Curriculum for Undergraduate Degree (B.Tech.) in Mechanical Engineering (w.e.f. AY: 2020-21)

Part III: Detailed Curriculum

Third Semester

Course Name:	**Mathematics III**		
Course Code:	BS-M303	**Category:**	Basic Sciences
Semester:	Third	**Credit:**	3
L-T-P:	2-1-0	**Pre-Requisites:**	High school mathematics and BSM-101
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To understand probability theory and its applications.
2	To know the concept of Complex Analysis.
3	To introduce the solution methodologies for second order Partial Differential Equations with applications in engineering.
4	Learn different tools of differentiation and integration of functions of a complex variable that are used with various other techniques for solving engineering problems
5	To provide an overview of statistics to engineers.

Course Contents:

Module No.	Description of Topic/ Experiment	Contact Hrs.
1	**Module-1: Basic Probability:** • **Probability** (i) Definition of random experiment, sample space, events and probability. (ii) Basic theorems (Statement only) of probability. (iii)Conditional probability and independent events; Multiplication theorem; Baye's theorem (statement only) and related problems. • **Probability Distribution** (i) Definition of random variable; Discrete and continuous random variable; Probability mass function (p.m.f.) and probability density function (p.d.f.) of single random variable; Cumulative distribution function (c.d.f.);	10L

	Applications. (ii) Expectation and variance of random variable; Properties and applications. (iii) **Some special types of distributions** ➢ **Discrete probability distribution:** Binomial and Poisson distributions; Mean and variance (no proof) and examples. ➢ **Continuous probability distribution:** Uniform, Exponential and Normal distributions; Mean and variance (no proof) and examples.	
2	**Module-2: Statistics:** • **Measure of Central Tendency** (i) Statistical data and frequency distribution. (ii) Mean, Median and Mode (formulae only) and related problems. (iii)Variance and standard deviation (formulae only) and applications. • **Regression Analysis** (i) Introduction to bivariate data; Scatter diagram. (ii) Correlation and Correlation Coefficient, Rank Correlation; related problems. (iii) Regression line and linear curve fitting; Properties of regression line and coefficients; related problems. (iv) Introduction to non-linear regression.	6L
3	**Module-3: Calculus of Complex Variables:** • **Introduction to differential calculus of function of complex variable** (i) Function of complex variable. (ii) Concept of Limit, continuity and differentiability. (iii)Analytic function; Cauchy-Riemann equations (Statement only); Sufficient conditions for a function to be analytic; Harmonic function and Conjugate Harmonic function; related problems. (iv)Construction of Analytic function; Milne-Thomson Method; related problems. • **Complex Integral Calculus** (i) Zeros and singularities of an analytic function: Zeros of an analytic function; Singularities of an analytic function, Nature and Location of Singularities, Pole; Examples. (ii) Concept of simple curve, closed curve, smooth curve and contour; Line integrals along a piecewise smooth curve; Examples. (iii)Cauchy's Theorem (statement only), Cauchy-Gousrsat	12L

	Theorem (statement only), Examples. (iv)Cauchy's Integral Formula; examples. (v) Taylor's series, Laurent's series; examples. (vi)Residues of a given function. (vii) Cauchy's Residue Theorem (statement only); evaluation of definite integrals involving sine and cosine.	
4	**Module-4: Bessel and Legendre Equations:** • **Bessel's Equation** (i) Series solution of Bessel's equation. (ii) Bessel's function; Recurrence relations of Bessel's function of first kind; Examples. • **Legendre's Equation** (i) Series solution of Legendre's equation. (ii) Legendre's Polynomials. (iii)Generating function of Legendre Polynomials and Orthogonal Properties; Examples. (iv)Recurrence relations; Examples. (v) Rodrigue's Formula; Examples.	6L
5	**Module-5: Solution of Partial Differential Equations:** (i) Brief introduction to PDEs; Types of PDEs. (ii) Solution of Boundary Value Problems by Method of Separation of Variables: (a) Two dimensional Laplace equation (b) One dimensional heat conduction equation **(c)** One dimensional wave equation	6L
Total		**40L**

Course Outcomes:
After completion of the course, students will be able to:
1. Learn the ideas of probability and random variables, various discrete and continuous probability distributions with their properties and their applications in physical and engineering environment. 2. To apply statistical methods for analysing experimental data. 3. Apply statistical tools for analysing complex field. 4. Students will be able to solve field problems in engineering involving PDEs

Learning Resources:	
1	Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2	N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.

3	P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).
4	S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
5	W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, Wiley
6	Advaced differential equation-M.D. Raisinghania, S. Chand Publication

Course Name:	**Biology**		
Course Code:	BS-BIO301	**Category:**	Basic Sciences
Semester:	Third	**Credit:**	2
L-T-P:	2-0-0	**Pre-Requisites:**	Basic knowledge of Physics, Chemistry and Mathematics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Bring out the fundamental differences between science and engineering.
2	Discuss how biological observations of 18th Century that lead to major discoveries.

Course Contents:

Module No.	Description of Topic/ Experiment	Contact Hrs.
1	**Introduction** To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry.	2L
2	**Module2-Classification System in Biology:** The underlying criterion, such as morphological, biochemical or ecological be highlighted. Hierarchy of life forms at phenomenological level. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. *E. coli, S. cerevisiae, D. melanogaster, C. elegance, A. thaliana, M. musculus.*	2L

3	**Module 3: Genetics:** To convey that "Genetics is to biology what Newton's laws are to Physical Sciences" Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be given not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Importance of stem cell research.	2L
4	**Module 4: Biomolecules:** To convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA.	4L
5	**Module 5: Enzymes:** To convey that without catalysis life would not have existed on earth Enzymology: How to monitor enzyme catalysed reactions. How does an enzyme catalyse reactions? Discuss at least two examples.	2L
6	**Module 6: Information Transfer:** The molecular basis of coding and decoding genetic information is universal Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.	4L
7	**Macromolecular analysis** *Purpose*: How to analyse biological processes at the reductionist level Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.	4L
8	**Module 8: Metabolism:** ATP as an energy currency. This should include the breakdown of glucose to CO2 + H2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO2 and H2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge.	2L
9	**Module 9: Microbiology:** Concept of microscopic organisms. Concept of species and strains. Identification and classification of microorganisms. Sterilization and media compositions. Growth kinetics. Microscopy: simple, compound, phase-contrast, SEM, TEM, Confocal: principle and applications.	2L
Total		**24L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	State different engineering applications from biological perspective.
2	Classify biological systems and identify different organisms and microorganisms depending on their morphological, biochemical and ecological criterion.
3	Explain the concept of recessiveness and dominance during the passage of genetic material from parent to offspring and describe DNA as a genetic material in the molecular basis of information transfer.
4	Discuss structures of different biomolecules starting from basic units and hence understand different biological processes at the reductionistic level.
5	Describe protein structures and enzymology and also compare different mechanisms of enzyme action.
6	Describe energy transformation processes in biological systems.

Learning Resources:	
1	Biology for Engineers. Arthur T. Johnson. CRC Press.
2	Biology and Engineering of Stem Cell Niches. A K Vishwakarma and Jefferey Karp, Elsevier.
3	Environmental Biology for Engineers and Scientists. David A. Vaccari, P. P. Storm and J. F Alleman. ELBS
4	Biology for Engineers. G. K. Suraishkumar. Oxford

Course Name:	**Materials Engineering**		
Course Code:	ES-ME 301	**Category:**	Engineering Sciences
Semester:	Third	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Nil
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.
2	To provide a detailed interpretation of equilibrium phase diagrams.
3	Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1	**Crystal Structure:** Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress.	6L
2	**Mechanical Property measurement:** Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength.	6L
3	**Static failure theories:** Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture mechanics: Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Introduction to nondestructive testing (NDT)	6L
4	**Alloys, substitutional and interstitial solid solutions- Phase diagrams:** Interpretation of binaryphase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstrctural aspects of ledeburite, austenite, ferrite and cementite, cast iron.	6L
5	**Heat treatment of Steel:** Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening	6L
6	**Alloying of steel:** properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons-copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titanium alloys	6L
Total		**36L**

Course Outcomes:

After completion of the course, students will be able to:
1. Student will be able to identify crystal structures for various materials and understand the defects in such structures. 2. Categorize different material imperfections and apply this knowledge to explain failures. 3. Know about the concept of iron-carbon equilibrium diagram & phase diagrams and understand the basic terminologies associated with metallurgy. Construction and identification of phase diagrams and reactions. 4. Describe about different types of heat treatment methods to tailor the properties of Fe-C alloys. 5. Understand how to tailor material properties of ferrous and non-ferrous alloys.

Learning Resources:	
1	W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India.
2	Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
3	V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999.
4	U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.

Course Name:	**Engineering Mechanics**		
Course Code:	ES-ME 302	**Category:**	Engineering Sciences
Semester:	Third	**Credit:**	4
L-T-P:	3-1-0	**Pre-Requisites:**	Nil
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	The objective of this Course is to provide an introductory treatment of *Engineering Mechanics* to all the students of engineering, with a view to prepare a good foundation for taking up advanced courses in the area in the subsequent semesters.
2	A working knowledge of statics with emphasis on force equilibrium and free body diagrams provides an understanding of the kinds of stress and deformation and how to determine them in a wide range of simple, practical structural problems, and an understanding of the mechanical behavior of materials under various load conditions.

Course Contents:		
Module	**Description of Topic/ Experiment**	**Contact**

No.		Hrs.
1	**Module 1***: 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 Indeterminancy.	2L
2	**Module 2***: Friction covering,* Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack.	6L
3	**Module 3***: 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.	4L
4	**Module 4***: 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.	5L
5	**Module 5***: 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.	3L
6	**Module 6***: 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).	5L
7	**Module 7:** *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.	5L

8	**Tutorials** *from the above modules covering*, To find coefficient of friction between various materials on inclined plane; Free body diagrams various systems including block-pulley; Simple truss problems; To calculate centre of gravity and moment of inertia of standard and composite sections.	10T
Total		**30L+10T**

Course Outcomes:
After completion of the course, students will be able to:
1. Describe different types of forces and their effect on rigid bodies. 2. Employ basic laws of vector algebra. 3. Analyze system of forces and condition of equilibrium. 4. Recognize laws of friction and solve problems related to it, basic concepts of center of gravity and moment of inertia. 5. Identify laws of dynamics and solve related problems. 6. Solve simple truss problems and study of virtual work.

Learning Resources:	
1	Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
2	F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill
3	R. C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
4	J.L Meriam and L.G Kraige (2006), Engineering Mechanics: Statics- Vol.1 and Dynamics - Vol. 2, Wiley India Private Limited
5	P.K. Nag, S. Pati and T.K. Jana (2013), Engineering Mechanics, McGraw Hill Education.
6	Hibler and Gupta (2010), Engineering Mechanics (Statics, Dynamics) by Pearson Education
7	B. Bhattacharyya and S.C. Bera (2009), Basic Mechanics, New Age International Private Limited.
8	Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications
9	Dr. D.S. Kumar (2013), Engineering Mechanics (Statics & Dynamics), S.K. Kataria & Sons.

Course Name:	**Thermodynamics**		
Course Code:	PC-ME 301	**Category:**	Professional Core
Semester:	Third	**Credit:**	4
L-T-P:	3-1-0	**Pre-Requisites:**	Nil

Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To learn about work and heat interactions, and balance of energy between system and its surroundings.
2	To learn about application of laws to various energy conversion devices.
3	To evaluate the changes in properties of substances in various processes.
4	To understand the difference between high grade and low grade energies and II law limitations on energy conversion.

Course Contents:

Module No.	Description of Topic/ Experiment	Contact Hrs.
1	**Module 1:** Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work-Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work.	5L
2	**Module 2:** Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy.	5L
3	**Module 3:** Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables and R134a tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart.	8L
4	**Module 4:** First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume.	5L
5	**Module 5:** Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale.	5L

6	**Module 6:** Clausius inequality; Definition of entropy S ; Demonstration that entropy S is a property; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of s from steam tables- Principle of increase of entropy; Illustration of processes in Ts coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles- Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis.	8L
7	**Module 7:** Thermodynamic cycles - Basic Rankine cycle; Basic Brayton cycle; Basic vapor compression cycle and comparison with Carnot cycle.	4L
Total		**40L**

Course Outcomes:
After completion of the course, students will be able to:
1. After completing this course, the students will be able to apply energy balance to systems and control volumes, in situations involving heat and work interactions 2. Students can evaluate changes in thermodynamic properties of substances 3. The students will be able to evaluate the performance of energy conversion devices 4. The students will be able to differentiate between high grade and low grade energies.

Learning Resources:	
1	Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, *Fundamentals of Thermodynamics*, John Wiley and Sons.
2	Jones, J. B. and Duggan, R. E., 1996, *Engineering Thermodynamics*, Prentice-Hall of India
3	Moran, M. J. and Shapiro, H. N., 1999, *Fundamentals of Engineering Thermodynamics*, John Wiley and Sons.
4	Nag, P.K, 1995, *Engineering Thermodynamics*, Tata McGraw-Hill Publishing Co. Ltd.

Course Name:	**Basic Manufacturing Processes**		
Course Code:	PC-ME 302	**Category:**	Professional Core
Semester:	Third	**Credit:**	4
L-T-P:	4-0-0	**Pre-Requisites:**	Nil
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To motivate and challenge students to understand and develop an appreciation of the processes in correlation with material properties which change the shape, size and form of the raw materials into the desirable product by conventional or unconventional manufacturing methods.
2	To learn about application of different manufacturing processes.

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1	**Module 1:** Basic Introduction, Importance of Manufacturing, Economics and Technological Definition, Classification and Selection of Manufacturing Processes.	1L
2	**Module 2:** Conventional Manufacturing processes: Patterns, Types of patterns, allowances and material used for patterns. Casting and moulding: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses.	12L
3	**Module 3:** 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.	12L
4	**Module 4:** Joining/fastening processes: Physics of welding, brazing and soldering; design considerations in welding, Different solid and liquid state joining processes; Adhesive bonding.	15L
Total		**40L**

Course Outcomes:
After completion of the course, students will be able to:
1. To understand the different conventional manufacturing methods employed for making different products. 2. Familiarize with different forming processes like rolling, forging, extrusion & their specific applications. 3. Learn about powder metallurgy process. 4. Know about different solid and liquid state joining processes.

Learning Resources:	
1	Kalpakjian and Schmid, Manufacturing Processes for Engineering Materials (5th Edition)-Pearson India, 2014
2	Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley Publication.
3	Degarmo, Black & Kohser, Materials and Processes in Manufacturing, Wiley Publication.
4	Ghosh A. & Mallick A. K., Manufacturing Science, East-West Press Pvt. Ltd.

Course Name:	**Basic Manufacturing Processes Lab**		
Course Code:	PC-ME 391	**Category:**	Professional Core
Semester:	Third	**Credit:**	3
L-T-P:	0-0-3	**Pre-Requisites:**	Nil
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To have real time experience of different conventional manufacturing processes.
2	To gain knowledge about the practical techniques and working principles of manufacturing processes.

Course Contents:

Module No.	Description of Topic/ Experiment	Contact Hrs.
1	Pattern Making, Moulding and Casting.	6P
2	Smithy Shop: Forge Welding	3P
3	Welding Shop: Gas Welding, MMAW, GMAW and GTAW	9P
4	Fitting Shop	3P
5	Sheet Metal Shop	3P
8	Machine Shop: Lathe (Eccentric turning, Taper Turning) Straight & Angular Drilling, Boring, Shaping (Straight & Dovetail) and Milling Operations (Gear Cutting).	12P
Total		**36P**

Course Outcomes:

After completion of the course, students will be able to:
1. Understand the idea for selecting materials for patterns. Types and allowances of patterns used in casting and analyze the components of moulds. 2. Understand the application of arc and gas welding in industries. 3. Know how casting, drilling, shaping, milling are done and demonstrate primary working skills on lathe. 4. To know and implement different safety precautions to be taken during manufacturing processes.

Learning Resources:	
1	Laboratory manual