesis of a polymer/drug
10. Saponification/acid value of an oil
11. Chemical analysis of a salt
12. Lattice structures and packing of spheres
13. Models of potential energy surfaces
14. Chemical oscillations- Iodine clock reaction
15. Determination of the partition coefficient of a substance between two immiscible liquids
16. Adsorption of acetic acid by charcoal
17. Use of the capillary viscosimeters to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

SEMESTER: II

Course Title: PROGRAMMING FOR PROBLEM SOLVING LAB
Course Code: BME207

L	T	P	Credits
0	0	2	1

Learning Outcomes:

On successful completion of this course, the students would be able to:

1. Create, read and write to and from simple text files.
2. Identify and correct logical errors encountered at run time
3. Apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration
4. Represent data in arrays, strings and structures and manipulate them through a program
5. Test and execute the programs and correct syntax and logical errors

Course Content

List of Experiments:

Tutorial 1: Problem solving using computers
Lab1: Familiarization with programming Environment

Tutorial 2: Variable types and type conversions
Lab 2: Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions
Lab 3: Problems involving if-then-else structures

Tutorial 4: Loops, while and for loops
Lab 4: Iterative problems e.g., sum of series

Tutorial 5: 1D Arrays: searching, sorting
Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and Strings, memory structure
Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value
Lab 7: Simple functions

Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numerical integration)
Lab 8 and 9: Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions

Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures

Tutorial 12: File handling
Lab 12: File operations

Suggested Readings:

1. Byron Gottfried, Schaum's (1995), *Outline of Programming with C,* McGraw-Hill
2. E. Balaguruswamy (2005) Programming in ANSI C, Tata McGraw-Hill.

.

SEMESTER: II

Course Title: COMMUNICATION SKILLS LAB
Course Code: BME208

L	T	P	Credits
0	0	2	1

Learning Outcomes:

On successful completion of this course, the students would be able to:
1. Illustrate the importance of pronunciation and apply the same day to day conversation
2. Apply verbal and non-verbal communication techniques in the Professional Environment
3. Develop coherence, cohesion and competence in Oral discourse.
4. Handle the interview process confidently.
5. Communicate contextually in specific personal and professional situations with courtesy.

Course Content **Total Hours: 15**

Oral Communication

(This unit involves interactive practice sessions in Language Lab)

- Listening Comprehension

- Pronunciation, Intonation, Stress and Rhythm
- Common Everyday Situations: Conversations and Dialogues
- Communication at Workplace
- Interviews
- Formal Presentations

SEMESTER: II

Course Title: NUMERICAL APTITUDE & REASONING ABILITY
Course Code: BME209

L	T	P	Cr.
1	0	0	1

Learning Outcomes:

On successful completion of this course, students would be able to:

1. Understand the basic concepts of quantitative ability
2. Understand the basic concepts of logical reasoning Skills
3. Acquire satisfactory competency in use of reasoning
4. Solve campus placements aptitude papers covering Quantitative Ability, Logical Reasoning Ability
5. Compete in various competitive exams like CAT, CMAT, GATE, GRE, GATE, UPSC, GPSC etc.

Course Content

UNIT I **4 Hours**

1. Quantitative Ability (Basic Mathematics)
1.1. Number Systems
1.2. LCM and HCF
1.3. Decimal Fractions
1.4. Simplification
1.5. Square Roots and Cube Roots
1.6. Average
1.7. Problems on Ages
1.8. Surds & Indices
1.9. Percentages
1.10 Problems on Numbers

UNIT II **4 Hours**

2. Quantitative Ability (Applied & Engineering Mathematics)
2.1. Logarithm
2.2. Permutation and Combinations
2.3 Probability

2.4 Profit and Loss
2.5 Simple and Compound Interest
2.6. Time, Speed and Distance
2.7. Time & Work
2.8. Ratio and Proportion
2.9. Area
2.10 Mixtures and Allegation

UNIT III **3 Hours**

3. Data Interpretation
3.1. Data Interpretation
3.2. Tables
3.3. Column Graphs
3.4. Bar Graphs
3.5. Line Charts
3.6. Pie Chart
3.7. Venn Diagrams

UNIT IV **4 Hours**

4. Logical Reasoning (Deductive Reasoning)
4.1. Analogy
4.2. Blood Relation
4.3 Directional Sense
4.4. Number and Letter Series
4.5. Coding – Decoding
4.6. Calendars
4.7. Clocks
4.8. Venn Diagrams
4.9. Seating Arrangement
4.10. Syllogism
4.11. Mathematical Operations

Suggested Readings:

1. A Modern Approach To Verbal & Non Verbal Reasoning By R S Agarwal
2. Analytical and Logical reasoning By Sijwali B S
3. Quantitative aptitude for Competitive examination By R S Agarwal
4. Analytical and Logical reasoning for CAT and other management entrance test By Sijwali B S
5. Quantitative Aptitude by Competitive Examinations by AbhijitGuha 4th edition

SEMESTER: II

Course Title: DIGITAL MARKETING
Course Code: BME210

L	T	P	Credits
1	0	0	1

Learning Outcomes:

On successful completion of this course, students would be able to:

1. Use digital marketing to increase sales in today's business world.
2. Use Google AdWords and can optimize on-page / off-page.
3. Maintain a good social media strategy.
4. Understand web analytics to optimize your website for better traffic and revenue generation.
5. Grasp the concepts and become familiar management of e-commerce store, marketing and uploading of products on website.
6. Make WordPress account and create website.
7. Grasp the concepts and become familiar e-mail and affiliate marketing.

Course Content

UNIT I **4 Hours**

1.Introduction to Digital Marketing

Defining digital marketing, how is it different from traditional marketing and why is it relevant now?

2.Search Engine Optimisation (SEO)

Techniques used to optimize any article, website, or blog for traffic & revenue generation.

3.Social Media Marketing

Using different social media platforms (Facebook/Instagram/Twitter) to connect with the audience & convert them to a call of action (purchase or form filling).

UNIT II **3 Hours**

1.Search Engine Marketing

Techniques used to increase the visibility of your webpage on Google search results (SERP); Search engine marketing mostly revolves around paid search advertising (text-based ads that are visible on top of every search result).

2. Web Analytics

Analyzing the behavior of visitors to a website through reports based on traffic source, referring sites, page views, and conversion rates of that website.

3.E-Commerce Management

Maintenance of an online product-listing website through product keyword research, product pricing, positive reviews, and customer retention.

UNIT III **4 Hours**

1.Planning and Creating a Website

How to create a website on WordPress and later use website analytics to track the behavior of visitors to a website.

2.Email Marketing

How to create and send product-based emails in bulk, and ensure that all of the emails have a good open rate and conversion rate.

UNIT IV **4 Hours**

1.Content Strategy

How to create content that matches the user intent and also your business goals.

2. Affiliate Marketing

Generation of traffic via a third party (company/website). The third party is paid a commission fee to drive traffic to your website.

Suggested Readings:

1. Deiss, R. &Henneberry, R (2020). *Digital Marketing For Dummies, 1st edition*. Dummies.
2. Kingsnorth, S. (2019). *Digital Marketing Strategy – An Integrated Approach to Online Marketing, 2nd edition*. KoganPage.

SEMESTER: II

Course Title: STRESS MANAGEMENT
Course Code: BME211

L	T	P	Cr.
1	0	0	1

Learning Outcomes:

On successful completion of this course, students would be able to:

1. Identify the nature and causes of stress in organizations
2. Knowledge of stress prevention mechanism
3. Demonstrate the strategies that help cope with stress
4. Apply stress management principles in order to achieve high levels of performance
5. Adopt effective strategies, plans and techniques to deal with stress

Course Content

UNIT I **4 Hours**

1. Understanding Stress (7 hours)
1.1 Stress – concept, features, types of stress
1.2 Relation between Stressors and Stress
1.3 Potential Sources of Stress – Environmental, Organizational and Individual
1.4 Consequences of Stress – Physiological, Psychological and Behavioural Symptoms
1.5 Stress at work place – Meaning, Reasons
1.6 Impact of Stress on Performance
1.7 Work Stress Model
1.8 Burnout – Concept
1.9 Stress v/s Burnout

UNIT II **4 Hours**

2. Managing Stress – I (8 hours)
2.1 Pre-requisites of Stress-free Life
2.2 Anxiety - Meaning, Mechanisms to cope up with anxiety
2.3 Relaxation - Concept and Techniques
2.4 Time Management - Meaning, Importance of Time Management
2.5 Approaches to Time Management
2.6 Stress Management - Concept, Benefits
2.7 Managing Stress at Individual level
2.8 Role of Organization in Managing Stress/ Stress Management Techniques
2.9 Approaches to Manage Stress - Action oriented, Emotion oriented, Acceptance oriented.

UNIT III **4 Hours**

3. Managing Stress – II (7 hours)
3.1 Models of Stress Management - Transactional Model, Health Realization/ Innate Health Model
3.2 General Adaption Syndrome (GAS) - Concept, Stages
3.3 Measurement of Stress Reaction - The Physiological Response,
3.4 The Cognitive Response, TheBehavioural Response.

3.5 Stress prevention mechanism - Stress management through mind control and purification theory and practice of yoga education.
3.6 Stress management interventions: primary, secondary, tertiary.
3.7 Meditation – Meaning, Importance

UNIT IV **4 Hours**

4. Stress Management Leading to Success (8 hours)
4.1 Eustress – Concept, Factors affecting Eustress
4.2 Stress Management Therapy - Concept, Benefits
4.3 Stress Counselling - Concept
4.4 Value education for stress management
4.5 Stress and New Technology
4.6 Stress Audit Process
4.7 Assessment of Stress - Tools and Methods
4.8 Future of Stress Management

Suggested Readings:

1. Heena T. Bhagtani. (2018). Stress Management. Himalaya Publishing House.
2. Dutta, P,K, (2010) Stress Management. Himalaya Publishing House.
3. Roy,S (2012). Managing Stress. Sterling Publication.

SEMESTER: II

Course Title: BASIC THERMODYNAMICS
Course Code: BME212

L	T	P	Credits
3	0	0	3

Learning Outcomes:

On successful completion of this course, the students would be able to:

1. Apply energy balance to Systems and Control Volumes in situations involving heat and work interactions.
2. Evaluate changes in thermodynamic properties of substances.
3. Evaluate performance of energy conversion devices.
4. Explain and apply various gas power and vapor power cycles.

Course Content

UNIT I **10**

HoursBasicConcepts

Definition of thermodynamics, Concept of Thermodynamic System and of thermodynamic equilibrium, Boundary and Surroundings; Open, Closed and Isolated Systems. Property, state, path, process and cycle; dot/point functions and path functions, Phase and pure substances, Equation of State, reversible, Quasi-static and irreversible processes; Energy and its forms, Energy transfer across the System boundaries. Types of work transfer, heat and work; sign conventions for heat and work interaction, Concept of temperature and heat, microscopic and macroscopic approach, Concept of continuum, Zeroth law of thermodynamics. Concept of thermal equilibrium and principles of thermometry. Ideal gas and characteristic gas equation.

UNIT II **12 Hours**

First Law of Thermodynamics

Concept of First law of thermodynamics, essence and corollaries of First law; internal energy and enthalpy, analysis of non flow and flow processes for an ideal gas for constant volume(isochoric), constant pressure(isobaric), constant temperature(isothermal), adiabatic and polytropic processes. Changes in various properties, work done and heat exchange during these processes, free expansion and throtting process and its applications in Engineering processes; Steady Flow Energy Equation and its application to various thermodynamic Systems(ie, in engineering devices);

UNIT III **12 Hours**

Second Law of Thermodynamics

Limitations of First law of thermodynamics, concept of Kelvin Plank and Clausius statements of the Second law and their equivalence and their application to Refrigerator, Heat Pump and Heat Engine. Thermodynamic temperature scale, Efficiency and philosophy of Carnot cycle and its consequences, Carnot Engine and Carnot theorem; Carnot refrigerator, Heat Pump and Heat Engines. Clausius theorem; Clausius inequality; concept of entropy, principleof increase in entropy, representation of various processes on T-S coordinates and change in entropy for different processes, concept of entropy generation in Closed and Open systems, high grade and low grade energy, available and unavailable energy; availability and unavailability, Second law efficiency and energy analysis of Thermodynamic Systems, Third law of Thermodynamics (definition only). (8)

UNIT IV **11 Hours**

Second Law of Thermodynamics

Air-standard efficiency, Nomenclature of Piston-Cylinder arrangement w.r.t. swept volume; clearance volume, compression ratio and mean effective pressure; Analysis and philosophy of Air-Standard Cycles i.e. Otto Cycle, Diesel Cycle and Dual Cycle; their compression ratio, mean effective pressure, power output and Efficiency; Comparison between the three Cycles.

Suggested Readings:

1. Yadav, R.(2011).*Applied Thermodynamics*. Central PublishingHouse.
2. Rajadurai, J.S. (1985).*Thermodynamics and Thermal Engineering*. New Age International (P) Ltd. Publishers.
3. Nag, P.K.(2008).*Basic and Applied Thermodynamics*. Tata McGraw Hill.
4. Kumar,D.S. &Vasandani,V.P.(1979).*Heat Engineering*. Metropolitan Book Co. Pvt.Ltd.
5. Soman,K.(2010).*Thermal Engineering*. PHI Learning Pvt.Ltd.
6. Rogers,G. and Mayhew,Y.(1992).*Engineering Thermodynamics*. Pearson.

SEMESTER: II

Course Title: NON-CONVENTIONAL ENERGY RESOURCES

L	T	P	Credits
3	0	0	3

Course Code: BME213

Learning Outcomes:
On successful completion of this course, the students would be able to:

Course Content

UNIT I **8 Hours**

Renewable and non-renewable energy sources, their availability and growth in India: energy consumption as a measure of Nation's Development: strategy for meeting the future energy requirements.

UNIT II **12 Hours**

Solar radiations-beam and diffused radiations; earth sun angles, attenuation and measurement of solar radiations; Optical properties of materials and selective surfaces.

UNIT III **11 Hours**

Principles, introduction to different types of collectors, flat plate, cylindrical and parabolic collectors; solar energy storage systems-their types, characteristics and capacity; solar ponds. Application of solar energy in water, space and process heating, solar refrigerant and air conditioning; water desalination and water pumping; solar thermal power generation; solar cells and batteries.

UNIT IV **15 Hours**

1. **Wind Energy:** Principle of wind energy conservation; basic components of wind energy conversion systems; wind mill components, various types and their constructional features; wind data and site selection considerations.
2. **Bio-Mass:** Concept of bio-mass conversion, photo-synthesis and bio-gasification; bio gas generators and plants, their type's constructional features and functioning; fuel properties of bio gas and community bio gas plants.
3. **Geothermal:** Sources of geothermal energy types, constructional features and associated prime movers.
4. **Tidal and Wave Energy:** Basic principles and components of tidal and wave energy plants; single basin and double basin tidal power plants; conversion devices, Advantages/disadvantages and applications of above mentioned energy systems.

Suggested Readings:

1. Prakash, J.& Garg, H.P.(1997).*Solar Energy: Fundamentals and Applications*. TataMcGraw Hill.
2. Sukhatme, S.P.(1996). *SolarEnergy: Principles of thermal collection & storage*. Tata McGrawHill.

SEMESTER: III

Course Title: FLUID MECHANICS
Course Code: BME301

L	T	P	Credits
3	1	0	4

Learning Outcomes:

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

1. Understand the different fluids and their properties; apply the analytical tools to solve different types of problems related to fluid flow in pipes.
2. Understand the behavior of fluids at rest or in motion and the subsequent effects of the fluids on the boundaries
3. Learn about the relationship between pressure and elevation as it relates to manometers, barometers and other pressure measuring devices.
4. Evaluate how properties of fluids change with temperature and their effect on pressure and fluid flow.
5. Classify fluid pressure and its measurement.

Course Content

UNIT I **10 Hours**

1. **Fundamentals of Fluid Mechanics**: Introduction; Applications; Concept of fluid; Difference between solids, liquids and gases; Concept of continuum; Ideal and real fluids; Fluid properties: density, specific volume, specific weight, specific gravity, viscosity (dynamic and kinematic), vapour pressure, compressibility, bulk modulus, Mach number, surface tension and capillarity; Newtonian andnon-Newtonianfluids.
2. **Fluid Statics:** Concept of static fluid pressure; Pascal's law and its engineering applications; Hydrostatic paradox; Action of fluid pressure on a plane submerged surface (horizontal, vertical and inclined): resultant force and centre of pressure; Force on a curved surface due to hydrostatic pressure; Buoyancy and flotation; Stability of floating and submerged bodies; Metacentric height and its determination; Periodic time of oscillation; Pressure distribution in a liquid subject to: (i) constant acceleration along horizontal, vertical and inclined direction (linear motion), (ii)constantrotation.

UNIT II **16 Hours**

1. **Fluid Kinematics:** Classification of fluid flows; Lagrangian and Euler flow descriptions; Velocity and acceleration of fluid particle; Local and convective acceleration; Normal and tangential acceleration; Path line, streak line,

streamline and timelines; Flow rate and discharge mean velocity; One dimensional continuity equation; Continuity equation in Cartesian (x,y,z), polar (r,θ) and cylindrical (r,θ,z) coordinates; Derivation of continuity equation using the Lagrangian method in Cartesian coordinates; Rotational flows: rotation, vorticity and circulation; Stream function and velocity potential function, and relationship between them;Flownet.

2. **Fluid Dynamics:** Derivation of Euler's equation of motion in Cartesian coordinates, and along a streamline; Derivation of Bernoulli's equation using principle of conservation of energy and equation of motionand its applications to steady state ideal and real fluid flows; Representation of energy changes in fluid system (hydraulic and energy gradient lines); Impulse momentum equation; Kinetic energy and momentum correction factors; Flow along a curved streamline; Free and forcedvortex motions.

UNIT III **8**

HoursDimensional Analysis and Similitude: Need of dimensional analysis; Fundamental and derived units; Dimensions and dimensional homogeneity; Rayleigh's and Buckingham's π - method for dimensional analysis; Dimensionless numbers (Reynolds, Froude, Euler, Mach, and Weber) and their significance; Need of similitude; Geometric, kinematic and dynamic similarity; Model and prototype studies; Similaritymodellaws.

UNIT IV **12 Hours**

1. **Internal Flows:** Laminar and Turbulent Flows: Reynolds number, critical velocity, critical Reynolds number, hydraulic diameter, flow regimes; Hagen – Poiseuille equation; Darcy equation; Head losses in pipes and pipe fittings; Flow through pipes in series and parallel; Concept of equivalent pipe; Roughness in pipes,Moody'schart.
2. **Pressure and Flow Measurement:** Manometers; Pitot tubes; Various hydraulic coefficients; Orifice meters; Venturi meters; Borda mouthpieces; Notches (rectangular, V and Trapezoidal) andweirs;Rotameters.

Suggested Readings:

1. Kumar,D.S.(2012).*Fluid Mechanics and Fluid Power Engineering*. S.K. Kataria and SonsPublishers.
2. Som,S.K., Biswas,G.,&Chakraborty,S.(2012).*Introduction to Fluid Mechanics and Fluid Machines*. Tata McGrawHill.
3. Ojha,C.S.P., Berndtsson,R.,&Chandramouli,P.N.(2010).*Fluid Mechanics and Machinery*. Oxford UniversityPress.
4. Cengel,Y.A.,&Cimbala,J.M.(2011).*Fluid Mechanics - Fundamentals and Applications*.Tata McGraw Hill.
5. Munson,B.R., Young,D.F., Okiishi,T.H.,&Huebsch,W.W.(2011).*Fundamentals of Fluid Mechanics*.John Wiley andSons.

6. Douglas,J.F.,Gasiorek,J.M., Swaffield,J.A.,&Jack,L.B.(2005).*Fluid Mechanics*.Pearson.

SEMESTER: III

Course Title: THEORY OF MACHINES-I
Course Code: BME302

L	T	P	Credits
3	1	0	4

Learning Outcomes:

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

1. Describe the basic concepts of mechanisms computing the velocity and accelerationwith diagrams of basic linkmechanism.
2. Analyze the turning moment and crank effortdiagram.
3. Learn about the types of lowerpairs.
4. Understand the types of drives such as: belts, ropes andchains for enhancement of skill and employability.
5. Understand the functions, types and characteristics of governors and related numerical problems for skill development

Course Content

UNIT I **12 Hours**

Basic Concept of machines: Link, Mechanism, Kinematic Pair and Kinematic Chain, Principles of Inversion, Inversion of a Four Bar Chain, Slider-Crank-Chain andDouble Slider-Crank-Chain. Graphical and Analytical methods for finding: Displacement, Velocity, and Acceleration of mechanisms includingCorliolis Components.Universal Joint, Calculation of maximum Torque, Steering Mechanisms including Ackerman and Davis approximate steering mechanism, Engine Indicator, Pentograph, Straight Line Mechanisms, Introduction to Higher Pairs with examples.

UNIT II **8**

HoursBelts, Ropes and Chains: Material & Types of belt, Flat and V-belts, Rope & Chain Drives, Idle Pulley, Intermediate or Counter Shaft Pulley, Angle and Right Angle Drive, Quarter Turn Drive, Velocity Ratio, Crowning of Pulley, Loose and fast pulley, stepped or cone pulleys, ratio of tension on tight and slack side of belts, Length of belt, Power transmitted by belts including consideration of Creep and Slip, Centrifugal Tensions and its effect onpowertransmission.

UNIT III **12 Hours**

Cams: Types of cams and follower, definitions of terms connected with cams. Displacement,velocity and acceleration diagrams for cam followers. Analytical and Graphical design of cam profiles with various motions (SHM, uniform velocity,

uniform acceleration and retardation,cycloidal Motion). Analysis of follower motion for circular, convex and tangentcamprofiles.

Friction Devices: Concepts of friction and wear related to bearing and clutches. Types of brakes function of brakes. Braking of front and rear tyres of a vehicle. Determination of braking capacity, Types of dynamometers, (absorption,andtransmission).

UNIT I **14**

HoursFlywheels: Turning moment and crank effort diagrams for reciprocating machines' Fluctuations of speed, coefficient of fluctuation of speed and energy, Determination of mass and dimensions of flywheel used for engines andpunchingmachines.

Governors: Function, types and characteristics of governors. Watt, Porter and Proell governors. Hartnell and Willson-Hartnell spring loaded governors. Numerical problems related to these governors. Sensitivity, stability, isochronisms and hunting of governors. Governor effort and power, controlling force curve, effect ofsleevefriction.

Suggested Readings:

1. Ballaney,P.L.(1965).*Theory of Machines*.KhannaPublications.
2. Shigley.(2013).*Theory of Machines*. Mc GrawHill.
3. Rattan,S.S.(1972).*Theory of Machines*,Tata Mc. GrawHill.
4. Ghosh &Mallick.(2008).*Theory of Mechanisms and Machines*. Affiliated East West Pvt.Ltd
5. Singh,V.P. (2004)*Theory of Machines*. Dhanpat Rai &Company,P.Ltd.

SEMESTER: III

Course Title: MACHINE DRAWING
Course Code: BME303

L	T	P	Credits
1	0	4	3

Learning Outcomes:

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

1. Understandthe basics of machine drawings and layouts.
2. Understand completelyengineeringdrawings of basic machine parts and

components.
3. Analyze various terminologies used in machine drawing.
4. Understandthe various terminologies used in production drawing.
5. Understand the CAD tools for making drawings of machine components and assemblies

Course Content

UNIT I **8 Hours**

Introduction: Classification of drawings, Principles of drawing, Requirements of machine Drawing, sectional views and conventional representation, dimensioning, concept of limits, fits & tolerances and their representation, machining symbols, various types of screw threads, types of nuts and bolts, screw fasteners, welded joints and riveted joints, introduction and familiarization of code SP 46:2003 by Bureau of Indian Standards.

UNIT II **8Hours**

Free hand sketches of:

a. **Couplings**: solid and rigid couplings, protected type flange coupling, pin type flexible coupling, muff coupling.
b. Knuckle and cotterjoints.
c. **Pipe and Pipe fittings**: Flanged joints, spigot and socket joint, union joint, hydraulic andexpansion joint.

2. UNIT III22Hours

Assembly of:

a. **IC Engine Parts:** piston and connectingrod.
b. **Boiler Mountings**: Steam stop valve, blow off cock, feed check valve and spring loaded safetyvalve.
c. **Bearing:** Swivel bearing, Plummer Block and Foot Stepbearing.
d. **Miscellaneous:** Screw jack, Tail Stock andcranehook.

3. UNIT IV8 Hours

Practice using Computer Aided Drafting (CAD) toolsfor:

(a) Machine components, screw fasteners, Keys cotters and joint, shaft couplings, Pipe joints and fittings, riveted joints and weldedJoints.
(b) Assemblies: - Bearings (Plumber Block, Footstep, Swivel), boiler mountings, screw jack, Exercise in computer Plots ofdrawing
(c) Case studies in computer plots andindustrialblueprint.

Suggested Readings:

1. Gill, P.S.(2013).*Machine Drawing*.S.K. Kataria& Sons.

2. Bhatt,N.D.(2014).*Machine Drawing*.Charotar. Publishing House.
3. Sidheshwar,N.(2011).*Machine Drawing*.Charotar Publishing House.
4. Behl,R.C.&Goel,V.K.(1982).*Machine Design*.Standard Publishers. Distributors.

SEMESTER: III

Course Title: STRENGTH OF MATERIALS-I
Course Code: BME304

L	T	P	Credits
3	1	0	4

Learning Outcomes:

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

1. Understandthe fundamental concepts of mechanics of deformable solids, including static equilibrium, geometry of deformation, and material constitutive behavior
2. Apply the systematic methods for solving the engineering problems in solid mechanics.
3. Applythe basic mechanical principles underlying modern approaches for design of various types of structural members subjected to axial load, torsion, bending, transverse shear, and combined loading.
4. Understand the necessary theoretical background for further structural analysis and design courses.
5. Select the materials for various applications.

Course Content

UNIT I **16Hours**

Simple, Compound Stresses and Strains: Stress and Strain and their types, Hook's law, longitudinal and lateral strain, Poisson's ratio, stress-strain diagram for ductile and brittle materials, extension of a bar due to without and with self weight, bar of uniform strength, stress in a bar, elastic constants and their significance, relation between elastic constants, Young's modulus of elasticity, modulus of rigidity and bulk modulus. Temperature stress and strain calculation due to axial load and variation of temperature in single and compound bars. Two-dimensional stress system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress. Generalized Hook's law, principal stresses related to principal strains.

UNIT II **18Hours**

1. Bending Moment (B.M) and Shear Force (S.F) Diagrams: S.F and B.M definitions; relation between load, shear force and bending moment; B.M and

S.F diagrams for cantilevers, simply supported beams with or without overhangs, and calculation ofmaximum
B.M and S.F and the point of contra flexure under different loads: Concentrated loads, Uniformity distributed loads over the whole span or part of span, Combination of concentrated and uniformly distributed load, uniformly varying loads and Application of moments.

2.**Bending Stresses in Beams**: Assumptions in the simple bending theory; derivation of formula and its application to beams of rectangular, circular and channel, I and T- sections. Combined direct and bending stresses in afore-mentioned sections, composite / flitched beams.

UNIT III **10Hours**

Torsion: Derivation of torsion equation and its assumptions and its application to the hollow and solid circular shafts. Torsional rigidity, combined torsion and bending of circular shafts; principal stress and maximum shear stresses under combined loading of bending and torsion.

UNIT IV **16Hours**

1. **Columns and struts**: Introduction, failure of columns, Euler's formula, Rankine-Gordon's formula, Johnson's empirical formula for axially loaded columns and theirapplications.
2. **Slope and deflection**: Relationship between moment, slope and deflection; method of integration, Macaulay's method, moment area method and use of these methods to calculate slope and deflection for: Cantilevers, Simply supported beams with or without overhang, Under concentrated loads, uniformly distributed loads or combination of concentrated &uniformlydistributed loads.

Suggested Readings:

1. Ferdinand, P.B. &Johnston, E.R.(Jr).(2009).*MechanicsofMaterials*.McGraw Hill.
2. Popov, E.P. (1976). *Mechanics of Materials,SI (2nd Edition).*Prentice HallIndia.
3. Shames,D.H.(1999).*Introduction to Solid Mechanics*.PrenticeHallInc.
4. Bedi, D.S. (2004). *Strength of materials*, Khanna book publishingCompany.
5. Lehri,R.S.,&Lehri,A.S.(1978).*Strength of materials*. S.K KatariaandSons.

SEMESTER: III

Course Title: APPLIED THERMODYNAMICS-I
Course Code: BME305

L	T	P	Credits
3	1	0	4

Learning Outcomes:

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

1. Evaluate the performance of reciprocating air compressors.
2. Analyze the combustion phenomenon in boilers and I.C. engines.
3. Apply the steam tables and MollierChart to solve vapour power cycle problems.
4. Understandthe constructional features and working of steam power plants and to evaluate their performance.
5. Evaluate the performance of thermal power plant

Course Content

UNIT I **18Hours**

1. Steam: Properties of Steam Pure substance ; Steam and its formation at constant pressure: wet, dry, super-saturated and super-heated (*super-saturated*) steam; Sensible heat*(sensible enthalpy)*, latent heat (*latent enthalpy*) and total or stagnation heat (*total or stagnation enthalpy*) of steam; dryness fraction and its determination; degree of superheat and degree of sub-cool; Entropy and internal energy of steam; Use of Steam Tables and Mollier Charts; Basic thermodynamic processes with steam(isochoric, isobaric, isothermal, isentropic and adiabatic processes) and their representation on T-S Charts and Mollier Charts(**h-s** diagrams), significance ofMollier Charts.

2. Vapour Power Cycle: Carnot Cycle and its limitations; Rankine steam power cycle, Ideal and actual; Mean temperature of heat addition; Effect of pressure, temperature and vacuum on Rankine Efficiency; Rankine Cycle Efficiency and methods of improving Rankine efficiency: Reheat cycle, Bleeding(feed-water-heating), Regenerative Cycle, Combined reheat-regenerative cycle; Ideal working fluid; Binary vapour cycle, Combined power and heatingcycles.

3. Steam Nozzles: Definition, types and utility of nozzles; Flow of steam through nozzles; Condition for maximum discharge through nozzle; Critical pressure ratio, its significance and its effect on discharge; Area of throat and at exit for maximum discharge; Effect of friction; Nozzle efficiency; Convergent and Convergent - divergent nozzles. Calculation of Nozzle dimensions (length and diameters of throat and exit); Supersaturated (or metastable) flow throughnozzle.

UNIT II12Hours

Reciprocating Air Compressors:-Single stage single acting reciprocating compressor(with and without clearance volume): construction, operation, work input and best value of index of compression, heat rejected to cooling medium, isothermal, overall thermal, isentropic, polytropic and mechanical efficiency, Clearance volumetric efficiency, Overall volumetric efficiency, effect of various parameters on volumetric efficiency, free air delivery; Multistage

compressors**:** purpose and advantages, construction and operation, work input, heat rejected in intercoolers, minimum work input, optimum pressure ratio; isothermal, overall thermal, isentropic, polytropic and mechanical efficiencies; Performance curves.

UNIT III16Hours

1. Steam Turbines (Impulse Turbine): Introduction; Classification; Impulse versus Reaction turbines. Simple impulse/**De Level** turbine: pressure and velocity variation, Compounding of impulse turbines: purpose, types and pressure and velocity variation, Velocity diagrams/triangles; Combined velocity diagram/triangle and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, maximum work and maximum efficiency overall efficiency and relative efficiency, effect of blade friction on velocity diagram, effect of speed ratio on blade efficiency, condition foraxialdischarge.

2. Reaction Turbine:- Pressure and velocity variation, velocity diagrams/triangles, Degree of reaction, combined velocity diagram/triangle and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, overall efficiency and relative efficiency, maximum work and maximum efficiency; Calculations of blade height; Multistaging**:** Overall efficiency and relative efficiency; Reheating, Reheat factor and condition curve; Losses in steam turbines; Back pressure and extraction Turbines ; Co-generation; Economic assessment; Governing ofsteamturbines.

UNIT IV 12Hours

Steam Condensers:- Function; Elements of condensing unit; Types of condensers; Dalton's law of partial pressures applied to the condenser problems; Condenser and vacuum efficiencies; Cooling water calculations; Effect of air leakage; Method to check and prevent air infiltration; Description of air pump and calculation of its capacity; Cooling towers: function, types andtheiroperation.

Suggested Readings:

1. Yadav, R.(2011).*Applied Thermodynamics*. Central PublishingHouse.
2. Rajadurai, J.S. (1985).*Thermodynamics and Thermal Engineering*. New Age International (P) Ltd. Publishers.
3. Nag, P.K.(2008).*Basic and Applied Thermodynamics*. Tata McGraw Hill.
4. Kumar,D.S. &Vasandani,V.P.(1979).*Heat Engineering*. Metropolitan Book Co. Pvt.Ltd.
5. Soman,K.(2010).*Thermal Engineering*. PHI Learning Pvt.Ltd.

6. Rogers,G. and Mayhew,Y.(1992).*Engineering Thermodynamics*. Pearson.
7. Keartan,W.A.J.(2004).*Steam Turbine: Theory and Practice*. ELBSSeries.

SEMESTER: III

Course Title: STRENGTH OF MATERIALS LAB
Course Code: BME306

L	T	P	Credits
0	0	2	1

Learning Outcomes:

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

1. Understand the fundamental concepts of mechanics of deformable solids, including static equilibrium, geometry of deformation, and material constitutive behavior
2. Utilizethe systematic methods for solving engineering problems in solid mechanics.
3. Apply the necessary theoretical background for further structural analysis and design courses.
4. Selectthe materials for various applications.

Course Content

List of Experiments

1. To perform tensile and compression test in ductile and brittle materials and to draw stress-strain curve and to determine various mechanical properties.
2. To perform any hardness tests (Any one from Rockwell, Brinell&Vicker's test).
3. To perform impact test to determine impact strength.
4. To perform torsion test and to determine various mechanical properties.
5. To perform Fatigue test on circular test piece.
6. To perform bending test on beam and to determine the Young's modulus and modulus of rupture.
7. Determination of Bucking loads of long columns with different end conditions.

SEMESTER: III

Course Title: THEORY OF MACHINES LAB
Course Code: BME307

L	T	P	Credits
0	0	2	1

Learning Outcomes:

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

1. Describe the various links andmechanisms which are useful for real life.
2. Illustrate various inversions of 4- bar chain and single slider crankchain.
3. Develop velocity and diagram of engine mechanism using graphicalmethods.
4. Evaluate various types of governors and draw graphs between height and equilibrium speed of agovernor.
5. Understand the gear- train value of compound gear trains and Epicyclical geartrains.

Course Content

List of Experiments

1. Conduct experiments on various types of governors and draw graphs between height and equilibrium speed of a governor.
2. Determination of gyroscopic couple (graphical method).
3. Balancing of rotating masses (graphical method).
4. Cam profile analysis (graphical method)
5. Determination of gear- train value of compound gear trains and epicyclic gear trains.
6. To draw circumferential and axial pressure profile in a full journal bearing.

SEMESTER: III

Course Title: FLUID MECHANICS LAB
Course Code: BME308

L	T	P	Credits
0	0	2	1

Learning Outcomes:

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

1. Calculatethe flow through a variable area ductwith Bernoulli's energyequation.
2. Compare the coefficient of discharge for various obstruction flow meters.
3. Calculate the transition from laminar to turbulent flow based on Reynolds

numbers.
4. Evaluate the various head losses in flow pipes under different conditions.

Course Content

List of Experiments

1. To determine the metacentric height of a floating vessel under loaded and unloaded conditions.
2. To study the flow through a variable area duct and verify Bernoulli's energy equation.
3. To determine the coefficient of discharge for an obstruction flow meter (venturi meter/ orifice meter)
4. To determine the friction coefficients, head loss in pipes.
5. To determine the velocity distribution for pipeline flow with a pitot static probe.
6. Experimental evaluation of free and forced vortex flow.

SEMESTER: III

Course Title: INTERNAL COMBUSTION ENGINES
Course Code: BME310

L	T	P	Credits
3	0	0	3

Learning Outcomes:

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

1. Understand the different types of reciprocating internal combustion engines (ICE), their typical design features and performance characteristics.
2. Analyze the power cycle of internal combustion engines using ideal gas cycles, air cycles, and fuel-air cycles. Compute indicated power and thermal efficiency.
3. Illustrate the gas exchange process and power boosting by means of turbo charging.
4. Solve engine heat transfer problems and its relation to thermal loading of engine components and cooling.
5. Examine the rate of heat release based on measured dynamic cylinder pressure.

Course Content

UNIT I **10Hours**

Introduction

Review of Otto, Diesel, Dual and Stirling Cycle, Comparison of Cycles, Actual Cycles and their Analysis, Classification of IC Engine, Two Stroke and Four Stroke cycle Engines, Difference between C.I. and S.I. Engines, Engine Design and Operating Parameters, Fuels and Their Properties, Stoichiometric and Actual Air Requirements, Flue Gas Analysis.

UNIT II **12Hours**

Combustion In S.I.& C.I Engines

Combustion in S.I. Engines, Flame Front Propagation, Flame Speed, Ignition Delay, Abnormal Combustion, Combustion Chambers for S.I. Engines.Combustion in C.I. Engines, Ignition Delay, combustion Knock, Combustion Chamber for C.I. Engines, Fuel Injection Testing.

UNIT III **10Hours**

Performance Parameters &Emissions

Parameters, Engine Power, Engine Efficiencies, Type Of Tests And Characteristic Curves, Variables Affecting Performance Characteristics, Methods of Improving Engine Performance, Engine Economy, Air Pollution Due To IC Engines, Engine Emissions, Particulates, Emission Control Methods, EGR (Exhaust Gas Recirculation),

UNIT II **12Hours**

Carburettion, Lubrication, Cooling and Ignition Systems

Simple and Complex Carburettors, Gasoline Injection, Combustion Design For S.I. Engines, Friction And Lubrication, Types Of Lubrication Systems, Engine Cooling, Ignition Systems, Magneto And Battery Ignition Systems, Ignition Timing.

Suggested Readings:

1. Heywood, B.J.(1988). *Internal Combustion Engine Fundamentals*. Tata McGraw Hill Book Co.
2. Richard, S.(1985). *Introduction to Internal Combustion Engines*. Palgrave Macmillan.
3. Pulkrabek, W.W.(2004). *Engineering Fundamentals of the Internal Combustion Engine*. Prentice Hall International, Inc.
4. Somasundaram, S.L.(1996). *Thermal Engineering*. New Age International Publishers.
5. Kumar, D.S. &Vasandhani, V.P.(1996). *Heat Engineering*.New Delhi Metropolitan Book Co. Pvt. Ltd.
6. Mathur, R.P. & Sharma, M.L.(1994). *A Course in ICEngine*.Dhanpat Rai & Sons. NDelhi.
7. Ganesan, V.(2003). *Internal Combustion Engine*. Tata McGraw Hill

SEMESTER: III

Course Title: ENERGY CONSERVATION AND MANAGEMENT
Course Code: BME311

L	T	P	Credits
3	0	0	3

Learning Outcomes:

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

1. Calculate the efficiency of various thermal utilities.

2. Develop the suitable energy monitoring system to analyze and optimize the energy consumption in an organization.
3. Improve the thermal efficiency by designing suitable systems for heat recovery and co-generation.
4. Examine the cost- benefit analysis of various investment alternatives for meeting the energy needs of the organization.
5. Encourage the employees of the organization for various methods of energy conservation for implementation.

Course Content

UNIT I **10Hours**

Need for Energy Conservation, Its Potentials, Fiscal Incentives, Primary Energy Sources Such as Coal, Gas, Oil, Nuclear Fuel

UNIT II **12Hours**

Optimum Use of Prime Movers for Power Generation Such As Steam Turbines, Gas Turbines, Diesel and Gas Engines, Energy Intensive Industries i.e. Iron and Steel, Aluminum, Pulp and Paper, Textile and Oil Refineries and Their Energy Usage Pattern.

UNIT II **11Hours**

Plant: Good Housekeeping, Measures in Air Conditioning, Boilers, Combustion System, Steam, Furnaces and General Awareness, Energy Audit, Methodology And Analysis, Energy Conservation Case Studies In Air Conditioning, Boiler And Burners

UNIT II **12Hours**

Waste Heat Recovery Systems i.e. Recuperates, Economizers Waste Heat Boilers, Heat Pipe Heat Exchangers, Regenerators etc. Energy Storage Systems Thermal Storage, Insulation, Refractory, Specialized Processes such As Dielectric & Micro Wave Heating, Electronic Beam Welding, Fluidized Bed Technology, Laser as a Welding Tool, Alternative Sources of Energy.

Suggested Readings:

1. Reay, D.A.(1977*). Industrial Energy Conservation Handbook*.Pergamon Press.

2. Richard, G.(1982). *Process Energy Conservation (Chemical Engineering)*. Tata McGrawHill Publication Co.

SEMESTER: III

Course Title: AUTOMOBILE ENGINEERING
Course Code: BME312

L	T	P	Credits
3	0	0	3

Learning Outcomes:

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

1. Understand the functioning of automobiles,maintenance and their manufacturing.
2. Examine the servicing of automobiles or trading/ manufacturing of auto components this helps to make skillful.
3. Illustrate the types of air compressors, working principle of two stroke and four stroke engines.
4. Differentiate the operating characteristics of common internal combustion engines.
5. Apply the various thermodynamics laws in engineering applications.

Course Content

UNIT I

10Hours

Vehicle Structure and Engines

Types of Automobiles - Vehicle Construction – Chassis – Frame and Body – Aerodynamic forces. Engine components, Materials and functions - Cooling and Lubrication systems in engines – Turbo Chargers – Engine Emission Control by three way Catalytic converter – Electronic Engine Management System.

UNIT II

10Hours

Engine Auxiliary Systems

Carburetor–working principle - Electronic fuel injection system – Mono-point and Multi - Point Injection Systems – Construction, Operation and Maintenance of Lead Acid Battery - Electrical systems – Battery generator – Starting Motor and Drives – Lighting and Ignition (Battery, Magneto Coil and Electronic Type) - Regulators-cut outs.

UNIT III **10Hours**

Transmission Systems

Clutch – Types and Construction – Gear Boxes, Manual and Automatic – Floor Mounted Shift Mechanism – Over Drives – Fluid flywheel - Torque converters– Propeller shaft – Slip Joint – Universal Joints – Differential and Rear Axle – Hotchkiss Drive and Torque Tube Drive – Introduction to rear wheel drive.

UNIT IV **15Hours**

1.Steering, Brakesand Suspension

Wheels and Tyres – Wheel Alignment Parameters - Steering Geometry and Types of steering gear box– Power Steering – Types of Front Axle – Suspension systems – Braking Systems – Types and Construction – Diagonal Braking System – Antilock Braking System.

2. Alternative Energy Sources

Use of Natural Gas, LPG, Biodiesel, Alcohol and Hydrogen in Automobiles - Electric and Hybrid Vehicles, Fuel Cells – Introduction to off road vehicles.

Suggested Readings:

1. Crouse, W.H. (1965). *Automotive Mechanics*.TataMcGrawHill.
2. Singh, K.(2009).*Automobile Engineering(Vol. I & II)*.StandardPublishers.
3. Newton, K., Steeds, W. & Garrett, T.K. (1996).*The Motor Vehicle*.ButterworthInternational.
4. Heitner, J.(2004).*Automotive Mechanics*.EastWestPress.
5. Gupta, R.B.(2016).*Automobile Engineering*. SatyaPrakashan publications.

SEMESTER: IV

Course Title: APPLIED THERMODYNAMICS-II
Course Code: BME401

L	T	P	Credits
3	1	0	4

Learning Outcomes:

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

1. Compare the concept of petrol and diesel engines with their knocking phenomenon and methods to reduce theeffects.
2. Describe the concept of supercharging with their applications and compute the efficiency of different typesofengines.
3. Examine the theory of different types of compressors based upon design attributes and theory of various heads of enthalpy during the workingprocess.
4. Compute the efficiency of all compressors to solve problems based upon compression of theair.
5. Illustrate the concept of gas turbines with the use of compressors and theirapplications.

Course Content

UNIT I **16Hours**

IC Engines: Pressure-Time/Pressure-ɵ diagram, Characteristics of the fuel oil for a diesel engine; Combustion process in diesel engine, and various parameters controlling the delay Period; Uncontrolled combustion, Diesel knock or Fuel knock, period of controlled combustion, effect of turbulence on power and efficiency, after-

burning etc.Process of combustion in a Petrol engine, Ignition lag and factors effecting it, Rate of flame propagation and various factors effecting it, detonation(in Petrol engines) and various factors affecting it; comparison of diesel knock and detonation and effect of various parameters on these; comparison of pre-ignition and detonation; dopes/antiknock substances for SI/CI Engines; Effect of compression ratio and fuel-air ratio on power and efficiency of **(i)** Diesel Engines **(ii)** Petrol Engines. Performance curves for a petrol engine at constant speed; Consumption loops for Petrol and Diesel engines; Effect of turbulence on Petrol and Diesel engines; Dissociation and it's effect on power and efficiency; Octane and Cetane numbers, Knock-meter; Use of high speed cinematography for observation of burning gases characteristics; various methods of Governing IC Engines; Super-charging and its methods, Advantages of super-charging; Variation of Engine power with altitude; causes of pressure loss at high altitudes and power requirements of Super-chargers; Effect of Super-charger on PV- diagrams of SI Engines; High Speed Engine Indicators: Farnborough balanced Engine Indicator; Cathode-ray Oscillograph Engine Indicator; Construction and working principle of Rotary or Wankel Engine, it's advantages and disadvantages over reciprocating piston engines; application of Wankel Engine; Logrithmic plotting of PV-diagrams.

UNIT II **18Hours**

1. Air Compressors:- Introduction, Classification of Air Compressors; Application of compressors and use of compressed air in industry and other places; Complete representation of compression process(for Reciprocating and Rotary compressors) on P-v and T-s coordinates with detailed description of areas representing total work done and polytropic work done; Areas representing energy lost in internal friction, energy carried away by cooling water and additional flow work being done for un-cooled and cooled compression processes on T-S coordinates; Best value of index of compression; Isentropic, polytropic and isothermal efficiencies and their representation in terms of ratio of areas representing various energy transfers on T-S coordinates. Applications of Steady-Flow-Energy Equation and

thermodynamics of dynamic (i.e., centrifugal and axial flow machines); Stagnation and static

2. Positive Displacement Rotary Compressors:- Introduction and general classification of rotary Comressors**;** Comparison of rotary positive displacement compressors with reciprocating compressors; **Classification** of rotary compressors: Construction, operation, work input and efficiency of positive displacement type of rotary compressors like Roots blower, Lysholm compres4or and Vane-type Blower.

3. Centrifugal Compressors:- Complete thermodynamic analysis of a centrifugal compressor stage; Polytropic, isentropic and isothermal efficiencies; Complete representation of compression process in a centrifugal compressor starting from ambient air flow through the suction pipe, Impeller, Diffuser and finally to the delivery pipe on T-S coordinates; Pre-guide vanes and pre-whirl; Slip factor; Power input factor; Various modes of energy transfer in the impeller and diffuser; Degree of Reaction and its derivation; Energy transfer in backward, forward and radial vanes; Pressure coefficient as a function of Slip factor and its effect on efficiency and out coming***velocity profile*** from the impeller; Derivation of non-dimensional parameters for plotting compressor characteristics; Centrifugal compressor characteristic curves; Surging and choking in centrifugal compressors.

UNIT III **8Hours**

Axial Flow Compressors:- Different components of axial flow compressor and their arrangement; Discussion on flow passages and simple theory of aerofoil blading; Angle of attack; coefficients of lift and drag; Turbine versus Compressor blades; Velocity vector; Vector diagrams; Thermodynamic analysis; Work Done on the compressor and Power calculations; Modes of energy transfer in rotor and stator blade flow passages; Detailed discussion on Work Done factor, degree of reaction, blade efficiency and their derivations; Isentropic, polytropic and isothermal efficiencies; Surging, Choking and Stalling in axial flow compressors; Characteristic curves for axial flow compressor; flow parameters of axial flow compressor like Pressure Coefficient, Flow Coefficient, Work Coefficient, Temperature-rise Coefficient

and Specific Speed; Comparison of axial flow compressor with centrifugal compressor and reaction turbine; Field of application of axial flow compressors.

UNIT IV **16Hours**

1. Gas Turbines:- Classification and comparison of the Open and Closed cycles; Classification on the basis of combustion(at constant volume or constant pressure); Comparison of gas turbine with a steam turbine and IC engine; Fields of application of gas turbines; Position of gas turbine in power industry; Thermodynamics of constant pressure gas turbine cycle (Brayton cycle); Calculation of net output, work ratio and thermal efficiency of ideal and actual cycles; Cycle air rate, temperature ratio; Effect of changes in specific heat and that of mass of fuel on power and efficiency; Operating variables and their effects on thermal efficiency and work ratio; Thermal refinements like regeneration, inter-cooling and reheating and their different combinations in the gas turbine cycle and their effects on gas turbine cycle, Multistage compression and expansion; Dual Turbine system; Series and parallel arrangements; Closed and Semi-closed gas turbine cycle; Requirements of a gas turbine combustion chamber; Blade materials. Gas turbine fuels. Values of pressure, Temperature and enthalpy (and their co-relation) etc. for flow through dynamic,rotary machines.

2. Jet Propulsion: - Principle of jet propulsion; Description of different types of jet propulsion systems like rockets and thermal jet engines, like (**i)** Athodyd (ramjet and pulse-jet), **(ii)** Turbojet engine, and **(iii)** Turboprop engine. Thermodynamics of turbojet engine components; Development of thrust and methods for its boosting/augmentation; Thrust work and thrust power; Propulsion energy, Propulsion and thermal(*internal*) efficiencies; Overall thermal efficiency; Specific fuel consumption; Rocket propulsion, its thrust and thrust power; Propulsion and overall thermal efficiency; Types of rocket motors(e.g. ***solid propellant*** and ***liquid propellant*** systems); Various common propellant combinations (i.e. of fuels) used in rocket motors; Cooling of rockets; Advantages and disadvantages of jet propulsion over other propulsion systems; brief introduction to performance characteristics of different propulsion systems; Fields of application of various propulsion units.

Suggested Readings:

1. Yadav, R., Sanjay&Rajay.(2011).*Applied Thermodynamics*. Central PublishingHouse.
2. Nag, P.K.(2010).*Basic and Applied Thermodynamics*.TataMcGrawHill.
3. Kumar,D.S. &Vasandani,V.P.(1985).*Heat Engineering*. Metropolitan Book Co. Pvt.Ltd.
4. Soman,K.(2010).*Thermal Engineering*. PHI Learning Pvt.Ltd.
5. Rogers,G. and Mayhew,Y.(2002).*Engineering Thermodynamics*.Pearson.
6. Yadav,R.(1989).*Thermodynamic and Heat Engines-Vol. II.*CentralPublishersHouse.
7. Shephered, D.G.(1961).*Principles of Turbo machinery*.Macmillan.
8. Cohen,H., Rogers,G.F.C.,&Sarvan,M.(1951).*Gas Turbine Theory*.Longmans.
9. Mattingly,J.D.(1996).*Elements of Gas Turbine Propulsion*.McGrawHill.

SEMESTER: IV

Course Title: STRENGTH OF MATERIALS-II
Course Code: BME402

L	T	P	Credits
3	1	0	4

Learning Outcomes:

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

1. Apply the basics to find stresses in various applications (shells, curved beams and rotating discs).
2. Analyze the change in dimensions of shells, curved beams and rotating discs under operation.
3. Determine stresses, deflection and energy stored in various kinds of springs subjected to load and twist.
4. Describe the concept of failure theories and strain energy.
5. Evaluate shear stress variation in beams of different cross-section and materials.

Course Content

UNIT I **14Hours**

Strain Energy: Introduction to strain energy, energy of dilation and distortion. Resilience, stress due to suddenly applied loads. Castigliano's and Maxwell's theorem of reciprocal deflection.

Theories of Failure: Maximum principal stress theory, maximum shear stress theory, maximum principal strain theory, total strain energy theory, shear strain energy theory. Graphical representation and derivation of equation for these theories and their application to problems related to two-dimensional stress systems.

UNIT II **16Hours**

Springs: Open and closed coiled helical springs under the action of axial load and/or couple. Flat spiral springs- derivation of formula for strain energy, maximum stress and rotation. Leaf spring deflection and bending stresses.

Thin Cylinders and Spheres: Calculation of Hoop stress, longitudinal stress in a cylinder, effects of joints, change in diameter, length and internal volume. Principal stresses in sphere, change in diameter and internal volume.

UNIT III **18Hours**

Thick Cylinders: Derivation of Lame's equations, calculation of radial, longitudinal and hoop stresses and strains due to internal pressure in thick cylinders, compound cylinders, hub shrunk on solid shafts, shrinkage allowance and shrinkage stress.

Bending of Curved Beams: Calculation of stresses in cranes or chain hooks, rings of circular and trapezoidal section, and chain links with straight sides.

UNIT IV **12Hours**

Shear Stresses in Beams: Shear stress distribution in rectangular, circular, I, T and channel section; built up beams. Shear centre and its importance.

Rotational Discs: Stresses in rotating discs and rims of uniform thickness; disc of uniform strength.

Suggested Readings:

1. Crandell, Dahl & Lardner.(1978).*Introduction to Mechanics of Solids*. McGrawHill
2. Singh, Dr.Kirpal,(2003).*Mechanics of Materials*.Standard Publishers &Distributors.
3. Lehri,R.S.(2010).*Strength of Materials*.S.KKataria and Sons.

4. Beer,F. P., and Johnston,E. Russel (Jr).(2016).*Mechanics of Materials*.McGrawHill,India.

SEMESTER: IV

Course Title: THEORY OF MACHINES-II
Course Code: BME403

L	T	P	Credits
3	1	0	4

Learning Outcomes:

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

1. Compute, both analytically and graphically forces and couples for reciprocating parts and dynamically equivalent system.
2. Understand the theory of inertia force and apply to four-bar linkage mechanism.
3. Learn about the types of balancing and its need & balancing to reciprocating and Rotating masses.
4. Understand the types of both tooth gear and the nomenclature of gears & various types of gear trains.
5. Apply Gyro effect on moving bodies.

Course Content

UNIT I **12Hours**

Static force analysis: Concept of force and couple, free body diagram, condition of equilibrium, static equilibrium of mechanism, methods of static force analysis of simple mechanisms. Power transmission elements, considerations of frictional forces.
Dynamic force analysis Determination of forces and couples for a crank, inertia of reciprocating parts, dynamically equivalent system, analytical and graphical method, inertia force analysis of basic engine mechanism, torque required to overcome inertia and gravitational force of a four-bar linkage.

UNIT II **16Hours**

Balancing: Necessity of balancing, static and dynamic balancing, balancing of single and multiple rotating masses, partial unbalanced primary force in an engine, balancing of reciprocating masses,and condition of balance in multi cylinder in line V-engines, concept of direct and reverse crank, balancing of machines, rotors, reversible rotors.

UNIT III **18Hours**

Gears: Toothed gears, types of toothed gears and its terminology. Path of contact, arc of contact, conditions for correct gearing, forms of teeth, involutes and its variants, interference and methods of its removal. Calculation of minimum number of teeth on

pinion/wheel for involute rack, helical, spiral, bevel and worm gears. Center distance for spiral gears and efficiency of spiral gears.
Gear Trains: Types of gear trains, simple, compound and epicyclic gear trains, problems involving their applications, estimation of velocity ratio of worm and worm wheel.

UNIT IV **14Hours**

Gyroscopic motion and couples: Effect on supporting and holding structures of machines.
Stabilization of ships and planes, Gyroscopic effect on two and four wheeled vehicles.
Kinematic synthesis of Mechanism: Freudenstien equation, Function generation errors in Synthesis, two- and three-point synthesis Transmission angles, least square technique.

Suggested Readings:

1. Ballaney,P.L.(1965).*Theory of Machines*.KhannaPublications.
2. Shigley.(1980).*Theory of Machines*. Mc GrawHill.
3. Singh, V.P.(2005).*Theory of Machines*. Dhanpat Rai &Company,P.Ltd.
4. Rattan, S.S.(2009).*Theory of Machines*,Tata Mc. GrawHill.
5. Ghosh &Mallick.(2008).*Theory of Mechanisms and Machines*.Affiliated East West Pvt.Ltd.

SEMESTER: IV

Course Title: MATERIAL ENGINEERING & METALLURGY
Course Code: BME404

L	T	P	Credits
4	0	0	4

Learning Outcomes:

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

1. Know the significance of structure-property-correlation for engineering materials including ferrous and nonferrous.
2. Explain the use and importance of various heat treatment processes used for engineering materials and their practical applications.
3. Describe the various structural changes occurring in metals with respect to time temperature transformations.
4. Analyze the significance of Fe-C and TTT diagram for controlling the desired structure and properties of the materials.

Course Content

UNIT I **14Hours**

Crystallography: Atomic structure of metals, atomic bonding i solids, crystal structures, crystal lattice of body centered cubic, face centered cubic, closed packed hexagonal; crystalline and noncrystal line materials; crystallographic notation of atomic planes; polymorphism and allotropy; imperfection in solids: theoretical yield strength, point defects, line defects and dislocations, interfacial defects, bulk or volume defects. Diffusion: diffusion mechanisms, steady-state and nonsteady-state diffusion, factors affecting diffusion. Theories of plastic deformation, recovery,re-crystallization.

UNIT II **16Hours**

2. Phase Transformation: General principles of phase transformation in alloys, phase rule and equilibrium diagrams, Equilibrium diagrams of Binary systems. Iron carbon equilibrium diagram and various phase transformations. Time temperature transformation curves (TTT curves): fundamentals, construction and applications.

UNIT I **18Hours**

3. Heat Treatment: Principles and applications. Processes viz. annealing, normalizing, hardening, tempering. Surface hardening of steels: Principles of induction and oxyacetylene flame hardening.Procedure for carburising, nitriding and cyaniding. Harden-ability: determination of harden-ability.Jominy end-quench test. Defects due to heat treatment and their remedies; effects produced byalloying elements. Composition of alloy steels.

UNIT I **10Hours**

4. Ferrous Metals and Their Alloys: Introduction, classification, composition of alloys, effect ofalloying elements (Si, Mn, Ni, Cr, Mo, W, Al) on the structures and properties of steel.

Suggested Readings:

1. Avner, S. H.(1974*).Introduction to Physical Metallurgy*.McGraw Hill BookCompany.
2. Raghavan,V.(2015*).Physical Metallurgy: Principles and Practice*. Prentice Hall ofIndia.
3. Wadhwa,A. S.,&Dhaliwal, H. S.(2008).*Engineering Materials and Metallurgy*. Laxmi Publications Pvt. Ltd.
4. Callister,William D.(2010).*Material Science and Engineering*.JohnWiley&Sons.

SEMESTER: IV

Course Title: ENVIRONMENTAL SCIENCE
Course Code: BME405

L	T	P	Credits
2	0	0	2

Learning Outcomes:

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

1. Measure environmental variables and interpret results
2. Evaluate local, regional and global environmental topics related to resource usage and management
3. Propose solutions to environmental problems related to resource usage and management
4. Interpret the results of scientific studies of environmental problems
5. Describe threats to global biodiversity, their implications and potential solutions

Course Content

UNIT I **6Hours**

Introduction: Definition and scope and importance of multidisciplinary nature of environment. Need for public awareness.

Natural Resources: Natural Resources and associated problems, use and over exploitation, case studies of forest resources and water resources.

Ecosystems: Concept of Ecosystem, Structure, interrelationship, producers, consumers and decomposers, ecological pyramids-biodiversity and importance. Hot spots of biodiversity.

UNIT II **10Hours**

Environmental Pollution: Definition, Causes, effects and control measures of air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management: Causes, effects and control measure of urban and industrial wastes. Role of an individual in prevention of pollution, Pollution case studies.

UNIT III **8Hours**

Disaster Management: Floods, earthquake, cyclone and landslides.

Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Case studies. Environmental ethics: Issues and possible

solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of pollution) Act. Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation Public awareness.

UNIT IV **6Hours**

Human Population and the Environment: Population growth, variation among nations. Population explosion – Family Welfare Program. Environment and human health, Human Rights, Value Education, HIV/AIDS. Women and child Welfare. Role of Information Technology in Environment and human health. Case studies.

Suggested Readings:

1. Agarwal, K. C.(1987). *Environment Biology*. Nidi Publ. Ltd.Bikaner.
2. Jadhav, H, &Bhosale, V.M.(1995).*Environment Protection and Laws*. Himalaya Pub House,Delhi
3. Rao, M. N. &Datta, A.K.(2008).*Waste Water Treatment*. Oxford & IBH Publ. Co. Pvt.Ltd

SEMESTER: IV

Course Title: APPLIED THERMODYNAMICS LAB
Course Code: BME406

L	T	P	Credits
0	0	2	1

Learning Outcomes:

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

1. Compare the construction and operation of 2 stroke and 4 stroke Petrol and Diesel engines using actual engines models.
2. Describe the construction and operation of steam condensers and cooling towers.
3. Evaluate the equivalent evaporation and efficiency of a fire tube/ water tube boiler.
4. Calculate the dryness fraction of steam and estimation of brake power, Rankine efficiency, relative efficiency, generator efficiency, and overall efficiency of an impulse steam turbine and to plot a Willian's line.
5. Analyze the brake power, indicated power, friction power and mechanical efficiency of a multi cylinder petrol engine running at constant speed (Morse

Test).

Course Content

List of Experiments

1. Study of construction and operation of 2 stroke and 4 stroke Petrol and Diesel engines and to plot actual valve timing diagram of 4 stroke petrol and diesel engines and study its impact on the performance of engine.
2. Study of working, construction, mountings and accessories of various types of boilers.
3. To perform a boiler trial to estimate equivalent evaporation and efficiency of a fire tube/ water tube boiler.
4. Determination of dryness fraction of steam and estimation of brake power, Rankine efficiency, relative efficiency, generator efficiency, and overall efficiency of an impulse steam turbine and to plot a Willian's line.
5. Determine the brake power, indicated power, friction power and mechanical efficiency of a multi cylinder petrol engine running at constant speed (Morse Test).
6. Performance testing of a Petrol and Diesel engine from no load to full load (at constant speed) for a single cylinder/ multi- cylinder engine in terms of brake power, indicated power, mechanical efficiency and specific fuel consumption and to measure the exhaust emission. Draw/obtain power consumption and exhaust emission curves. Also make the heat balance sheet.

SEMESTER: IV

Course Title: MATERIAL ENGINEERING LAB
Course Code: BME407

L	T	P	Credits
0	0	2	1

Learning Outcomes:

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

1. Analyze the Structure of materials at different levels, basic concepts of crystalline materials like unit cell, FCC, BCC, HCP, APF (Atomic Packing Factor), co-ordination number etc.
2. Understand the concept of mechanical behavior of materials and carry outcalculations of same using appropriate equations
3. Investigate the concept of phase & phase diagram & understand the basic terminologies associated with metallurgy and understand the construction and identification of phase diagrams and reactions

4. Analyze the microstructure of prepared specimens of Mild Steel, Aluminum alloys and hardened steel with or without heat treatment.

Course Content

List of Experiments

1. Preparation of models/charts related to atomic/crystal structure of metals.
2. Hardening/Annealing of steel specimen and study the effect of quenching time/annealing time and temperature on hardness of steel.
3. Practice of specimen preparation (cutting, mounting, polishing, and etching) of mild steel, Aluminium and hardened steel specimens.
4. Study of the microstructure of prepared specimens of Mild Steel, Aluminium and hardened steel.
5. Identification of ferrite and pearlite constituents in given specimen of mild steel.
6. Determination of hardenability of steel by Jominy End Quench Test.

SEMESTER: IV

Course Title: NON TRADITIONAL MACHINING
Course Code: BME408

L	T	P	Credits
3	0	0	3

Learning Outcomes:
On successful completion of this course, the students will be able to:

1. Understand the need of Non Traditional Machining Processes and be able to Classify various processes.
2. Comprehend the role of mechanical energy in non-traditional machining processes.
3. Apply the knowledge of machining electrically conductive material through electrical energy in non-traditional machining processes.
4. Understand the concept of machining the hard material using chemical energy and electrochemical energy.
5. Learn about the various thermal energy based nontraditional machining processes.

Course Content

UNIT I **8Hours**

Modern Machining Processes: An Overview, trends in Manufacturing machining, transfer machining, flexible machining system, and computer integrated

manufacturing

UNIT II **10Hours**

Advanced Mechanical Processes: Ultrasonic machining and Abrasive Flow Machining-elements of process, Applications and limitations

UNIT III **10Hours**

Electrochemical & Chemical Removal Processes: Principle of operation, elements and applications of Electrochemical Machining, Electrochemical grinding, Electrochemical deburring, Electrochemical honing, Chemical Machining:

UNIT IV **16Hours**

Thermal Metal Removal Processes: Electric Discharge Machining, Mechanism of metal removal, electrode feed control, die electric fluids flushing, selection of electrode material, applications. Plasma Arc, Machining- Mechanism of metal removal, PAM parameters, Equipment's, safety precautions and applications. Laser Beam machining- Material removal, limitations and advantages. Hot machining-method, Applications and limitations. Electron-Beam Machining-, Generation and control of electron beam, process capabilities and limitations

Suggested Readings:

1. Panday, P.C. & Shan, H.S.(1980).*Modern Machining Processes.* Tata McGrawHill
2. Boothroyd, G.& Knight, W.A.(2005).*Fundamentals of Machining and Machine Tools.* CRC Press Inc.
3. Benedict, G.F.(1981).*Non Traditional Manufacturing Processes.* Marcel DekkerInc.

SEMESTER: IV

Course Title: COMPUTER AIDED MANUFACTURING
Course Code: BME409

L	T	P	Credits
3	0	0	3

Learning Outcomes:

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

1. Understand the basic tools of computer-aided design (CAD) and computer-aided manufacturing (CAM).
2. Apply the computer design tools for aerospace and mechanical engineers.
3. Evaluate the CAD/CAM system based on costing.
4. Learn about data management and its importance for decision making in CIMS environment.
5. Comprehend the Computer Aided Quality control and Process Planning Control.

Course Content

UNIT I **10Hours**

Introduction: Historical Background, Role of Computers in Manufacturing, automation, Types of Automation, Automation Strategies.

Fundamentals of CNC Machines: CNC Technology, functions of CNC Control in Machine Tools, Classification of CNC Systems, Contouring System, Interpolators, Open loop and Closed loop CNC System, CNC Controllers, Hardware Features, Direct Numerical Control(DNC Systems) and Adaptive Control.

UNIT II **12Hours**

Constructional Features of CNC Machines: Design considerations of CNC machines for improving machining accuracy, Structural Members, Slide ways, Slides linear bearings, Ball Screws, Spindle drives and feed drives, Work holding devices and tool holding devices, Automatic tool changers. Feedback devices, Principles of Operation, Machining Centers, Tooling for CNC machines.

Part Programming For CNC Machines: Numerical control codes, Standards, Manual Programming, Canned cycles and subroutines, Computer Assisted Programming, CAD/CAM approach to NC part programming, APT language, machining from 3D models.

UNIT III **12Hours**

Introduction to Robot Technology in CAM: Group Technology and Cellular manufacturing: Introduction, Part families, parts classification and coding, production flow analysis, machine cell design. Computer Aided Process Planning (CAPP): Types of Process planning system, Advantages of CAPP.

Production Planning and Control: Introduction to production planning and control, Shop Floor Control Systems, Just-in –time approach, Engineering Challenges in CAD/CAM, Product Data Management, Product Modeling, Assemble and Tolerance Modeling.

UNIT IV **10Hours**

Integrated Manufacturing System: Introduction toFlexible Manufacturing Systems(FMS), different types of flexibilities in FMS, type of FMS, machining system of FMS, Tool Management systems, work piece handling system, FMS Control, Lay

out considerations in FMS, Advantages of FMS. Introduction to Computer Aided Manufacturing Systems (CIMS), the future automated factory, trends in manufacturing, human factors in future automated factory, the social impact. Rapid Prototyping, Artificial Intelligence and Expert system in CIM.

Suggested Readings:

1. Groover, M.P.(1980).*Automation: Production Systems &CAM*.Englewood Cliffs New Jersey
2. Chang, T.C.&Wysk, R.A.(1985).*An introduction to Automated Process Planning*.Longman Higher Education
3. Singh, N. (1995).*System approach to Computer Integrated Design and Manufacturing*.Wiley.
4. Pable, B.S.&Adithan, M.(1994). CNC Machines.New Age International(P) Ltd.
5. Dalela, S. & Jain, P.K.(2000).*CAD/CAM*.S Chand & Company Pvt Ltd.

SEMESTER: IV

Course Title: COMPUTER AIDED PROCESS PLANNING
Course Code: BME410

L	T	P	Credits
3	0	0	3

Learning Outcomes:

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

1. Understand the structure of automated process planning system and use the principle of generative and retrieval CAPP systems for automation.
2. Apply the manufacturing sequence to reduce the total set up cost for a particular sequence.
3. Examine the effect of machining parameters on production rate, cost and surface quality and determination of manufacturing tolerances.
4. Comprehend the generation of tool path and solve optimization models of machining processes.
5. Understand the design strategies. Planning, modeling and coding scheme.

Course Content

UNIT I **8Hours**

Introduction: Traditional process planning; processplanning elements; product design evaluation; selection of tooling and process parameters; operation sequence evaluation.

Group Technology: Introduction; advantages; part families; classification and coding systems; production flow analysis; design of machine cells.

UNIT II **12Hours**

Production Systems at Operation Level: Manufacturing support systems and concepts at the level of production processes; computer generated time standards; machinability data system; cutting condition optimization.

Production Systems at Plant Level: Communication oriented production information and control system (COPICS); material requirements planning; capacity planning; shop floor control and operation scheduling.

UNIT III **15Hours**

Automated Process Planning: Advantages of automated process planning; standardization of manufacturing process plans; variant process planning; its features; and different stages; different variant systems; advantages and limitations of variant process planning

UNIT IV **10Hours**

Generative process planning: Its features; design strategies; planning modeling and coding scheme; decision mechanism for software; decision trees for process; process information.

Artificial intelligence: overview & application; search strategies for AI production systems; resolution and reduction systems; knowledge acquisition; machine selection, cutting tool selection; software; various generative process planning systems; advantages of generative process planning systems; case studies.

Suggested Readings:

1. Chang, T.C.andWysk, R.A.(1984).*An Introduction to the Automated Process Planning*. Prentice Hall.
2. Groover, M.P.&Zimmers, E.W.(1984).*Computer Aided Design & Manufacturing*. Prentice Hall.
3. Gallagher, C.C. and Knight, W.A.(1998).*Group TechnologyProduction Methods in Manufacturing*, Ellis Hosewood.
4. Groover, M.P.(2008).*Automation; Production System & Computer Integrated Manufacturing*. Prentice Hall.

SEMESTER: V

Course Title: HEAT TRANSFER
Course Code: BME501

L	T	P	Credits
3	1	0	4

Learning Outcomes:

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

1. Apply the phenomenon of heat transfer in various applications.
2. Illustrate the various types of heat transfer modes
3. Compare the various methods which can improve the heat transfer rate
4. Compare and contrast the Free Convection and Forced Convection.
5. Describe the Radiation type heat transfer.

Course Content

UNIT I **16Hours**

Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heissler charts.

UNIT II **12Hours**

Heat convection,basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow-Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

UNIT III **12Hours**

Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method.

UNIT IV **16Hours**

Types of heat exchangers, Analysis and design of heat exchangers using bothLMTD and ε-NTU methods.Boiling and Condensation heat transfer, Pool boiling curveIntroduction mass transfer, Similarity between heat and mass transfer

Suggested Readings:

1. Kumar,D.S.(2013).*Fundamentals of Heat and Mass transfer*. SK Kataria and SonsDelhi.
2. Domkundwar,S.(2007).*A Course in Heat and Mass Transfer*. Dhanpat Rai and Sons Delhi.
3. Rajput,R.K.(2015).*Heat and Mass Transfer*. S. Chand &CompanyLtd.
4. Holmans,J.P.(1997).*Heat transfer*. McGraw Hill, London.

SEMESTER: V

Course Title: NUMERICAL METHODS
Course Code: BME502

L	T	P	Credits
3	1	0	4

Course Learning Outcomes:

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

1. Apply numerical methods to find solution of algebraic equations using different methods under different conditions, and numerical solution of system of algebraic equations
2. Use various interpolation methods and finite difference concepts to find roots of polynomial equations using numerical analysis.
3. Differentiate numerical integration and differentiation and Work out on numerical differentiation and integration whenever and wherever routine methods are not applicable
4. Explain how to interpolate the given set of values and the curve fitting for various polynomials
5. Work numerically on the ordinary differential equations using different methods through the theory of finite differences and Runge-Kutta method.

Course Content

UNIT I **16Hours**

Introduction & Error analysis

Introduction to Numerical methods and its significance in engineering, classification of errors, significant digits and numerical stability.

Linear Algebraic Equations

Cramer's rule, Gauss Elimination and LU Decomposition, Gauss-Jordan elimination, Gauss-Seidel and Relaxation Methods.

UNIT II **16Hours**

Non Linear Algebraic Equations

Single variable successive substitutions (Fixed Point Method), Multivariable successive substitutions, single variable Newton-Raphson Technique.

Eigen values and Eigen vectors of Matrices

FaddeevLeverrier's Method, Power Method.

UNIT III **16Hours**

Function Evaluation

Least squares curve-fit (Linear Regression), Newton's interpolation formulae (equal intervals), Newton's Divided Difference Interpolation Polynomial, Lagrangian Interpolation Unequal intervals).

Numerical Differentiation, Numerical Integration or Quadratures (Trapezoidal, Simpson's 1/3 and 3/8 rules), Extrapolation Technique of Richardson and Gaunt.

UNIT IV **14Hours**

Ordinary Differential Equations (ODE-IVPs) and partial differential Equations

The Finite difference Technique, Runge-Kutta method

Suggested Readings:

1. Gupta, S.K. (2009). *Numerical Methods for Engineers (2nd Edition).* New Age International Publishers.
2. Jain, M.K., Iyengar, S.R.K., &Jain, R.K. (2012).*Numerical Methods for Scientific and Engineering Computation.* New Age International.
3. Finlayson, B.A. (1980).*Nonlinear Analysis in Chemical Engineering.*MCGraw Hill
4. Villadsen, J. and Michelsen, M.L. (1978).*Solution of Differential Equation Models by Polynomial Approximation.* Prentice Hall.
5. Rice, R.G. & Do Duong, D. (1995).*Applied Mathematics and Modelling for Chemical Engineers.* John Wiley.
6. Sastry, S.S. (2005).*Introductory Methods of Numerical Analysis (4th Edition).* Prentice Hall of India.

SEMESTER: V

Course Title: MECHANICAL MEASUREMENT AND METROLOGY
Course Code: BME503

L	T	P	Credits
3	1	0	4

Learning Outcomes:

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

1. Describe the measurement of various quantities using instruments, their accuracy & range, and the techniques for controlling devices automatically.
2. Apply the principles of measuring devices and error measurements
3. Illustrate working of various displacements, strain measuring devices
4. Evaluate angular velocity, pressure measurement and vacuum by using various instruments
5. Explain the various measurement control system in manufacturing

engineering

Course Contents

UNIT I **14Hours**

Need and classification of measurements and instruments, basic and auxiliary functional elements of a measurement system, mechanical, electrical, electronic instruments, Range and span, accuracy and precision, calibration, hysteresis and dead zone, sensitivity and linearity, threshold and resolution, speed of response, lag, fidelity and dynamic error, dead time and dead zone

UNITII **16Hours**

Line, end and wavelength standards, linear measurements - vernier scale and micrometer, vernier height gauge and depth gauge, Angular measurements, Sin bar, Clinometers, Measurement of geometric forms like straightness, flatness, roundness comparators -their types, relative merits and limitations, Measurement of major diameter, minor diameter, effective diameter, pitch, angle and form of threads for internal and external threads, measurement of tooth thickness, pitch and checking of profile for spur gears, angle gauge.

UNIT III **18Hours**

Strain measurement, Types of strain gauges and their working, temperature compensation, strain rosettes, calibration, application of strain gauges for direct, bending and Torsional loads. Introduction to amplifying, transmitting and terminatingdevices. Mechanical tachometers, vibration reed tachometer and stroboscope, proving ring, hydraulic and pneumatic load cells, torque on rotating shafts, Absorption, transmission and driving dynamo meters

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UNIT IV **12Hours**

Bourdon tube, diaphragm and bellows, vacuum measurement - McLeod gauge, thermal conductivity gauge and ionization gauge, Dead weight gauge tester. Electromagnetic flux meters, ultra-sonic flow meters and hot wire anemometer, flow visualization techniques. Temperature measurement, Thermometers, Thermistors and Pyrometer, thermo-electric sensors, common thermocouples.

Suggested Readings:

1. Doebelin, E.O. (1988). *Measurement System Application and Design.* McGraw Hill Publishing. Company.
2. Holman, J.P. (1989). *Experimental Methods for Engineers*. McGraw Hill Publication Company.
3. Kumar, D.S. (1979). *Mechanical Measurement and Control*, Metropolitan Book Co Pvt.Ltd.
4. Jain, R.K. (2013). *Engineering Metrology*, Khanna publishers.
5. Kuo, B.C. (1975). *Automatic Control systems*, PrenticeHall.

SEMESTER: V

Course Title: MANUFACTURING PROCESSES
Course Code: BME504

L	T	P	Credits
4	0	0	4

Learning Outcomes:

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

1. Evaluate the mechanism of metal cutting and different forces acting on the tools according tothe tool wear and tool life
2. Explain the different gear manufacturing processes and gear finishing operations.
3. List the different advance manufacturing processes and their applications.
4. Describe the advance welding processes with the jigs and fixtures.
5. Understand the various Unconventional Machining Processes:

Course Content

UNIT I **12Hours**

Casting and moulding: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses.

UNIT II **18Hours**

Introduction to bulk and sheet metal forming, plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk forming(forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending) principles of powder metallurgy.

Metal cutting: Single and multi-point cutting; Orthogonal cutting, various force components: Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, Cutting tool materials, Cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNC machining.

Additive manufacturing: Rapid prototyping and rapid tooling

UNIT III **10Hours**

Joining/fastening processes: Physics of welding, brazing and soldering; design considerations in welding, Solid and liquid state joining processes; Adhesive bonding.

UNIT IV **20Hours**

Unconventional Machining Processes:

Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, principles and process parameters, Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, dielectric, power and control circuits, wire EDM; Electro-chemical machining (ECM), etchant &maskant,process parameters, MRR and surface finish. Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining

Suggested Readings:

1. Rao, (2013).*Manufacturing Technology: Foundry, Forming and Welding*. Tata McGrawHill.
2. Campbell, J.S. (1982).*Principles of Manufacturing Materials and Processes*. Tata McGrawHill.
3. Hajra& Choudhury. (2008).*Elements of Workshop Technology, Vol. I and II*. Media Promoters Pvt. Ltd.
4. Sharma, P.C. (2014).*A text book of production technology*. S. Chand and Company.

SEMESTER: V

Course Title: ENGINEERING MECHANICS
Course Code: BME505

L	T	P	Credits
4	0	0	4

Learning Outcomes:

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

1. Understand the basic force system.
2. Apply the principles of particle kinematics
3. Examine the concept of particle dynamics
4. Identify the general equations of equilibrium
5. Describe the methods of minimization of potential energy.

Course Content

UNIT I **14Hours**

Introduction to Engineering Mechanics covering, Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy

Friction covering, Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack;

UNIT II **13 Hours**

Basic Structural Analysis covering, Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines;

Centroid and Centre of Gravity covering, Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from

first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere,Hook.

UNIT III **15Hours**

Virtual Work and Energy Method- Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.

Review of particle dynamics- Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy.Impulse-momentum (linear, angular); Impact (Direct and oblique).

UNIT IV **18Hours**

Introduction to Kinetics of Rigid Bodies covering, Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation;

Mechanical Vibrations covering, Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsionpendulums;

Suggested Readings:

1. Shames, Irving H. (2006). *Engineering Mechanics*4th Edition. PrenticeHall
2. Beer, F. P. & Johnston, E. R. (2011). *Vector Mechanics for Engineers*. Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGrawHill
3. Hibbler, R.C. (2006). *Engineering Mechanics: Principles of Statics and Dynamics*. PearsonPress.
4. Ruina, Andy &Pratap, Rudra. (2011). *Introduction to Statics and Dynamics*. Oxford University.
5. Shanes& Rao. (2006). *Engineering Mechanics*. PearsonEducation,
6. Hibler & Gupta (2010). *Engineering Mechanics (Statics, Dynamics)*. PearsonEducation
7. Reddy, Vijay. K. and Suresh,K. K. (2010). *Singer's EngineeringMechanics*
8. Bansal, R.K. (2010). *A Text Book of Engineering Mechanics*. LaxmiPublications
9. Khurmi, R.S. (2010). *Engineering Mechanics*. S. Chand &Co.
10. Tayal, A.K. (2010), *Engineering Mechanics.* UmeshPublications

SEMESTER: V

Course Title: PROJECT-I
Course Code: BME506

L	T	P	Credits
0	0	2	1

Learning Outcomes:

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

1. Develop understanding regarding the size and scale of operations and nature of field work in which students are going to play their role after completing the courses of study.
2. Develop understanding of subject based knowledge given in the class room in the context of its application at work places.
3. Develop first hand experience and confidence amongst the students to enable them to use and apply knowledge and skills to solve practical problems in the world of work.
4. Develop special skills and abilities like interpersonal skills, communication skills, attitudes and values.

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Course Content

Some of the suggested project activities are given below:

a. Projects connected with repair and maintenance of machines.
b. Estimating and costing projects.
c. Design of jigs / fixtures.
d. Projects related to quality control.
e. Project work related to increasing productivity.
f. Projects relating to installation, calibration and testing of machines.
g. Projects related to wastage reduction.
h. Project, related to fabrication.
i. Energy efficiency related projects.
j. Projects related to improving an existing system

Note:

1. Students are required to prepare working drawings of the projects and will prepare the estimate, material lists as required, and carry out market survey etc.
2. Students will specify various processes involved in the project

SEMESTER: V

L	T	P	Credits

Course Title: HEAT TRANSFER LAB

0	0	2	1

Course Code: BME507

Learning Outcomes:

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

1. Evaluate heat transfer through lagged pipe, Insulating powder and Drop and Film wise condensation.
2. Calculate the Thermal conductivity of a given metal Rod.
3. Measure the Heat transfer coefficient for Pin Fin, Forced convection, Natural Convection / parallel and counter flow heat exchanger.
4. Understand the emissivity, Stefan Boltzmann Constant and Critical Heat flux of material
5. Compare the performance of Refrigeration and Air conditioning and to determine the overall heat transfer coefficient for a composite slab.

Course Content

List of Experiments

1. Determination of thermal conductivity of a solid insulating material by slab method.
2. Determination of coefficient of heat transfer for free/forced convection from the surface of a cylinder / plate when kept:
   i) Along the direction of flow
   ii) Perpendicular to the direction of flow
   iii) Inclined at an angle to the direction of flow.
3. To determine total resistance and thermal conductivity of composite wall.
4. Determination of heat transfer coefficient for
   i) Film condensation
   ii) Drop-wise condensation.
5. Determination heat transfer coefficient by radiation and hence find the Stefan Boltzman's constant using two plates/two cylinders of same size by making one of the plates/cylinders as a black body.
6. To determine the emissivity of non black plate surface.
7. Evaluate the performance of a heat pipe.
8. To study the rate of heat transfer through different types of fins (1-4) under free convection heat transfer.

SEMESTER: V

Course Title: MODERN WELDING FORMATION PROCESS
Course Code: BME508

L	T	P	Credits
3	0	0	3

Learning Outcomes:

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

1. Illustrate the modern manufacturing operations, including their capabilities and limitations.
2. Apply the modern welding techniques to influence the manufacturing schedule and cost.
3. Analyze the manufacturability and processing cost of modern welding techniques.
4. Develop the relationship between customer desires, functional requirements, and manufacturing process selection.

Course Content

UNIT I **10Hours**

Introduction: Overview of general trends in Manufacturing, concept and significance of important properties related to manufacturing processes, limitations of conventional manufacturing processes need and evolution of advanced manufacturing, selection and economics of manufacturing processes.

UNIT II **12Hours**

Advanced Machining Processes: Classification, Review of conventional machining processes, Principles, process parameters, capabilities and mechanism of material removal of AJM, WJM, AWJM, USM

UNIT III **10Hours**

Electro Chemical Type Advanced Machining Processes: ECM-Process principle, mechanism of material removal; Kinematics and dynamics of ECM; Tooling design; Choice and analysis of process parameters; Surface finish and accuracy.

UNIT III **13Hours**

Thermal Type Advanced Machining Processes: EDM, LBM and EBM processes: Working principle; Power circuits; Mechanism of material removal; Process parameters and characteristics; Surface finish and accuracy: Shape and materials applications, limitations.

Derived And Hybrid Advanced Machining Processes: Introduction of processes like rotary ultra sonic machining, electro stream drilling, shaped tube electro machining, wire electro discharge machining, electro chemical grinding, electro chemical honing, electro chemical deburring and electrochemical spark machining.

Suggested Readings:

1. Panday, P.C. and Shan, H.S. (1980).*Modern Machining Processes*, Tata McGrawHill
2. Boothroyd, G.and Knight, W.A.(1996).*Fundamentals of Machining and Machine Tools*.MareelDekkerInc.
3. Benedict, G.F.(1987).*Nontraditional Manufacturing Processes*. Marcel DekkerInc.

SEMESTER: V

Course Title: MACHINING SCIENCE
Course Code: BME509

L	T	P	Credits
3	0	0	3

Learning Outcomes:

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

1. Evaluate the values of various forces involved in the machining operations
2. Analyze the various single and multipoint cutting tools performance
3. Understand the heat generation in machining &application of coolant in operation
4. Illustrate the properties of various cutting tool materials and hence select an appropriate tool material for particular machining application
5. Develop the inter-relationship between cutting parameters and machining performance.

Course Content

UNIT I **10Hours**

Machining: Plastic Deformation, Tensile Test, Stress and Strain; Mechanism of Plastic Deformation: Slips, defects, plastic deformation on atomic scale; Types of machining processes; Chip formation; Orthogonal and Oblique Cutting; Types of Chips; Built-up edge formation; Tool specification; Tool angle relationships in ORS and ASA and NRS; Selection of Tool Angles; Multiple-point cutting tools: twist drill, helical milling cutter.

UNIT II **12Hours**

Merchant's Circle Diagram: Co-efficient of Friction: Determination of stress, strain and strain rate; Measurement of shear angle; Thin Zone model: Lee and Shaffer's Relationship; Thick Zone model: Okushima and Hitomi Analysis; Nature of sliding friction; Friction in Metal Cutting: Sticking and Sliding Zones, Determination of mean angle of friction.

UNIT III **13Hours**

Mechanism of Oblique Cutting: Normal Rake angle, velocity rake angle and effective rake angle; shear angles; velocity relationship; Force relationships in oblique cutting; Practical Marching Processes: Turning, shaping and planning, Slab milling, Drilling: Machining Parameters, force magnitudes, power consumption, material removal rate, time per pass.

UNIT IV **10Hours**

Measurement of Cutting Forces:Basic methods of measurement: Axially Loaded members, Cantilever Beam, Rings and Octagon, dynamometer requirements; machine tool dynamometers; Types of tool wear; Mechanisms of wear: Abrasion, Adhesion and Diffusion. Progressive tool wear: flank and crater wear. Tool Life: variables affecting tool life - cutting conditions, tool geometry, Types of tool materials, fabrication of cutting inserts, coatings, work material and cutting fluid; Machinability and their criteria.

Suggested Readings:

1. Rowe &Geoffrey W. (1977).*An introduction to the principles of Metal working*. Edward Arnold.

2. Bhattacharya,A.& Sen, G.C.(1969).*Principle of metal cutting*. New Central Book Agency.

3. Boothroyd, G. & Knight, W.A. (2005).*Fundamental of machining and machine tools*.CRC. Press.

4. Kalakjjan, S. (1992). Manufacturing Engineering &Technology.Addison-Wesley Pub Company.

SEMESTER: V

Course Title: COMPOSITE MATERIAL
Course Code: BME510

L	T	P	Credits
3	0	0	3

Learning Outcomes:

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

1. Comprehend the various types of metal and reinforcements used in composites
2. Understand the polymer matrix composites, metal matrix composites, ceramic matrix composites, their manufacturing and applications
3. Analyze the post processing operations and micromechanics of composites
4. Illustrate the metal matrix and ceramic composites
5. Examine the stress strain transformation, graphic interpretation in testing of composite materials

Course Content

UNIT I **10Hours**

Basic concepts and characteristics: Geometric and Physical definitions, natural and man-made composites, Aerospace and structural applications, types and classification of composites. Reinforcements: Fibres – Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosetts, Metal matrix and ceramic composites.

UNIT II **11Hours**

Micromechanics: Unidirectional composites, constituent materials and properties, elastic properties of a lamina, properties of typical composite materials, laminate characteristics and configurations. Characterization of composite properties. Manufacturing methods: Autoclave, tape production, moulding methods, filament winding, man layup, pultrusion, RTM.

UNIT III **12Hours**

Coordinate transformation: Hooke's law for different types of materials, Hooke's law for two dimensional unidirectional lamina, Transformation of stress and strain, Numerical examples of stress strain transformation, Graphic interpretation of stress – strain relations. Off – axis, stiffness modulus, off – axis compliance. Elastic behavior of unidirectional composites: Elastic constants of lamina, relationship between engineering constants and reduced stiffness and compliances, analysis of laminated composites, constitutive relations.

UNIT IV **10Hours**

Strength of unidirectional lamina: Micro mechanics of failure, Failure mechanisms, strength of an orthotropic lamina, strength of a lamina under tension and shear

maximum stress and strain criteria, application to design. The failure envelope, first ply failure, free-edge effects. Micros mechanical predictions of elastic constants.

Suggested Readings:

1. Jones, R. M. (1998).*Mechanics of Composite Materials*.McGraw Hill Company.
2. Daniel, I.M. &Ishai, O. (1994). *Engineering Mechanics of Composite Materials*. Oxford University Press.
3. Agarwal B. D. &BroutmanL. J.(1980).*Analysis and performance of fibreComposites*.Wiley-Interscience.
4. Autar, K. K.(2005).*Mechanics of Composite Materials*. CRC Press.
5. Calcote, L. R.(1968).*Analysis of Laminated Composite Structures*.VanNost. Reinhold.
6. Vasiliev, V.V.&Morozov, E.V. (2007).*Advanced Mechanics of Composite Materials*. Elsevier.

SEMESTER: VI

Course Title: REFRIGERATION &AIR-CONDITIONING
Course Code: BME601

L	T	P	Credits
4	0	0	4

Learning Outcomes:

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

1. Illustrate the fundamental principles and applications of refrigeration and air conditioning system.
2. Examine cooling capacity and coefficient of performance by conducting test on vapour compression refrigeration systems.
3. Learn about the properties, applications and environmental issues of different refrigerants.
4. Evaluate cooling load for air conditioning systems used for various.
5. Analyze the refrigeration and air conditioning systems.

Course Content

UNIT I **14Hours**

Classification of refrigeration systems

UNIT II **16Hours**

Advanced vapour compression cycles, Refrigerants and their mixtures: properties and characteristics

-Ozone depletion and global warming issues-System components: Compressors, Condensers, Expansion devices and Evaporators-Performance matching of components of refrigeration systems

UNIT III **14Hours**

Advanced sorption refrigeration systems and their components.

UNIT IV **16Hours**

Review of Psychrometry and Air-conditioning processes-Comfort air conditioning and Cooling load calculations - Applications of AC systems - Concept of enthalpy potential - Air washers, Cooling towers, Evaporative condensers, Cooling and dehumidifying coils.

Suggested Readings:

1. Arora, C.P. (1983).*Refrigeration and Conditioning.* Tata McGraw Hill.
2. Prasad, Manohar.(2011)*Refrigeration and Conditioning.* Wiley EasternLimited.
3. Jordon, R.C.&Priester, G.B.(1956).*Refrigeration and Conditioning.* Prentice Hall ofIndia.
4. Stoecker, W.F.(2014). *Refrigeration and Conditioning.*Tata McGraw Hill.
5. Rajput, R.K.(2010). *Refrigeration and Conditioning.* KhannaPublications.

SEMESTER: VI

Course Title: MECHANICAL VIBRATIONS
Course Code: BME602

L	T	P	Credits
3	1	0	4

Learning Outcomes:

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

1. Describe the principle of conventional and advanced vibrations.
2. Develop basic knowledge on problem modeling for vibration analysis.
3. Illustrate various techniques for solving Vibration models/ systems.
4. Compare the various the iterative procedures for solving vibration problems for multi degree of freedom systems.
5. Apply the vibration solver techniques for analyzing the realistic complex structures.

Course Content

UNIT I **14Hours**

Introduction:

Basic concepts and its cause, Scope of vibration, degree of Freedom, Methods of vibration analysis, Types of vibration, Periodic &Harmonic vibrations .Beats and Beat Phenomena. Fourier analysis

For Single degree of freedom system

Un-damped free vibrations:

Torsional Vibration of rotor shaft system, compound Pendulum, Beam with several masses.

UNIT II **16Hours**

Damped free vibrations:

Types of damping, Differential equations of damped free vibration, Use of Critical damping

Damped force vibrations

Source of excitation, Equation of motion with harmonic Force, magnification Factor, Response of rotating and reciprocating unbalance system. Support motion vibration isolation transmissibility.

UNIT III **14Hours**

Vibration measuring instruments:-Vibrometer, Accelerometer, Frequency measuring device:-Frahm tachometer and Fullarton tachometer,Critical Speed

Two degrees of Freedom systems:

a) Principal modes of vibrations, natural frequencies, amplitude ratio, forced harmonic vibration combined rectilinear & angular modes.

b) Application; Vibration absorber - principle, centrifugal pendulum vibration absorber, torsional vibration damper, unturned viscous damper, dry friction dampers, torsional vibration of two rotor systems.

UNIT IV **14Hours**

Multi-degree of freedom systems:

Un-damped free vibrations, influence coefficients, generalized coordinates, orthogonality principal, matrix alteration methods,: Rayleigh and Dunkerley, Holzer's , stodola method, Eigen values &Eigen vector

Continuous systems:

Vibration of a string, longitudinal vibrations of bars, Euler's equation of motion for beam vibration, natural frequencies for various end conditions, torsional vibration of circular shafts

Suggested Readings

1. Grover, G.K.(2009). *Mechanical Vibrations*. Nem Chand & Bros Roorkee.
2. Purjara, K. &Pujara, R.S. (1984). *Vibrations for Engineers*. Dhanpat rai and sons Delhi
3. Singh,V.P.(2015).*MechanicalVibrations*. Dhanpat rai and sons Delhi
4. Rao, S.S.(2003). *MechanicalVibrations*.Pearson
5. Thompson, W.T.(1961). *MechanicalVibrations*.Prentice Hall Press
6. Srinivasan, P.(1996). *Mechanical Vibrations and Analysis*.John Wiley & Sons Inc.

SEMESTER: VI

Course Title: MANUFACTURING TECHNOLOGY
Course Code: BME603

L	T	P	Credits
4	0	0	4

Learning Outcomes:

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

1. Comprehend the manufacturing processes and tools commonly used to convert cast, Forged, molded, and wrought materials into finished products.
2. Understand the basic mechanisms of material removal, measurement, quality control, assembly processes.
3. Understand the different metal removing processes and super finishing processes for component production.
4. Learn about surface finishing techniques.
5. Examine the working of standard machine tools such as lathe, shaping and allied machines, milling, drilling and allied machines, grinding and allied machines and broaching.

Course Content

UNIT I **10Hours**

Mechanism of Metal Cutting: Deformation of metal during machining, nomenclature of lathe, milling tools, mechanics of chip formation, built-up edges, mechanics of orthogonal and oblique cutting, Merchant cutting force circle and shear angle relationship in orthogonal cutting, factors affecting tool forces. Cutting speed, feed and depth of cut, surface finish. Temperature distribution at tool chip interface. Numerically on cutting forces and Merchant circle.

UNIT II **18Hours**

Tool Wear and Machinability: Types of tool wear, tool life, factors governing tool life, Machinability: Definition and evaluation. Economics of machining, Numerical on tool life.

Cutting Tool Materials & Cutting Fluids: Characteristics of tool materials, various types of cutting tool materials, coated tools, cutting tool selection, Purpose and types of cutting fluids, basic actions of cutting fluids, effect of cutting fluid on tool life, selections of cutting fluid Jigs & Fixtures: Introduction, location and location devices, clamping and clamping devices, Drill Jigs, Milling Fixtures.

UNIT III **12Hours**

Gear Manufacturing: Introduction, methods of manufacture. Gear generation and forming: Gear cutting by milling, single point form tool, gear hobbing and shaping. Gear finishing operations: Gear shaving, gear burnishing, gear grinding, lapping.

UNIT IV **18Hours**

Unconventional Machining Processes: introduction, classification of unconventional machining processes, Abrasive jet machining: Principles, advantages, disadvantages and applications. Ultrasonic machining: Principles, advantages, disadvantages and applications. Electro-chemical machining and grinding: Principles of operation, advantages, disadvantages and applications. Electric discharge machining: Principles, advantages, disadvantages and applications. Electron beam machining: principle, advantages, disadvantages and applications. Laser beam machining: Principles and applications.

Suggested Readings

1. Rao, P.N. (1992).*Manufacturing Technology: Foundry, Forming and Welding*. Tata McGrawHill.
2. Campbell, J.S. (1961).*Principles of Manufacturing Materials and Processes*. Tata McGrawHill.
3. Hajra& Choudhury. (2008). *Elements of Workshop Technology, Vol. I and II*. Media Promoters Pvt Ltd.
4. Sharma, P.C. (2003).*A text book of production technology*. S Chand and Company.

SEMESTER: VI

Course Title: INDUSTRIAL AUTOMATION & ROBOTICS
Course Code: BME604

L	T	P	Credits
4	0	0	4

Learning Outcomes:

1. On successful completion of this course, the students will be able to:
2. Acquire an overview of industrial automation.
3. Understand the concepts ofautomation and robotic support which cater to the needs of the larger manufacturing enterprise.
4. Differentiate between the various sensors in construction & application which are used in robotic & automation systems.
5. Acquire the knowledge and skills associated with robot control.

Course Content

UNIT I **16Hours**

Introduction: Concept and scope of automation: Socio economic impacts of automation, Types of Automation, Low Cost Automation

Fluid Power: Fluid power control elements, Standard graphical symbols, Fluid power generators, Hydraulic and pneumatic Cylinders - construction, design and mounting; Hydraulic and pneumatic Valves for pressure, flow and direction control.

UNIT II **14Hours**

Basic hydraulic and pneumatic circuits: Direct and Indirect Control of Single/Double Acting Cylinders, designing of logic circuits for a given time displacement diagram & sequence ofoperations, Hydraulic & Pneumatic Circuits using Time Delay Valve & Quick Exhaust Valve, Memory Circuit & Speed Control of a Cylinder, Troubleshooting and "Causes & Effects of Malfunctions" Basics of Control Chain, Circuit Layouts, Designation of specific Elements in a Circuit.
Fluidics: Boolean algebra, Truth Tables, Logic Gates, Coanda effect.

UNIT III **16Hours**

Electrical and Electronic Controls: Basics of Programmable logic controllers (PLC), Architecture & Components of PLC, Ladder Logic Diagrams
Transfer Devices and feeders: Classification, Constructional details and Applications ofTransfer devices, Vibratory bowl feeders, Reciprocating tube, Centrifugal hopper feeders

UNIT IV **14Hours**

Robotics: Introduction, Classification based on geometry, control and path movement,Robot Specifications, Robot Performance Parameters, Robot Programming, Machine Vision, Teach pendants, Industrial Applications of Robots

Suggested Readings

1. Esposito, A. (2009).*Fluid Power withapplications*.Pearson Prentice Hall.
2. Majumdar, S.R. (1996).*PneumaticControl*.TataMcGrawHill Education
3. Deb, S.R. & Dev, S.(2001). *Robotics and FlexibleAutomation*.Tata McGraw-Hill Education.
4. Goyal, K.&Bhandari, D. (2011).*IndustrialAutomationandRobotics*.S.K. Katariaand Sons.
5. Gupta, A.K.,&Arora,S.K.(2009).*Industrial Automation and Robotics*.Laxmi Publications.

SEMESTER: VI

Course Title: MECHANICAL VIBRATION LAB
Course Code: BME605

L	T	P	Credits
0	0	2	1

Learning Outcomes:

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

1. Determine the viscosity of given fluid by single wire Torsional pendulum.
2. Examine the natural frequencies of a coupled pendulum.
3. Determine the fundamental natural frequency of a cantilever beam
4. Correlate the modules of elasticity from free vibrationtest
5. Understand the forced vibration of a two degree of freedom system under harmonicexcitation

Course Content

List of Experiments

1. Determine the viscosity of given fluid by single wire torsional pendulum.
2. Determine the natural frequencies of a coupled pendulum.
3. Find out the fundamental natural frequency of a cantilever beam
4. Determine the modulas of elasticity from free vibration test
5. Study of forced vibration of a two degree of freedom system under harmonic excitation
6. Study of a dynamic absorber

SEMESTER: VI

Course Title: PROJECT-II
Course Code: BME606

Learning Outcomes:

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

1. Develop understanding regarding the size and scale of operations and nature of field work in which students are going to play their role after completing the courses of study.
2. Develop understanding of subject based knowledge given in the class room in the context of its application at work places.
3. Develop first hand experience and confidence amongst the students to enable

them to use and apply knowledge and skills to solve practical problems in the world of work.

4. Develop special skills and abilities like interpersonal skills, communication skills, attitudes and values.

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Course Content

Some of the suggested project activities are given below:

a. Projects connected with repair and maintenance of machines.
b. Estimating and costing projects.
c. Design of jigs / fixtures.
d. Projects related to quality control.
e. Project work related to increasing productivity.
f. Projects relating to installation, calibration and testing of machines.
g. Projects related to wastage reduction.
h. Project, related to fabrication.
i. Energy efficiency related projects.
j. Projects related to improving an existing system

Note:

1. Students are required to prepare working drawings of the projects and will prepare the estimate, material lists as required, and carry out market survey etc.
2. Students will specify various processes involved in the project

SEMESTER: VI

Course Title: MECHANICAL MEASUREMENT AND METROLOGY LAB
Course Code: BME607

L	T	P	Credits
0	0	2	1

Learning Outcomes:

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

1. Exhibit the use of instruments for measuring linear (internal and external), angular dimensions and surface roughness
2. Perform alignment tests on various machine tools.
3. Validate the use of instruments for measuring pressure, flow, speed, displacement and temperature
4. Calibrate the Bourdon tube pressure gauge

Course Content

List of Experiments

1. Measurement using Optical Projector / Toolmaker Microscope.
2. Measurement of angle using Sine Center / Sine bar / bevel protractor
3. Measurement of alignment using Autocollimator / Roller set
4. Measurement of cutting tool forces using a) Lathe tool Dynamometer OR b) Drill tool Dynamometer.
5. Measurement of Screw threads Parameters using two wire or Three-wire methods.
6. Measurement of Surface roughness, using Tally Surf/Mechanical Comparator.
7. Measurement of gear tooth profile using gear tooth Vernier /Gear tooth micrometer.
8. Calibration of Micrometer using slip gauges.
9. Measurement using Optical Flats.

SEMESTER: VI

Course Title: CASTING PROCESSES
Course Code: BME608

L	T	P	Credits
3	0	0	3

Learning Outcomes:

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

1. Understand the principles of metal casting processes and develop analytical relation between input and output process parameters.
2. Understand the concept of cooling rate of materials in metal casting.
3. Apply theoretical and experimental techniques for measurement of important outcomes of casting processes like hardness, dimensional accuracy etc.
4. Comprehend the model of casting economics and optimization and its measurement.
5. Apply the fundamentals of physics to develop theoretical relations for different types of casting processes

Course Content

UNIT I **10Hours**

Structure of Silica and Different Types of Clays: Bonding mechanism of silica – water-clay Systems. Swelling of clays, sintering adhesion and colloidal clay; silica grain shape and size distribution standard permeability A.F.S. clay.

Characteristics: Ingredients and additives of moulding sand, core sands.

UNIT II **12Hours**

Solidifications of Metals, nucleation, free energy concept, critical radius of nucleus. Nucleation and growth in metals and alloys. constitutional super cooling. Columnar equiacquiesced and dendritic structures. Freezing of alloys centreline feeding resistance. Rate of solidification, time of solidification, mould constant. Fluidity of metals, volumes redistribution.

Various Moulding and Casting Processes, hot box, cold box process, investment, shell moulding, full mould process, die casting, ceramic shell mould, vaccummoulding etc.

UNIT III **10Hours**

Riser Designshape, size and placement. Effect of appendages on risering. Effective feeding distances for simple and complex shapes. Use of chills, gating design, filling time. Aspiration of gases. Top, bottom and inside gating. Directional solidifications stresses in castings. Metal mould reactions. Expansion scale and metal penetration.

UNIT IV **13Hours**

Non-Ferrous Die-casting of Aluminum and its alloys, brass and bronze.

Inspection and testing of casting i.e. visual, mechanical, ultrasonic, dye penetration, magnetic particle and x-ray., Casting Defects.

Suggested Readings

1. Flinn, R.A.(1963). *Fundamentals of Metals Casting*. Addison Wesley.
2. Heine, R.W.(1967). *Principles of Metal Casting*.Tata McGraw Hill.
3. Niebel, B.W.& Draper, A.B.(1974). *Product Design & Process Engineering*. Tata McGraw Hill.
4. ASME (1988). *Metals Handbook- Metal Casting*. ASM International.

SEMESTER: VI

Course Title: MICROMACHINING TECHNOLOGIES
Course Code: BME609

L	T	P	Credits
3	0	0	3

Learning Outcomes:

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

1. Understand the principle of micro-systems and feedback systems
2. Differentiate the different methods of micro-fabrication.
3. Examine the properties and microstructure of materials

4. Apply the integration processes in machining
5. Acquire the knowledge of semiconductor manufacturing processes.

Course Content

UNIT I **10Hours**

Introduction to Micro System design, Material properties, micro fabrication technologies. Structural behavior, sensing methods, micro scale transport – feedback systems.

UNIT II **16Hours**

Micromechanics : Microstructure of materials, its connection to molecular structure and its consequences on macroscopic properties – Phase transformations in crystalline solids including martensite, ferroelectric, and diffusional phase transformations, twinning and domain patterns, smart materials

UNIT III **8Hours**

Basic micro-fabrication: Bulk Processes – Surface Processes – Sacrificial Processes and Bonding Processes

UNIT IV **10Hours**

Special machining: Laser beam micro machining – Electrical Discharge Machining – Ultrasonic Machining – Electro chemical Machining. Electron beam machining.

Suggested Reading

1. Franssila,S.(2004). *Introduction to Micro Fabrication*. John Wiley and sons Ltd.
2. Madore, J.(2002). *Fundamental of Micro Fabrication*. CRC Press.
3. Jackson,M. J. (2006). *Microfabrication and Nano-manufacturing*. CRC Press.
4. Zant, P.V.(2004). *Microchip fabrication*.Tata McGraw Hill.
5. Gad-el-Hak, M.(2006). *The MEMS Handbook*. CRC Press.

SEMESTER: VI
Course Title: PLASTIC TECHNOLOGY
Course Code: BME610

L	T	P	Credits
3	0	0	3

Learning Outcomes:

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

1. Understand the various aspects of plastics technology viz. plastic materials manufacturing, properties, applications, processing, product design, mold design, testing & quality control, and recycling
2. Apply the various aspects of product design, mold design, testing & quality control, and recycling.

3. Develop the processes for the manufacturing of plastic materials, and analyze their properties.
4. Examine the effect of crystalline on properties of cross-linked plastics

Course Content

UNIT I **10Hours**

Introduction to Polymer Chemistry Sources of raw materials- Monomers - Polymers- Polymerization - Types of Polymerization – Classification. Definition and Classification of Plastics – General properties – Historical development of plastic industry-future trends, Thermoplastics, Thermosetting, Engineering & High performance plastics.

UNIT II **10Hours**

Structure of Plastics: Molecules –Crystallinity – Effect of Crystallinity on properties – crosslinked plastics – Determination of Molecular weight – Effect of Molecular weight on processing and properties – Molecular weight distribution. Linear, Branched and cross linked structures in polymers. Flexibility and movement of macromolecules. Glass transition temperature (Tg). Relationship

UNIT III **14Hours**

Sources and manufacture of raw materials- basic chemistry- Methods of manufacture, Flow behavior- General properties and applications of Olefin Polymer and Co- polymers Vinyl chloride polymers and co-polymers

Introduction – Sources and manufacture of raw materials –basic chemistry – Methods of manufacture –Flow behavior – General properties and applications of Styrene and Styrene co- polymers PMMA. Cellulose polymers

UNIT IV **10Hours**

Bio degradable and Bio Plastics Principle and Mechanism of Plastics degradation, Natural Bio-degradable Polymers – Synthetic Biodegradable Polymers – Water soluble Polymers. Bio plastics types, properties and applications Case studies on applications of above materials.

Suggested Readings

1. Brydson, J.A. (1999). *Plastics Materials*. Butterworth-Heinemann.
2. Schwartz, S.S.&Goodman, S.H.(1982). *Plastics materials and processing*. Van Nostrand Reinhold.
3. Irwin, I. R. (1990). *Hand book of Plastic Materials and Technology*. New York: Wiley

SEMESTER: VII

Course Title: DESIGN OF MACHINE ELEMENTS
Course Code: BME701

L	T	P	Credits
4	0	0	4

Learning Outcomes:

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

1. Comprehend the different concepts & considerations of machine design.
2. Analyze the design of different types of mechanical joints
3. Examine the different types of keys & couplings
4. Develop a design procedure of transmission of shafts.
5. Differentiate the various types of springs &Conceptualize the design of different types of clutches

Course Content

UNIT I **10Hours**

Principles of Mechanical Design: General considerations & procedure of design of machine elements, Engineering materials & their mechanical properties, Selection of material, theories of failures, static loading, factor of safety under different loading conditions, stress concentration, Concept of fatigue failures for dynamic loading.

UNIT II **14Hours**

Mechanical Joints: Design of riveted &welding joints under different static load conditions. Design of screwed joints against static load, eccentrically loading, Design of cotter joints and knuckle joint.

Keys & Couplings: Design of different type of keys; sunk key, saddle key, tangent key, round key & splines. Design of different shaft couplings against torque; Rigid & Flexible couplings.

UNIT III **14Hours**

Transmission Shafts: Design of shaft subjected to static loading: pure torsion, simple bending, combined bending and torsion, combined bending torsion and axial loads. Design of shafts for fluctuating loads.

UNIT IV **18Hours**

Springs: Terminologies of springs, Different type of springs, Design of helical springs for static & dynamic loading, Eccentric loading, Surge in springs, Springs in series & parallel connection, Type of leaf springs, Design of leaf springs.

Clutches: Various types of clutches, Design of friction clutches; Single plate clutch, Multi-plate clutch, Cone clutch & Centrifugal clutch.

Suggested Readings

1. Shigley, J. E. (1983).*Mechanical Engineering Design*. Tata McGraw Hills.
2. Bhandari,V.B.(2010). *Design of Machine Elements*.Tata McGraw Hills.
3. Norton, R. L.(2000).*Machine design: an integrated approach*. Prentice Hall.

SEMESTER: VII

Course Title: COMPUTER AIDED DESIGN
Course Code: BME702

L	T	P	Credits
4	0	0	4

Learning Outcomes:

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

1. Comprehend the various software used in CAD and the functions of a graphics package.
2. Understand the various concepts and characteristics in geometric modeling.
3. Analyze the components and systems of NC and CNC machine tools.
4. Apply the various programming methods for specific jobs.
5. Differentiate the FMS and CIMS with reference to components, advantages and applications.

Course Content

UNIT I **12Hours**

Overview of conventional design & manufacturing process, computer's role in design, benefits of computer application, relation of CAD with CAM, history of CAD development, current trends in CAD.Central processing unit, memory, input & output devices, types of computer systems, computer programming, general information of various software for CAD, types of file formats & their exchange, graphics standards**.**

UNIT II **16Hours**

Geometric Modeling:

Curve representation methods, surface representation methods, half spaces, boundary representation (B-rep),sweeprepresentation,constructivesolidgeometry(CGS),solidmanipulations, modeling facilities desired.

Transformations:

Translation, rotation, scaling symmetry, reflection, homogeneous transformations, orthographic projections, axonometric projections, oblique projections, perspective transformation.

UNIT III **12Hours**

VisualRealization:

Basicconceptsofvisualrealization,hiddenlineremoval,hiddensurfaceremoval,shadings urfacesandsolids visibility techniques, sorting coherence, hidden line removal for curved surface.

UNIT IV **20Hours**

CADandCAMintegration:

Introduction, part production cycle, manufacturing system, process, integration requirements, process planning, tool path generation and verification, Design and Engg. applications.

Introduction to Design and Engineering Applications:

Geometry and mass property formulations.Practice on Drafting and Modeling systems : Basic geometric commands, layers, display control commands, editing, dimensioning, solid modeling on available CAD packages.

Suggested Readings

1. Groover, M. &Zimmers,E.(1984). *CAD/CAM*. Prentice Hall of India
2. Groover, M.P.(1980).*Automation: Production Systems &CAM*.Englewood Cliffs New Jersey
3. Chang, T.C. &Wysk, R.A.(1985). *An introduction to Automated Process Planning*.Longman Higher Education
4. Singh, N.(1995).*System approach to Computer Integrated Design and Manufacturing*.Wiley.
5. Pable, B.S. &Adithan, M.(1994). CNC Machines. New Age International(P) Ltd.
6. Dalela, S.& Jain, P.K.(2000).*CAD/CAM*. S Chand & Company Pvt Ltd.
7. Ibraham,Z. (2009). *CAD/CAM - Theory and Practice*. Tata McGraw Hill Pub Co.

SEMESTER: VII

Course Title: OPERATION RESEARCH
Course Code: BME703

L	T	P	Credits
3	1	0	4

Learning Outcomes:

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

1. Comprehend the role of operation research in decision-making, and its applications in industry and design for real-world problems through models & experiments
2. Apply various types of deterministic models like linear programming, transportation model etc.
3. Analyze various types of stochastic models like waiting line model, project line model, simulation etc.
4. Develop the relationship between a linear program and its dual and perform sensitivity analysis.
5. Understand the decision making environment and apply decision making process in the real world situations.

Course Content

UNIT I **12Hours**

Introduction:

Origin & development of OR and its role in solving industrial problems: General approach for solving OR problems. Nature and characteristic feature of OR. Use and limitation of OR. Classification of mathematical models:

Deterministic Models:

Formulation of deterministic linear mathematical models: Graphical and simplex techniques for solution of linear programming problems, Big M method and two phase method, Introduction to duality theory and sensitivity analysis: transportation models, test for optimality, degeneracy in transportation. Assignment problems (Hungarian method) travelling salesman problems, and sequencing models; Introduction to goal programming; Solution techniques of linear goal programming problems.

UNIT II **14Hours**

Probabilistic Models:

Decision making: various decision making environments. Maximum and minimum models; Introduction to decision tree. Game theory: Solution of simple two person zero-sum games: Examples of simple competitive situation.

Simulation:

Concept general approach and application. Use of Monte-Carlo simulation technique to queuing and inventory problems.

Dynamic Programming:

Introduction to deterministic and probabilistic dynamic programming. Solution of simple problems. Advantages of dynamic

UNIT II **18Hours**

Queuing theory:

Types of queuing situation: Queuing models with Poisson's input and exponential service, their application to simple situations.

Replacement Models:

Replacement of items that deteriorate, Replacement of items whose maintenance and repair costs increase with time, replacement of items that fail suddenly; replacement of items whose maintenance costs increase with time and value of money also changes, individual replacement policy, group replacement policy.

Inventory models:

Classification of inventory control models: Inventory models with deterministic demand, inventory models with probabilistic demand, and inventory models with price breaks. Advantages and disadvantage of inventory

UNIT I **10Hours**

Network models:

PERT & CPM introduction, analysis of time bound project situations, construction of net works, identification of critical path, slack and floats, crashing of network for cost reduction, resource leveling and smoothening.

Suggested Readings

1. Wagner, H.M.(1980). *Principles of Operations Research.*PrenticeHall.
2. Gupta, P.K.& Hira, D.S.(1976).*Operations Research.* S. Chand &Co.
3. Taha, H.(1999). *Introduction to OperationResearch*. Pearson.
4. Hillier, F. S. & Lieberman, G. J. (1967). *Introduction to Operations Research.* San Francisco: Holden-Day.

SEMESTER: VII

Course Title: RESEARCH METHODOLOGY
Course Code: BME704

L	T	P	Credits
4	0	0	4

Course Learning Outcomes:

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

1. Understand some basic concepts of research and its methodologies.
2. identify appropriate research topics
3. Select and define appropriate research problem and parameters.
4. Organize and conduct research (advanced project) in a more appropriate manner.
5. Know how to write a research report and thesis

Course Content

UNIT I **10Hours**

RESEARCH FORMULATION AND DESIGN

Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis.

UNIT II **16Hours**

DATA COLLECTION AND ANALYSIS

Accepts of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statically package (Sigma STAT,SPSS for student t-test, ANOVA, etc.), hypothesis testing.

SOFT COMPUTING

Computer and its role in research, Use of statistical software SPSS, GRETL etcin research. Introduction to evolutionary algorithms - Fundamentals of Genetic algorithms, Simulated Annealing, Neural Network based optimization, Optimization of fuzzy systems

UNIT III **14Hours**

RESEARCH ETHICS, IPR AND SCHOLARY PUBLISHING

Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.

UNIT IV **15Hours**

INTERPRETATION AND REPORT WRITING

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research

Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.

Suggested Readings

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
5. Wadehra, B.L. 2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.

SEMESTER: VII

Course Title: COMPUTER AIDED DESIGN LAB
Course Code: BME705

L	T	P	Credits
0	0	4	2

Course Learning Outcomes:

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

1. Understand and handle design problems in a systematic manner
2. Gain practical experience in handling 2D drafting and 3D modeling software systems
3. Apply CAD in real life applications.
4. Understand the concepts G and M codes and manual part programming.
5. Know the application of various CNC machines.

Course Content

List of Experiments

1. CAD exercises using Auto Cad software
2. Draw the different type of 3D modelling entries using viewing commands to view them (Isometric projection).
3. Sanctioning of solid primitives and rendering in 3D.

4. Part-programming on CNC machines
5. Execution of part programme for machining given profile.
6. Part modeling using some of the modeling technique
7. Component assembly in CAD and generating and modifying dawings

SEMESTER: VII

Course Title: PROJECT-III
Course Code: BME706

Learning Outcomes:

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

1. Develop understanding regarding the size and scale of operations and nature of field work in which students are going to play their role after completing the courses of study.
2. Develop understanding of subject based knowledge given in the class room in the context of its application at work places.
3. Develop first hand experience and confidence amongst the students to enable them to use and apply knowledge and skills to solve practical problems in the world of work.
4. Develop special skills and abilities like interpersonal skills, communication skills, attitudes and values.

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Course Content

Some of the suggested project activities are given below:

a. Projects connected with repair and maintenance of machines.
b. Estimating and costing projects.
c. Design of jigs / fixtures.
d. Projects related to quality control.
e. Project work related to increasing productivity.
f. Projects relating to installation, calibration and testing of machines.
    i. Projects related to wastage reduction.
g. Project, related to fabrication.
h. Energy efficiency related projects.
i. Projects related to improving an existing system

Note:

1. Students are required to prepare working drawings of the projects and will prepare the estimate, material lists as required, and carry out market survey etc.
2. Students will specify various processes involved in the project

SEMESTER: VII
Course Title: HEAT EXCHANGER
Course Code: BME707

L	T	P	Credits
3	0	0	3

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Learning Outcomes:

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

1. Understand the essentials and basic concepts of heat exchangers.
2. Illustrate the heat exchanger types and selection criteria of heat exchanger according to usage area.
3. Evaluate thermal, pressure drop, strength, and cost analysis of heat exchangers.
4. Comprehend the fundamentals of convective heat transfer process.
5. Analyze the consequence of heat transfer in thermal analyses of engineering systems.

Course Content

UNIT I **8Hours**

Introduction: Classification, types and applications of heat Exchangers, Heat Exchanger Design methodology, Selection of Heat Exchangers.

UNIT II **10Hours**

Single Phase Heat Exchangers: LMTD and NTU methods, Rating and sizing methods, design criteria, geometry, process parameters, pressure drops and applications.

Two Phase Heat Exchangers: Types of Boiling, Boiling mechanisms, two phase flow boiling pressure drop.

UNIT III **13Hours**

Condensation Mechanism, types of condensers and design procedures, Evaporators, Multiple effect evaporators, Design procedures, Liquid chillers, kettle, thermosiphon and forced circulation.

Augmented surface heat exchangers, Heat transfer coefficients, pressure drops, compact heat exchangers and air coolers, plate heat exchangers and plate fine heat exchangers.

UNIT IV **12Hours**

Heat Pipe Heat Exchangers: Types and design procedure and applications Installation, Operation and Maintenance: Fouling factors, type of fouling and cleaning methods.

Mechanical Considerations: Codes and Standards, Mechanical design requirements and materials.

Suggested Readings

1. Saunders, E.A.D.(1989). *Heat Exchangers Selection Design and Construction*. Longman Scientific and Technical John Wiley and Sons Inc. NewYork
2. Kern, D.Q.(1965). *Process Heat Transfer*. McGraw HillBook Company.
3. Holman, J.P.(1997). *Heat Transfer*. McGraw Hill Book CompanySingapore.
4. Gupta, J.P.(1986). *Fundamentals of Heat Exchangers and Pressure Vessels Technology*. Hemisphere Publishing Corporation.

SEMESTER: VII

Course Title: GAS DYNAMICS AND JET PROPULSION
Course Code: BME708

L	T	P	Credits
3	0	0	3

Learning Outcomes:

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

1. Understand the differences between compressible and incompressible flows.
2. Comprehend the rocket propulsion and various propellants in real life problems.
3. Solve the problems in Rayleigh and Fanno flow.
4. Appreciate the compressible flow fundamentals.
5. Apply the compressible flow with friction and heat transfer in engineering applications.

Course Content

UNIT I **8Hours**

COMPRESSIBLE FLOW–FUNDAMENTALS

Energy and momentum equations for compressible fluid flows, various regions of flows, reference velocities, stagnation state, velocity of sound, critical states, Mach number, critical Mach number, types of waves, Mach cone, Mach angle, effect of Mach number on compressibility.

UNIT II **14Hours**

FLOW THROUGH VARIABLEAREADUCTS

Isentropic flow through variable area ducts, T-s and h-s diagrams for nozzle and diffuser flows, area ratio as a function of Mach number, mass flow rate through nozzles and diffusers, effect of friction in flow through nozzles.

FLOW THROUGH CONSTANTAREADUCTS

Flow in constant area ducts with friction (Fanno flow) - Fanno curves and Fanno flow equation, variation of flow properties, variation of Mach number with duct

length.
Flow in constant area ducts with heat transfer (Rayleigh flow), Rayleigh line and Rayleigh flow equation, variation of flow properties, maximum heat transfer.

UNIT III **16Hours**

NORMAL AND OBLIQUE SHOCK

Governing equations, variation of flow parameters like static pressure, static temperature, density, stagnation pressure and entropy across the normal shock, Prandtl – Meyer equation, impossibility of shock in subsonic flows, flow in convergent and divergent nozzle with shock. Flow with Oblique Shock – Fundamental relations, Prandtl‟s equation, Variation of flow parameters

UNIT IV **12Hours**

PROPULSION

Aircraft propulsion – types of jet engines – study of turbojet engine components – diffuser, compressor, combustion chamber, turbine and exhaust systems, performance of turbo jet engines
– thrust, thrust power, propulsive and overall efficiencies, thrust augmentation in turbo jet engine, ram jet and pulse jet engines.
Rocket propulsion – rocket engines thrust equation – effective jet velocity specific impulse – rocket engine performance, solid and liquid propellants.

Suggested Readings

1. Yahya, S.M.(2005).*Fundamental of compressible flow with Aircraft and Rocket propulsion*. New Age International (p) Ltd.
2. Patrich, H. (1997). *Compressible fluid flow.*Tata McGraw-Hill.
3. Cohen, H. (1987). *Gas TurbineTheory*. Addison Wesley Ltd.
4. Ganesan, V.(1999). *Gas Turbines*. Tata McGraw-Hill.
5. Rathakrishnan, E.(2001). *Gas Dynamics*. Prentice Hall of India.

SEMESTER: VII

Course Title: CRYOGENIC TECHNOLOGIES
Course Code: BME709

L	T	P	Credits
3	0	0	3

Learning Outcomes:

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

1. Apply the cryogenic engineering to real applications
2. Comprehend the basics of thermodynamics, heat transfer as well as refrigeration
3. Understand the various methods to create cryogenic temperatures and to maintain it.
4. Critically examine the various techniques used in applications of cryogenics in various fields.
5. Recognize the engineering problems solvable by applying cryogenic techniques.

Course Content

UNIT I **8**

HoursDefinition and history of cryogenics, Gas-Liquefaction and refrigeration systems, thermodynamics of gas liquefaction, liquefaction cycles, cryogenic refrigeration systems down to milli Kelvin range, Dilution Refrigerator and adiabatic demagnetization. 10 15

UNIT II **12Hours**

Properties of cryogenic liquids, superfluidity, properties of solids at cryogenic temperatures, mechanical, thermal, electrical and magnetic properties, superconductivity 10 15

Cryogenic insulations, storage and transfer of cryogenic liquids, cryostats, introduction to vacuum technology, cool down of cryogenic transfer lines, frost phenomena 9 15

UNIT III

10Hours Instrumentation in Cryogenics: measurement temperature, thermocouples, platinum resistance and semiconductor thermometry liquid level, flow rate, quality 9 15

UNIT IV

12Hours Cryogenics and its applications: applications of cryogenics in engineering, space technology, liquid fuel rockets, space simulation chambers, cryogenic heat pipes, nuclear research, bubble chambers, spectroscopy, cryo pumping, food processing, biology, medicine and LNG technology, cry cooler and its applications. 9 20

Principle of air separation, production of gases like oxygen, nitrogen and argon

Suggested Readings

1. Baron, R.F. (1966). *Cryogenic systems*. Tata McGraw Hill.
2. Haselden, G.G. (1971). *Cryogenic fundamentals.* Academic press New York.
3. Robert W.(1964). *Cryogenic technology*. American Journal of Physics
4. Bailey, C.A. (1971). *Advance cryogenic*. Plenum Press
5. Scott, &Russell, B.(1959).*Cryogenic engineering*. Princeton.

SEMESTER: VII

Course Title: COMPUTATIONAL FLUID DYNAMIC
Course Code: BME710

L	T	P	Credits
3	0	0	3

Learning Outcomes:

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

1. Develop the governing equations for fluid flow
2. Apply finite difference, finite volume and finite element methods to solve the flow problems
3. Understand the concept of grid generation.
4. Examine the stability and conduct a grid-convergence assessment
5. Evaluate turbulence models to engineering fluid flow problems

Course Content

UNIT I **10Hours**

Equations of fluid dynamics

Basic concepts Eulerarian and Lagrangian methods of describing fluid flow motion, acceleration and deformation of fluid particle, vorticity. Laws governing fluid motion, continuity, Navier – stokes & energy equations. Boundary layer equation, Euler equations, potential flow equations, Bernoulli's equation and vorticity transport equation. Initial and boundary conditions.Classification of equation of motions – hyperbolic, parabolic, elliptic.

UNIT II **10Hours**

Mathematical Preliminaries

Numerical integration. Review of linear algebra, solution of simultaneous linear algebraic equations – matrix inversion, solvers – direct methods, elimination methods, ill conditioned systems; Gauss- Sidel method, successive over relaxation method.

UNIT III **14Hours**

Grid Generation

Transformation of coordinates. General principles of grid generation – structured grids in two and three dimensions, algebraic grid generation, differential equations based grid generation; Elliptic grid generation, algorithm, Grid clustering, Grid refinement, Adaptive grids, Moving grids. Algorithms, CAD interfaces to grid generation. Techniques for complex and large problems: Multi block methods.

Finite difference discretization

Elementary finite difference coefficients, basic aspects of finite difference equations, consistency, explicit and implicit methods, errors and stability analysis.Stability of elliptic and hyperbolic equations. Fundamentals of fluid flow modeling-conservative property, upwind scheme, transporting property, higher order up winding. Finite difference applications in heat transfer – conduction, convection.

UNIT IV **10Hours**

Finite Volume Method

Introduction, Application of FVM in diffusion and convection problems, NS equations – staggered grid, collocated grid, SIMPLE algorithm. Solution of discretized equations using TDMA.Finite volume methods for unsteady problems – explicit schemes, implicit schemes. Finite Element Method: Introduction. Weighted residual and vibrationalformulations. Interpolation in one-dimensional and two-dimensional cases. Application of FEM to ID and 2D problems in fluid flow and heat transfer

Suggested Readings

1. Ferziger J. H.&Peric, M. (1999). *Computational Methods for fluid Dynamics*.Springer-Verlag.
2. Anderson J. (1995). *Computational fluid Dynamics*. McGraw Hill Inc.
3. Patankar, S. P. (1980). *Numerical Heat Transfer &Fluidflow*. CRC Press.
4. Sunderarajan& Muralidhar, K.(2009). *Computational Fluid Flow and Heat Transfer*.NarosaPublishing

SEMESTER: VII

Course Title: MECHATRONICS
Course Code: BME711

L	T	P	Credits
3	0	0	3

Learning Outcomes:

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

1. Understand the basic structure of mechatronics system, different sensors and its characteristics.
2. Comprehend the various types of hydraulic and pneumatic actuators used in mechatronics and develop simple hydraulic/ pneumatic automation circuits.
3. Illustrate micro electro mechanical system (MEMS), its fabrication technologies and various applications.
4. Develop the PLC programs and structure of PLC / CNC machines.
5. Analyze different case studies of mechatronic systems used in our daily life.

Course Content

UNIT I **10Hours**

Introduction:

What is mechatronics, systems, measurement systems, control systems, microprocessor- based controllers, the mechatronics approach.

Sensors Strain Gauge, Potentiometer, Optical Encoders:

Incremental and absolute encoders, linear variable differential transformer (LVDT), piezoelectric, proximity sensor, resistance temperature detector, (RTD), thermostats, thermocouple, hall effect sensor.

UNIT II **12Hours**

Electronic Fundamentals:

Signal conditioning process, operational amplifier, digital logic, logic gates, Boolean algebra, sequential logic, data acquisition systems, measurement systems, testing and calibration.

Precision Mechanical Actuation:

Pneumaticactuationsystems,electro-pneumaticactuationsystems,hydraulic actuationsystems,electro-hydraulicactuationsystems,mechanicalsystems,typesof motion,kinematics,inversekinematics,timingbelts,ballscrewandnut,linear motion guides,linearbearings,harmonictransmission,bearings,motor/driveselection.

UNIT III **12Hours**

Electromechanical Drives:

Relays andsolenoids, steppermotors,DCbrushedandbrushlessmotors, DCservomotors, AC / DCmotorsfor non-servo motion drives, braking methods, pulse width modulated,bipolardriver,MOSFETdrives,SCRdrives,variablefrequencydrives.

Microprocessor and Computers:

Introduction to 8085 , architecture, programming, computer interfacing, function of PLC, architecture, components of PLC, selection of PLC, ladder logic diagram, logic functions: latching, sequencing, counters, shift registers, jumpers, manipulation of data, arithmetic operations

UNIT IV **11Hours**

Input/Output Systems:

Interfacing, input / output ports, interface requirements,peripheral interface adapters, serialcommunicationinterface,directmemoryaccess.

Control System:

System transfer function, Laplacetransformation and its applications, continuous and discrete processes, proportional control, integral control, differential control,

PIDcontrol,digitalcontrollers,controlsystemperformance,controllertuning,

adaptive control, frequency response, PLC, PMC, introduction to fuzzy logic and neuralnetworks.

Suggested Readings

1. Bolton, W.(2010).*Mechatronics*. Pearson Education
2. Rafiquzzaman, M.(2016). *Microprocessors*.Pearson Education India.
3. Boennett, S.(1988). *Real time computer controls*.Longman Higher Education
4. Kuo, C.B.(1990). *Automatic Control Systems.* Prentice Hall , New Delhi

SEMESTER: VII

Course Title: PRODUCT DESIGN & DEVELOPMENT
Course Code: BME712

L	T	P	Credits
3	0	0	3

Learning Outcomes:

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

1. Understand the Product Design and Development Process, as a means to manage the development of an idea from concept through to production
2. Analyze the methodologies as these pertain to the product design process, meaning, and user experience.
3. Apply creative process techniques in synthesizing information, problem-solving and critical thinking.
4. Validate the hand drawing and drafting principles to convey concepts.
5. Understand the Product Design and Development Process, as means to manage the development of an idea from concept through to production.

Course Content

UNIT I **10Hours**

Basics of Product Design:

Introduction to product design, concept, terminology, principles, requirements of a good product design, product types and design considerations for engineering, production consumption cycle, flow and value addition in production consumption cycle.

UNIT II **10Hours**

Basic Design Considerations:

Functional & aesthetics consideration, basic design considerations, role of aesthetics in product design, basic concept and elements of visual design, functional design practice.

Manufacturing Consideration:

Producibility requirements in the design of machine components, forging design, pressed component design, design for machining, ease of location and clamping, some additional aspects of production design, design of powder metallurgical parts, redesigning on basis of production consideration.

UNIT III **12Hours**

Legal & Economic Considerations in Design:

Product value, design for safety, reliability and environmental considerations, economic analysis, profit and competitiveness, break even analysis, economics of a new product design, concurrent design, reverse engineering and rapid prototyping.

UNIT IV

12HoursValue Engineering:

Definition of value, nature, measurement & importance of value, maximum value, normal degree of value, the value analysis job plan, creativity, problem solving and value analysis, value engineering, cost reduction, materials and process selection in

value engineering.

Product Development:

Definition, concept and objective, role of designer in product development, manufacturing & economic aspects of product development, product promotion & development.

1. The capability to create, analyze and critically evaluate different technical/mechanical solutions.
2. A consciousness of the ethical aspects of research and development work.
3. The capability to critically and systematically integrate knowledge.

Suggested Readings

1. Mayall, W.H.(1967). *Industrial Design for Engineers.* London Llifee Books Ltd.
2. Huchingson, D.R.(1981). *New Horizons for Human Factors in Design.* Tata McGraw Hill College

SEMESTER-VIII

L	T	P	Cr
0	0	0	20

Course Title: INTERNSHIP
Course Code:BME801

Learning Outcome:

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

Course Content

Industrial Training aims at exposing the students to field practices, size and scale of operation and work culture at practical sites.

Each student is supposed to study the material and technology used at site and prepares adetailed report of the observation of process seen by him/her.

The teacher along with field supervisors will conduct performance assessment of students. The components of evaluation will include the following.

a)	Punctuality and regularity	15%
b)	Initiative in learning new things	15%
c)	Relationship with workers	15%
d)	Industrial training report	55%