Scheme of Instruction & Syllabi

of

Bachelor of Technology

3rd Year

(Mechanical Engineering)

(With effective from academic session 2022-23)

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HOD ME

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PROGRAM EDUCATIONAL OBJECTIVES (PEOs) FOR B.TECH IN MECHANICAL ENGINEERING

The B.TECH program aims to:

PEO1: Develop competent Mechanical engineering technicians with professional skills, knowledge, abilities & attitude for wage employment and/or to become entrepreneur.

PEO2: Provide opportunities and develop competence to work as a leader, manager or team member in multidisciplinary Mechanical engineering works and projects.

PEO3: Develop effective communication skills - Verbal, Written and Graphical, to justify technical solutions for diverse targets associated with mechanical engineering works.

PEO4: Provide opportunities and develop students in terms of social, economic and environment sensitive as responsible professionals.

PEO5: Develop understanding towards use of different codes - local, national and international, for execution of mechanical engineering works.

PEO6: Encourage and provide necessary knowledge, skills and opportunities for higher education and exploring different learning strategies for life-long learning.

PEO7: Provide opportunities and develop responsible professionals in terms of ethics and value systems.

PROGRAM OUTCOMES (POs) FOR B. Tech. IN MECHANICAL ENGINEERING

After successful completion of the B. Tech. program, learners shall be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2**. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5**. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6**. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10**. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11**. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1	Learners will be able to apply technical skills and modern engineering tools for mechanical engineering day to day practice
PSO2	Learners will be able to participate in practical aspects and problem solving of mechanical engineering field that requires analytical and design requirements.
PSO3	Learners will be able to pursue of lifelong learning and professional development to face the challenging and emerging needs of our society.
PSO4	Learners will comply with small to large concepts of components and mechanical engineering practical and field works to bring out safer and aesthetic environment to live.

INVERTIS UNIVERSITY BAREILLY

Established by Govt. of U.P. u/s 2F of UGC Act, 1956 vide U.P Act 22 of 2010.

STUDY AND EVALUATION SCHEME
(With effective from academic session 2022-2023)
B. Tech. in Mechanical Engineering
YEAR III, SEMESTER V

S. No.	Category	Course Code	Course Title/ Subjects	Hours per week			Evaluation Scheme		Total	Credits
				L	T	P	CA	EE		
THEORY										
1	Professional Core courses	BME-501	Kinematics & Theory of Machines	3	1	0	30	70	100	4
2	Professional Core courses	BME-502	Solid Mechanics	3	0	0	25	50	75	3
3	Professional Core courses	BME-503	Manufacturing Processes	3	0	0	25	50	75	3
4	Professional Core courses	BME-504	Heat Transfer	3	0	0	25	50	75	3
5	Humanities and Social Sciences including Management courses	BHU-501	Impact of Technology, Ethics and Human values	3	0	0	25	50	75	3
6	Mandatory course	BMC-003	Constitution of India*	1	0	0	0	0	0	0
7	Engineering Science Course	MFG15	Product Design	4	0	0	30	70	100	4
PRACTICALS AND PROJECTS										
8	Professional Core courses	BME-551	Heat Transfer Laboratory	0	0	2	10	15	25	1
9	Project (Summer Internship)	BME-552	Project-I	0	0	0	10	15	25	1
10	Professional Core courses	BME-553	Theory of Machine Laboratory	0	0	2	10	15	25	1
			TOTAL	**20**	**1**	**4**	**190**	**385**	**575**	**23**

L-Lecture, **T**- Tutorial , **P**- Practical ,**CA**- Continuous Assessment, **EE**- End Semester Examination
* THERE WILL BE MCQ PAPER OF 25 MARKS. PASSING REQUIRED FOR COMPLETING THE DEGREE.

STUDY AND EVALUATION SCHEME
(With effective from academic session 2022-2023)
B. Tech. in Mechanical Engineering
YEAR III, SEMESTER VI

S. No.	Category	Course Code	Course Title/ Subjects	Hours per week			Evaluation Scheme		Total	Credits
				L	T	P	CA	EE		
THEORY										
1	Professional Core course	BME-601	Design of Machine	3	1	0	30	70	100	4
2	Professional Core Course	BME-602	Manufacturing Technology	3	0	0	25	50	75	3
3	Professional Elective courses	BME-011-013	Elective-I	3	0	0	25	50	75	3
4	Professional Elective courses	BME-021-023	Elective-II	3	0	0	25	50	75	3
5	Open Elective Courses	BOE-601-603	Open Elective-I	3	1	0	30	70	100	4
6	Engineering Science Course	MFG26	Product Manufacturing	4	0	0	30	70	100	4
PRACTICALS AND PROJECTS										
7	Professional Core courses	BME-651	Machine Design Laboratory	0	0	3	10	15	25	1
8	Project (Summer Internship)	BME-652	Project-II	0	0	6	25	50	75	3
9	Professional Core courses	BME-653	Manufacturing Laboratory	0	0	2	10	15	25	1
			TOTAL	**19**	**2**	**11**	**210**	**440**	**650**	**26**

L-Lecture, **T-** Tutorial, **P-** Practical, CA- Continuous Assessment, **EE-** End Semester Examination

List of Elective

DEPARTMENTAL ELECTIVE-I

BME-011 Internal Combustion Engines
BME-012 Unconventional Manufacturing Processes
BME-013 Reliability Engineering

DEPARTMENTAL ELECTIVES-II

BME-021 Refrigeration and Air Conditioning
BME-022 Advanced Welding Technology
BME-023 Mechanical Vibrations

DEPARTMENTAL ELECTIVES-III

BME-031 Finite Element Analysis
BME-032 Gas Dynamics and Jet Propulsion
BME-033 Process Planning and Cost Estimation
BME-034 Automobile Engineering

DEPARTMENTAL ELECTIVES–IV

BME-041 Production and Operations Management
BME-042 Design of Transmission Systems
BME-043 Total Quality Management
BME-044 Energy Conversion and Management

DEPARTMENTAL ELECTIVES-V

BME-051 Maintenance Engineering & Management
BME-052 Mechanical System Design
BME-053 Management Information System

DEPARTMENTAL ELECTIVE-VI

BME-061 Power Plant Engineering
BME-062 Advanced Dynamics of Machinery
BME-063 Concurrent Engineering

OPEN ELECTIVES-I

BOE-601 Introduction to Composite Materials
BOE-602 Addictive Manufacturing Technology
BOE-603 Fracture Mechanics

OPEN ELECTIVES – II

BOE-071 Entrepreneurship Development
BOE-072 Operations Research

OPEN ELECTIVES – III

BOE-081 Non-Conventional Energy Resources
BOE-082 Product development

OPEN ELECTIVES – IV

BOE-083 Advanced Materials Technology

BME-501	Kinematics And Theory of Machines	3L:1T:0P	4 credits

Pre-requisites: BME302: Engineering Mechanics

Course Objectives: The basic objectives of this course are-

- To make familiar students about the various mechanisms and their application in daily life.
- To make capable the students to design some linkage mechanisms and cam systems to generate specified output motion
- To analyze the kinematics of gear trains

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

CO 1 Define important term like kinematic links, pairs, chain, linkage, mechanism, machine, degrees of freedom, instantaneous centre, friction, brakes and dynamometer, cam and follower, gear and its terminology.

CO2 Understand the concepts of displacement, velocity and acceleration, constraints, brake, dynamometer, cam, follower, gears and various gear trains.

CO3 Calculations related to degrees-of-freedom of a linkage, velocity, acceleration in various mechanisms, friction in journal bearing, and draw velocity and acceleration diagrams for different mechanisms.

CO4 Analyze the planar mechanisms, Hook's joint, gear train and distinguish between different kinematic pairs, interference and undercutting, involute and cycloidal teeth profile.

CO5 Check the behavior of a linkage

CO6 Design or create a cam profile as per follower movement.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1		1							1
CO2	2	3	2	3		2				1		1
CO3	2	1	3	3	2					1		2
CO4	2	1	3	1				1				2
CO5	1	2	1		2				3			1
CO6	1		3	3	2		2	2		1		2

Detailed Syllabus:-

Module 1:

Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain and slider crank chains- Limit positions- Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms

Module 2:

Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamics-
Coincident points- Coriolis component of acceleration- introduction to linkage synthesis- three position graphical synthesis for motion and path generation

Module 3:
Classification of cams and followers- Terminology and definitions- Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers

Module 4:
Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics
Surface contacts- sliding and rolling friction- friction drives- bearings and lubrication- friction clutches- belt and rope drives- friction in brakes

Text Books and References:

1. Theory of Machines and Mechanisms – John J Uicker ,Gordon r.pennock & Joseph e.shigley, oxford university publication, international edition, 2012

2. Theory of machines – by S.S.ratan, tmh publication, fourth edition, 2014

3. Theory of machines and mechanisms-Ghosh & Mallik

4. Theory of machines – Sadhu Singh, Pearson education publication, 2003

5 theory of machines – by R. S.khurmu, s. Chand publication, 3rd edition, 2013

6. Theory of machines and mechanisms – John J Uicker, Oxford University Publication, 2012

8. Theory of machines: through practice & solved papers – by b.k.sarkar

9. Mechanism & machine theory, ambekar, ashok g. New delhi : prentice hall of india, 2007,

10. Dynamics of machines: in si units, singh, v. P., new delhi : dhanpat rai publications , 2005

BME-502	Solid Mechanics	3L:0T:0P	3 credits

Pre-requisites: BME302: Engineering Mechanics

Course Objectives: The basic objectives of this course are-

- To present the mathematical and physical principles in understanding the linear continuum behavior of solids to the students.
- To develop the attitude of analysis of various machine members subjected to different loading conditions in the students
- Find out the stress strain and displacement relations

Course Outcomes: At the end of the course, the student will be able:

CO 1	To get the knowledge of properties of material, stress, thermal stress and various mechanical components like helical spring, leaf spring, column and struts.
CO2	To understand how different components will fail under load with help of theories of failure for brittle and ductile materials,
CO3	To apply concepts of stress, strain, principle stress in 1D, 2D and 3D objects and stress functions, and calculate stresses in plates and shells, thick circular cylinders and discs and employ contact stresses and stress concentration knowledge.
CO4	To analyze the different methods of unsymmetrical bending analysis and concept of shear center,
CO5	To evaluate force, stress and displacement in simple structures with use of energy methods,
CO6	To create stress-strain model for any mechanical component and design the pressure vessels,

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1			2					1
CO2	1		2	2	2		2			1		1
CO3	3	3	2	1				2	2			1
CO4	3	1	3	1		2	2			2		1
CO5	3	2	2	3			1			2		1
CO6	3	1	1				1		3			1

Detailed Syllabus:

Module 1:
Introduction to Cartesian tensors, Strains: Concept of strain, derivation of small strain tensor and compatibility, Stress: Derivation of Cauchy relations and equilibrium and symmetry equations, principal stresses and directions.

Module 2:
Constitutive equations: Generalized Hooke's law, Linear elasticity, Material symmetry; Boundary Value Problems: concepts of uniqueness and superposition.

Module 3:
Plane stress and plane strain problems, introduction to governing equations in cylindrical and spherical coordinates, axisymmetric problems. Bending of symmetric and asymmetric straight beams, effect of shear stresses, curved beams, Shear center and shear flow, shear stresses in thin walled sections.

Module 4:
Torsion of prismatic solid sections, thin walled sections, circular, rectangular and elliptical bars, Thick and thin walled cylinders, Composite tubes, Rotating disks and cylinders. Euler's buckling load, Beam Column equations. Strain measurement techniques using strain gages, Stress concentration problems, thermo-elasticity, Introduction to plasticity.

Text Books and References:

1. G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, Third Edition, CRC Press, 2004.
2. Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International, 1965.
3. Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hall international, 1969.

BME-503	Manufacturing Processes	3L:0T:0P	3 credits

Pre-requisites: none

Course Objectives: The various objectives of this course are-

- To motivate and challenge students to understand methods of manufacturing.
- 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

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

CO1	Select materials, types and allowances of patterns used in casting
CO2	Understand arc, gas, solid state and resistance welding processes.
CO3	Determine different forces set up during metal cutting and material removal rate in both the conventional and unconventional manufacturing processes
CO4	Analyze the components of moulds and cutting tool geometry and differentiate various manufacturing processes.
CO5	Monitor the effect of process variables to manufacture defect free products and check the feasibility of the various manufacturing processes.
CO6	Design core, core print and gating system in metal casting processes.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	2	1	1					3	1
CO2	3	3	1	1	1	1					1	1
CO3	2	2	3	2			1				1	1
CO4	3	3	3	2	2	2					1	1
CO5	3	3	2	2	1		1				1	1
CO6	1	2	1		1	1		2		3	2	2

Mapping of course outcomes with program outcomes

Detailed Syllabus:

Module 1:

Conventional Manufacturing processes:

Casting and moulding: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses. **(5)**

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.**(4)**

Module 2:

Metal cutting: Single and multi-point cutting; Orthogonal cutting, various force components: Chip formation, Tool wear & tool life, Surface finish & integrity, Machinability, Cutting tool materials, Cutting fluids, Coating; Turning, Drilling, Milling & finishing processes, Introduction to CNC machining.**(8)**

Module 3:

Additive manufacturing: Rapid prototyping and rapid tooling**(3)**

Joining/fastening processes: Physics of welding, brazing and soldering; design considerations in welding, Solid and liquid state joining processes; Adhesive bonding. **(4)**

Module 4:

Unconventional Machining Processes:

Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, principles and process parameters **(5)**

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. **(8)** Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining **(3)**

Text Books and References:

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
3. Degarmo, Black &Kohser, Materials and Processes in Manufacturing

BME-504	**Heat Transfer**	**3L:0T:0P**	**3 credits**

Pre-requisites: Thermodynamics

Course Objectives: The various objectives of this course are-

- To build a solid foundation in heat transfer by exposing students to the three basic modes namely conduction, convection and radiation.
- Rigorous treatment of governing equations and solution procedures for the three modes will be provided, along with solution of practical problems using empirical correlations.
- To briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.

Course Outcomes: At the end of the course, the student will be able:

CO 1	To know about different laws used in heat transfer conduction, convection, radiation, various heat transfer phenomena, Fin, boiling and condensation, Heat exchanger
CO2	To understand the heat transfer rate in conduction, convection and radiation, working of furnace, heat exchanger, boiler, condenser, analogy between heat and mass transfer and concept of unsteady heat transfer and mass transfer,
CO3	Calculate heat load based on furnaces, room air conditioning load, heat loss through cylindrical pipe, thermal insulation required for steam pipe, boiler, heat exchanger area, heat transfer rate through spherical shell, plane sheet.
CO4	To analyze the heat transfer rate for various components, fluids, infinite, semi-infinite body and parallel/counter flow heat exchanger.
CO5	To justify the significance of dimensionless number on heat transfer rate, and awareness of the ways that heat transfer applies to thermal design
CO6	To develop a room heater and plan for energy auditing in industry, thermal power plant and Design heat exchangers using LMTD and NTU methods,

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2	1						1
CO2	3	2	2	2	1	1						1
CO3	2	3	2	2	1	1	1					1
CO4	2	3	2	2	1	1	1					1
CO5	3	2	2	1	1	1	1					1
CO6	3	2	2	2	1	1						1

Detailed Syllabus:

Module 1:

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.

Module 2:
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.
Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and NTU methods,

Module 3:
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.
Boiling and Condensation heat transfer, Pool boiling curve
Introduction mass transfer, Similarity between heat and mass transfer

Text Books and References:

1. A. Bejan, Heat Transfer John Wiley, 1993
2. J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, Sixth Edition, 2007.
4. MassoudKaviany, Principles of Heat Transfer, John Wiley, 2002
5. Yunus A Cengel, Heat Transfer : A Practical Approach, McGraw Hill, 2002

BHU-501	**Impact of Technology, Ethics and Human values**	**3L: 0T :0P**	**3 credits**

Pre-requisites: None

Course Objectives: This course is designed to help students to acquire a critical understanding of:

- Fundamental questions, concepts and developments within the philosophy of technology
- Chronological development of technology to evolve the human life
- Various ethical and moral aspects and laws related to industrial environment.
- The ethical and social implications of science & technology

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

CO1 Fundamental questions, concepts and developments within the philosophy of technology.

CO2 Chronological development of technology to evolve the human life

CO3 Various ethical and moral aspects and laws related to industrial environment.

CO4 The ethical and social implications of science & technology

CO5 Human rights, Industrial Laws ethical and moral aspects of engineering and technology

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		2	2			2			2		2
CO2	3		3	3			3		3			2
CO3	2	1	3	1	1						2	1
CO4	2	1	3	2		3		1				1
CO5	3	2	3	2	1							1

Detailed Syllabus:

Module 1:

Defining Technology; Characteristics of Technology; Concepts in Technology; Technological Process - Invention, Innovation and Diffusion; Technological Development and Progress; Role of Social Factors in Technological Development, The Cultural Character of Technology; Limits of Science & Technology. Capitalist, Marxist & Gandhian Approaches to Technology.

Philosophy of Technology; Ethical & Social Aspects of Technology, Methods and Approaches of Ethics of Technology, Ethical Implications of Space Technology;; Nanotechnology; Bioinformatics, Robotics and Artificial Intelligence..

Module 2:

Senses of Engineering Ethics, Variety of moral issues, Types of inquiry, Moral Dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory, Consensus and Controversy, Models of professional roles Theories about right action, Self-interest, Customs and Religion, Ethical Theories Morals, values and Ethics Integrity and Work ethics, Service learning, Civic virtue, Respect for others

Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

Module 3:

Environmental law, Consumer rights ,Cyber laws, Intellectual Property law Concept of Human Rights United Nations and Human Rights Rights of Women and Children, Rights of Dalit, Tribes and Minorities, Rights of Old and Disabled, Unorganised Labour and Displaced Person Human Rights and Mental Health

Text Books and References:

- Albert Borgmann. *Technology and the Character of Contemporary Life.* University of Chicago Press, 1984
- Andrew Feenberg. *Questioning Technology.* Routledge, 1999
- Bryan Bunch. *The History of Science and Technology.* Houghton Mifflin Company, 2004
- James Smith. *Science and Technology for Development: Development Matters.* Zed Books,2009.
- Don Ihde. *Ironic Technics.* Automatic Press, 2008.
- M. Govindrajan, S. Natarajan, and V. S. Senthilkumar, Engineering Ethics :Includes Human Values

BMC-003	Constitution of India	2L:0T:0P	0 credits

Pre-requisites: None

Course Objective: The objective of this course is to learn and understand the Indian Constitution and to let the student understand various aspects, laws and rights which are provided by the Constitution.

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

CO1 Understand the insight of various aspects of Indian Constitutions

CO2 Understand the Laws and rights which are provided by the Constitution.

CO3 Determine the Roll, structure and functioning of the parliament of the country

CO4 Explain basic rights and distribution of authorities among the centre and state governance.

CO5 Explain the judiciary system of India

CO6 Generalize the local governance of India

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2		1					1	2		1
CO2	2	3		3	1	2			1		3	1
CO3		3	2		1			2	1			1
CO4	3	1		3	1		2		1		2	1
CO5	2		1	1	2		2		1	2		1
CO6	2	3		1					1		2	1

Detailed Syllabus:

Module 1:

Introduction and History of Indian constitution

Meaning of the constitution law and constitutionalism, Historical Background of the Constituent, Assembly, Government of India Act of 1935 and Indian Independence Act of 1947, Enforcement of the Constitution, Indian Constitution and its Salient Features,

Module 2

Basic Information about Indian Constitution

The Preamble of the Constitution, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Parliamentary System, Centre-State Relations, Amendment of the Constitutional Powers and Procedure, Emergency Provisions: National Emergency, President Rule, Financial Emergency, and Local Self Government – Constitutional Scheme in India.

Module 3

Union Executive and State Executive

Powers of Indian Parliament Functions of Rajya Sabha, Functions of Lok Sabha, Powers and Functions of the President, powers of Indian President, Powers and

Functions of the Prime Minister, Judiciary – Supreme Court, Judicial Review, Public Interest Litigation, Judicial Activism, LokPal, LokAyukta, The Lokpaland Lokayuktas Act 2013, State Executives – Powers and Functions of the Governor, Powers and Functions of the Chief Minister, Functions of State Cabinet, Functions of State Legislature, Functions of High Court and Subordinate Courts.

Text Books and References:

1. Brij Kishore Sharma: Introduction to the Indian Constitution, PHI, New Delhi, latest edition.
2. Granville Austin: The Indian Constitution: Cornerstone of a Nation. 1966, Oxford Clarendon Press.
3. Subhash C. Kashyap: Our Constitution: An Introduction to India's Constitution and constitutional Law, NBT, 2018.
4. PM Bakshi: The Constitution of India, Latest Edition, Universal Law Publishing
5. V.K. Ahuja: Law Relating to Intellectual Property Rights (2007)
6. Suresh T. Viswanathan: The Indian Cyber Laws, Bharat Law House, New Delhi-88
7. P. Narayan: Intellectual Property Law, Eastern Law House, New Delhi
8. Prabudh Ganguli: Gearing up for Patents: The Indian Scenario, Orient Longman.
9. BL Wadehra: Patents, Trademarks, Designs and Geological Indications.Universal Law Publishing - LexisNexis.

BME-551	**Heat Transfer Laboratory**	**0L:0T:2P**	**1 credits**

Pre-requisites: Thermodynamics

Course Objectives: The main objectives of this course are-

- To develop a knowledge based design ability in the students to formulate the solid conduction and Fluid convection

- As well to gain experience in designing experiment for thermal system and to familiar with the experimental techniques for the laboratory requirements.

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

CO1	Recognize the tools required to conduct the experiments in the heat transfer laboratory.
CO2	Translate the results obtained during experimentation.
CO3	Estimate heat transfer coefficient in forced convection and effectiveness of parallel and counter flow heat exchangers experimentally.
CO4	Measure heat transfer coefficient in free convection, correlate with theoretical values and also analyzed the results obtained during the experimentation.
CO5	Monitor and validate the results obtained.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1	1	1					1
CO2	2	2	2	3	1	1	1					1
CO3	2	2	2	2	1	1	1					1
CO4	2	2	2	3	1	1	1					1
CO5	3	2	2	2	1	1	1					1

Mapping of course outcomes with program outcomes

NOTE: Conduct atleast 8 of the following experiments

List of Experiments:

1. Measurement of heat transfer through composites wall.
2. To study the two phase heat transfer.
3. To measure the thermal conductivity of Slab
4. Convection - Heat transfer through fin-natural convection.
5. Convection - Heat transfer through tube/fin-forced convection.
6. Heat exchanger – Parallel and Counter flow in a double pipe heat exchanger.
7. Emissivity Measurement.
8. Free/Natural Convection.

BME-552	**Project I**	**(30 hours)**

Course Objectives:

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college.

Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

BME-553	Theory of Machine Laboratory	0L:0T:2P	1 credits

Pre-requisites: Kinematics & Theory of Machines.

Course Objective

This course will provide a basic understanding of the concepts discussed in Theory of Machine, Mechanical Vibrations & Dynamics of Machines courses. To observe, analyze and modify mechanical system components so as to perform safely their intended functions in harmony with other components of the system and analyze vibration behavior of mechanical systems.

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

CO1 Recognize different types of mechanism availably in the laboratory.

CO2 Clarify the results obtained during experimentation.

CO3 Calculate experimentally the various parameters related to the governor like sensitiveness, natural frequency of the vibratory system.

CO4 Analyze the results obtained during experimentation.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2		2							
CO2	3	3	2		2		2					
CO3	3	3	2	2	3	2						
CO4	3	3	2		2							

NOTE: Conduct atleast 8 of the following experiments-

List of Experiments:

1. To study the different types of Governor.
2. Balancing of rotating masses.
3. Determination of critical speed of a rotating shaft.
4. Determination of equilibrium speed, sensitiveness, power and effort of Porter/Proell / Hartnell Governor (Only one or more).
5. To study different types of gear trains.
6. To draw displacement diagram, velocity diagram and acceleration diagram of Cam and Follower

7. To study the different types of cam and follower.
8. Experiments on Gyroscope (Demonstration only).
9. To study the gyroscopic behavior of rotating masses and verify the gyroscopic relation.
10. To study the dynamometer.

BME-601	Design of Machine	3L:1T:0P	4 credits

Pre-requisites: **None**

Course Objectives:
This course seeks to provide an introduction to the design of machine elements commonly encountered in mechanical engineering practice, through

- A strong background in mechanics of materials based failure criteria underpinning the safety-critical design of machine components
- An understanding of the origins, nature and applicability of empirical design principles, based on safety considerations
- An overview of codes, standards and design guidelines for different elements
- An appreciation of the relationships between component level design and overall machine system design and performance

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

CO 1	To get the knowledge of properties of material, stress, fluctuating stress and various mechanical components.
CO2	To understand how mechanical components like rivet, shaft, keys, coupling, mechanical spring, power screws etc. will fail under load.
CO3	To apply failure theories on mechanical components and find out the dimensions for optimum amount of material use.
CO4	To analyze which material is economic and durable for given load.
CO5	To evaluate the dimensions of a mechanical component.
CO6	To design and create basic machine elements used in mechanical system like Shaft, key, couplings, riveted joint etc.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1						1		3		1
CO2	3	2		1	3	1		2		1		1
CO3	1	1				1		1		1		1
CO4	3	3	2	1		2		3		2		1
CO5	2	2	1	2		1	2	1		1		1

CO6	1	1	2	1		1		1	2	1	3	1

Detailed Syllabus:

Module 1:
Design considerations - limits, fits and standardization, Review of failure theories for static and dynamic loading (including fatigue failure),

Module 2:
Design of shafts, key under static and fatigue loadings, Shaft Coupling Analysis and design of sliding and rolling contact bearings,

Module 3:
Design of transmission elements: spur, helical, bevel and worm gears; belt and chain drives, Design of springs: helical compression, tension, torsional and leaf springs,

Module 4:
Design of joints: threaded fasteners, pre-loaded bolts and welded joints, Analysis and applications of power screws and couplings, Analysis of clutches and brakes, power screw

Text Books:

1. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
2. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.
3. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
4. Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
5. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998
6. Khurmi, R. S., Gupta, J.K., A Textbook of Machine Design, S. Chand Publications

BME-602	**Manufacturing Technology**	**2L:1T:0P**	**3 credits**

Pre-requisites: None
Course Objectives: The various objectives of the course are-

- To provide knowledge on machines and related tools for manufacturing various components to the students.
- To understand the relationship between process and system in manufacturing domain.
- To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.

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

CO1	To recall the various types of metal cutting process, machine tools, standardization, interchangeability, limits, tolerance and fits, conventional and unconventional processes.

CO2 Understand the concept of metal cutting, limits, fits and tolerance, conventional and non-conventional machining processes.

CO3 Draw network diagram and Calculate limits, fits and tolerance for various components.

CO4 Analyze various Inventory, networking models and differentiate between the CPM and PERT.

CO5 Detect the appropriate machine tools, processes and its ability to produce the required part and test the significance of jigs and fixture.

CO6 Design the various linear programming, assignment problems and predict the optimum solutions by applying the various algorithms and plan the production

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	1					1	1
CO2	3	3	1	1	1	1					1	1
CO3	2	2	2	2			1				1	3
CO4	3	3	3	2	2	2			1		1	1
CO5	3	3	2	2	1		1				1	1
CO6	2		1	2	2			3	2	3	2	2

Detailed Syllabus:

Module 1:
Tooling for conventional and non-conventional machining processes: Mould and die design, Press tools, Cutting tools; Holding tools: Jigs and fixtures, principles, applications and design; press tools – configuration, design of die and punch; principles of forging die design.

Module 2:
Metrology: Dimensions, forms and surface measurements, Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; Metrology in tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as micro-scale machining, Inspection and workpiece quality,

Module 3:
Assembly practices: Manufacturing and assembly, process planning, selective assembly, Material handling and devices.
Linear programming, objective function and constraints, graphical method, Simplex and duplex algorithms, transportation assignment, Traveling Salesman problem;

Module 4:
Network models: shortest route, minimal spanning tree, maximum flow model-
Project networks: CPM and PERT, critical path scheduling; Production planning& control: Forecasting models, aggregate production planning, materials requirement planning.

Inventory Models: Economic Order Quantity, quantity discount models, stochastic inventory models, practical inventory control models, JIT, Simple queuing theory models,

Text Books and References:

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014
2. Taha H. A., Operations Research, 6th Edition, Prentice Hall of India, 2003
3. Shenoy G.V. and Shrivastava U.K., Operations Research for Management, Wiley Eastern, 1994.

BME-651	**Machine Design Laboratory**	**0L:0T:3P**	**1 credits**

Pre-requisites: None

Course Objectives: The basic objectives of this course are-

- To make familiar the students with the measurement of mechanical properties and the deformation behavior of materials.
- To develop the habit of designing the mechanical components in the students and perform the experimentations.

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

CO1	Understand the deformation behavior of materials
CO2	Understanding of how the various mechanical properties of the materials are measured.
CO3	Determine the kinematic, dynamic characteristics of mechanical devices and the properties of the materials by conducting the experiments.
CO4	Analyze the micro structure of some commonly used materials, mechanical components

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2		1					1			1
CO2	2	3		3	1		2		1			2
CO3	3	3		3	1				1		2	1
CO4	2	1	1	1	2	1			1			3

NOTE: Conduct atleast 8 of the following experiments-

List of Experiments:

1. Design and drawing of cotter joint.

2. Design and drawing of knuckle joint
3. Design and drawing of screw jack.
4. Design and drawing of helical spring.
5. Design and drawing of flexible coupling.
6. Design and drawing of flange type rigid coupling.
7. Design and drawing of boiler riveted joint.
8. Design and drawing of eccentrically loaded riveted joint.
9. Write a programme in C language for sliding bearing.
10. Write a programme in C language for design of spur gear.
11. Write a programme in C language for helical gear.

BME-652	Project II	90 hours

Course Objectives:

- This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

BME-653	Manufacturing Laboratory	0L:0T:2P	1 credits

Pre-requisites: Manufacturing Technology

Course Objectives: The basic objective of this course is to make students familiar with the various manufacturing processes and execute the same in the workshop.

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

CO1	Name and perform different machining operations welding, arc welding and resistance welding
CO2	Represent joining process and perform the joining operations in the workshop.
CO3	Determine the tool wear and tool life experimentally.
CO4	Select a manufacturing process and perform the required manufacturing operation like surface finish, machining etc.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1		1			2	3	1	1
CO2	1	2	1		1	1	1		3	2	1	
CO3	2	1	2	2	1	1		3	1	3		1

CO4	1	2	2	2		2			3	3	1	1

NOTE: Conduct atleast 8 of the following experiments-

List of Experiments:

1. Bolt (thread) making on Lathe machine.
2. Machining a block on shaper machine.
3. Finishing of a surface on surface-grinding machine.
4. Gear cutting on milling machine (spur gear).
5. Arc welding experiment.
6. Soldering and Brazing Experiment.
7. Effect of AC current on weld strength and heat affected zone.
8. Experiment on tool wear and tool life.
9. To study the effect of a current on weld strength using spot welding process.
10. Drilling holes on drilling machine.

BME-011	**Internal Combustion Engines**	**3L:0T:0P**	**3 credits**

Pre-requisites: Thermodynamics.

Course Objectives: The basic objectives of this course are-

- To familiarize the students with the terminology associated with IC engines.
- To understand combustion, and various parameters and variables affecting it in various types of IC engines.
- To learn about various systems used in IC engines and the type of IC engine required for various applications

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

CO 1 Define internal combustion engine cycles as Otto Cycle, Diesel Cycle and Dual Cycle, Combustion phenomenon, cooling system, lubricating system,

CO2 Understand the concept of combustion in SI and diesel engines and stages of combustion, working of two stroke and four stroke SI and CI engines,

CO3 Differentiate between types of lubricating systems, direct and indirect injection system. Calculate the thermal efficiency and compression ratio of Otto Cycle, Diesel Cycle and Dual Cycle,

CO4 Analysis of Properties of coolants, Properties of lubricants, Air fuel ratio requirements of SI engines, Air fuel ratio and emissions.

CO5 Test the Engine performance, Engine testing standards and justify the need for cooling, supercharging and turbocharging in IC engines

CO6 Design factors controlling combustion chamber in Petrol Engine and Diesel Engine.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	3	1	1	1							1	
CO2	2	2	1		1		1				1	1
CO3	2	3	2	2	1	1	1					1
CO4	1	1	3		2	1		2	2			2
CO5	1		2	3	2	1						1
CO6	2	3	2	3	2	1	1	1				2

Detailed Syllabus:

Module 1:

Review of ideal cycles; Details of fuel-air cycles, Combustion in SI and CI engines, Combustion stages, Combustion chambers and abnormal combustion,

Module 2:

Fuel supply systems in SI and CI engines, carburetors, Port fuel injection, direct injection and Common rail injection,

Module 3:

Ignition system, Lubrication system and Cooling system,

Testing of IC engines, Engine emissions and control, Advanced IC Engine concepts,

Text Books and References:

1. Obert E. F, "Internal Combustion Engines and Air Pollution", Harper and Row Publication Inc. NY, 1973.
2. Heisler H, "Advanced Engine Technology", Edward Arnold, 1995.
3. Heywood J. B, "Internal Combustion Engine Fundamentals", McGraw Hill Book Co. NY, 1989
4. Heldt P. M, "High Speed Combustion Engines", Oxford & IBH publishing Co. India, 1985.
5. Ganeshan V, “Internal Combustion Engine”, McGrawh Hill Publications, 4th Edition

BME-012	**Unconventional Manufacturing Processes**	**3L:0T:0P**	**3 credits**

Pre-requisites: None

Course Objective: The basic objectives of this course are-

- To make students familiar with the various unconventional manufacturing processes.
- To enable students to understand the physics and principles of various manufacturing processes have the knowledge of advance manufacturing methods

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

CO1	Define principles and applications of electron beam, ion beam and laser hybrid welding processes.
CO2	Understand abrasive and electrical discharge machining processes, diffusion.
CO3	Knowledge of relation between the process parameters and mechanical properties.
CO4	Determine MRR, machining time etc in various processes.

CO5 Justify the significance of conventional and unconventional processes.

CO6 Explain the principles of various machining and joining processes

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1							1
CO2	3	2	2	2	1							1
CO3	2	3	2	1	1	1						1
CO4	2	3	2	1	1	1	1					1
CO5	3	3	2	1	1	1	1					1
CO6	2	2	1		1	1						1

Detailed Syllabus:

MODULE- I

Introduction: Limitations of conventional manufacturing processes, need of unconventional manufacturing processes & its classification and its future possibilities.

Unconventional Machining Process: Principle and working and applications of unconventional machining process such as Electro-Discharge machining, Electrochemical machining, ultrasonic machining, Abrasive jet machining etc.

MODULE- II

Unconventional Machining Process (continued) : Principle and working and application of unconventional machining processes such as Laser beam machining, Electron beam achining, Ultrasonic machining etc. (these can also be used for welding).

Unconventional welding processes: Explosive welding, Cladding etc. Under water welding, Metalizing, Plasma are welding/cutting etc.

MODULE- III

Unconventional Forming processes: Principle, working and applications of High energy forming processes such as Explosive Forming, Electromagnetic forming, Electro-Discharge forming, water hammer forming, explosive compaction etc.

Electronic-device Manufacturing: Brief description of Diffusion and Photo- Lithography process for electronic-device manufacturing.

Text Books and References:

1. Modern Machining Processes – P.C. Pandey
2. Unconventional Machining – V.K. Jain

BME-013	**Reliability Engineering**	**3L:0T:0P**	**3 credits**

Pre-requisites: None.

Course Objectives: The objectives of this course if to understand and estimate various failures associated with manufacturing, the concept and method of reliability in the industrial system.

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

CO1 Define failure, reliability , Maintenance, Bay's theorem

CO2 Understand the concepts of reliability, availability and maintainability

CO3 Build system reliability models for different configurations

CO4 Calculate MTTF, MTBF for various systems both in parallel and series order and asses reliability of components and systems using field and test data

CO5 Implement strategies for improving reliability of repairable and non-repairable systems and test the reliability of various systems.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1				2					1
CO2	3	2	1	1	1		2					1
CO3	3	2	2	1	2		2			1		1
CO4	3	2	1	3	1		2			1	1	1
CO5	3	3	1		2	1	2			1	1	1

Detailed Syllabus:

MODULE-1

Introduction: Definition of reliability, types of failures, definition and factors influencing system effectiveness, various parameters of system effectiveness.

Reliability Mathematics: Definition of probability, laws of probability, conditional probability, Bay's theorem; various distributions; data collection, recovery of data, data analysis Procedures, empirical reliability calculations.

MODULE-2

Reliability: Types of system- series, parallel, series parallel, stand by and complex; development of logic diagram, methods of reliability evaluation; cut set and tie set methods, matrix methods event trees and fault trees methods, reliability evaluation using probability distributions, Markov method, frequency and duration method.

Reliability Improvements:

Methods of reliability improvement, component redundancy, system redundancy, types of redundancies-series, parallel, series - parallel, stand by and hybrid, effect of maintenance.

MODULE- 3

Reliability Testing: Life testing, requirements, methods, test planning, data reporting system, data reduction and analysis, reliability test standards.

Text Books and References:

1. *R.Billintan & R.N. Allan,"Reliability Evaluation of Engineering and Systems", Plenum Press.*
2. *K.C. Kapoor & L.R. Lamberson,"Reliability in Engineering and Design", John Wiely and Sons.*
3. *S.K. Sinha & B.K. Kale,"Life Testing and Reliability Estimation", Wiely Eastern Ltd.*
4. *M.L. Shooman, "Probabilistic Reliability, An Engineering Approach", McGraw Hill.*

BME-021	Refrigeration and Air Conditioning	3L:0T:0P	3 credits

Pre-requisites: Thermodynamics.

Course Objective: The various objectives of this course are-

- To provide students the working knowledge of refrigeration and heating systems
- To get the knowledge of various refrigeration parts and its troubleshooting
- To understand the psychrometry of Air condition.

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

CO 1 Define various refrigeration cycles, air refrigeration, psychrometry, and the components of refrigeration system.

CO2 Understand the basic principle of a refrigeration system, DART, SHF, GSHF and classify air refrigeration systems, and the components.

CO3 Calculate the COP, heat transfer, refrigerant mass flow rate for different refrigeration systems, various psychrometric properties.

CO4 Analyze different refrigeration and air conditioning systems, and distinguish among various refrigeration systems, refrigerants, psychrometric properties.

CO5 Test the appropriateness of various refrigeration equipment's and refrigeration systems. Signify the effect of various thermodynamic properties on the performance of refrigeration system.

CO6 Design refrigeration systems with intercooling, multistage compression etc., air conditioning system and ducts.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	3	1		1	2	1	1			2
CO2	2	3	1	1	2				2			2
CO3	1	3	1	2	2				3			2
CO4	2	3		1	2				2			2
CO5		2	1	1	2	1		1	1			1
CO6	1	2	1	1	2	1			1			1

Detailed Syllabus:

Module 1:

Refrigeration: Introduction to refrigeration system, Methods of refrigeration, Carnot refrigeration cycle, Unit of Refrigeration, Refrigeration effect and COP.

Air Refrigeration cycle: Open and closed air refrigeration cycles, Reversed Carnot cycle, Bell Coleman or Reversed Joule air refrigeration cycle, Aircraft refrigeration system, Classification of aircraft refrigeration system. Boot strap refrigeration, Regenerative, Reduced ambient, Dry air rated temperature (DART).

Vapour Compression System: Single stage system, Analysis of vapour compression cycle, Use of T-S and P-H charts, Effect of change in suction and discharge pressures on C.O.P, Effect of sub cooling of condensate & superheating of refrigerant vapour on C.O.P of the cycle, Actual vapour compression refrigeration cycle, Multistage vapour compression system requirement, Removal of flash gas, Intercooling, Different configuration of multistage system, Cascade system.

Module 2:

Vapour Absorption system: Working Principal of vapour absorption refrigeration system, Comparison between absorption & compression systems, Elementary idea of refrigerant absorbent mixtures, Temperature – concentration diagram & Enthalpy – concentration diagram , Adiabatic mixing of two streams, Ammonia – Water vapour absorption system, Lithium-Bromide water vapour absorption system, Comparison.

Refrigerants: Classification of refrigerants, Nomenclature, Desirable properties of refrigerants, Common refrigerants, Secondary refrigerants and CFC free refrigerants.

Module 3:

Air Conditioning: Introduction to air conditioning, Psychometric properties and their definitions, Psychometric chart, Different Psychometric processes, Thermal analysis of human body, Effective temperature and comfort chart, Cooling and heating load calculations, Selection of inside & outside design conditions, Heat transfer through walls & roofs, Infiltration & ventilation, Internal heat gain, Sensible heat factor (SHF), By pass factor, Grand Sensible heat factor (GSHF), Apparatus dew point (ADP).

Refrigeration Equipment & Application: Elementary knowledge of refrigeration & air conditioning equipments e.g compressors, condensers, evaporators & expansion devices, Air washers, Cooling, towers & humidifying efficiency, Food preservation, Cold storage, Refrigerates Freezers, Ice plant, Water coolers, Elementary knowledge of transmission and distribution of air through ducts and fans, Basic difference between comfort and industrial air conditioning.

Text Books:

1. Refrigeration and Air conditioning by C.PArora.
2. Refrigeration and Air conditioning, by Manohar Prasad.
3. Refrigeration and Air conditioning by Roy J.Dossat.
4. A textbook of Refrigeration and Airconditioning by R. S. Khurmi and J. K Gupta

BME-022	**Advance Welding Technology**	**3L:0T:0P**	**3 credits**

Pre-requisites: None

Course Objective: The objective of this course is to study various advance methods of welding and the physics involved in these processes.

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

CO1 Understand solid state welding processes and applications.

CO2 Describe basic principle of electron beam and laser beam processes and its application.

CO3 Calculate the efficiency of welded joint and heat required.

CO4 Analyze different welding processes, HAZ, grain growth mechanism and related properties.

CO5 Generalize the welding power sources and test the significance of welding processes.

CO6 Explain the working principle of different welding processes.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1							1
CO2	3	2	2	2	1							1
CO3	2	3	2	1	1	1						1
CO4	2	3	2	1	1	1	1					1
CO5	3	3	2	1	1	1	1					1
CO6	3	2	2	2	1							1

Detailed Syllabus:

MODULE-I

Introduction: Importance and application of welding, classification of welding process, Selection of welding process.

Brief review of conventional welding process: Gas welding, Arc welding, MIG, TIG welding, Resistance welding. Electro slag welding, Friction welding etc, Welding of MS, CI, Al, Stainless steel & Maurer/Schaefflar Diagram. Soldering & Brazing.

MODULE-II

Advanced welding Techniques- Principle and working and application of advanced welding techniques such as Plasma Arc welding, Laser beam welding, Electron beam welding, Ultrasonic welding etc.

Advanced welding Techniques (continued) : Principle and working and application of advanced welding techniques such as explosive welding/ cladding, Underwater welding, Spray-welding / Metallising, Hard facing.

MODULE-III

Weld Design: Welding machines/equipment's and its characteristics and arc-stability, Weld defects and distortion and its remedies, Inspection/testing of welds, Weld Design, Welding of pipe-lines and pressure vessels.

Thermal and Metallurgical consideration: Thermal considerations for welding, temperature distribution, Analytical/Empirical analysis/formulae, heating & cooling curves. Metallurgical consideration of weld, HAZ and Parent metal, micro & macro structure. Solidification of weld and properties,

Text Books and References

1. *Welding Hand Book*
2. *Advance Welding Processes by J.Norrish*
3. *Advance Welding Technology by Mukti Chturvedi*
4. *Welding Technology by O.P Khanna*

BME-023	Mechanical Vibrations	3L:0T:0P	3 credits

Course objective: The various objectives of this course are

1. To Formulate the mathematical models of problems in Vibrations using various energy principles
2. To determine the complete solution of the models in vibrations
3. To correlate the mathematical model with the actual conditions.

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

CO1	Define the role of damping, stiffness and inertia in mechanical systems
CO2	Understand the causes and effects of vibration in mechanical systems.
CO3	Calculate the natural frequencies of different vibratory systems.
CO4	Analyze rotating and reciprocating systems and compute critical speeds.
CO5	Numerical solve the problems thorough various solvers
CO6	Design machine supporting structures, vibration isolators and absorbers and Develop schematic models for physical systems and formulate governing equations of motion.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	2	1	1					2
CO2	3	3	3	1	1							2
CO3	3	2	2	1	1							2
CO4	3	3	2	2	2							2
CO5	3	3	2	3	2		3					3
CO6	3	3	2	1	1							2

Detailed Syllabus:

MODULE - I

Introduction

Periodic motion, harmonic motion, superposition of simple harmonic motions, beats, Fourier analysis

Single Degree Freedom System

Free vibration, Natural frequency, Equivalent systems, Energy method for determining natural frequency, response to an initial disturbance, Torsional vibrations, Damped vibrations, Vibrations of systems with viscous damping, Logarithmic decrement

MODULE-II

Single Degree Freedom: Forced Vibration

Forced vibration, Harmonic excitation with viscous damping, steady state vibrations, Forced vibrations with rotating and reciprocating unbalance, Support excitation, Vibration isolation, Transmissibility, Vibration measuring instruments, Displacement, velocity and acceleration measuring instruments

Two Degree Freedom systems

Introduction, Principal modes, Double pendulum, Torsional system with damping, coupled system, undamped dynamic vibration absorbers, Centrifugal pendulum absorbers, Dry friction damper

MODULE-III

Multi Degree Freedom system: Exact Analysis: Undamped free and forced vibrations of multi-degree freedom systems, influence number, Reciprocal theorem, Torsional vibration of multi-degree rotor system, Vibration of gear system, Principal coordinates, Continuous systems- Longitudinal vibrations of bars, Torsional vibrations of circular shafts

Critical speed of Shafts: Shaft with one disc with and without damping, Multi-disc shafts, Secondary critical speed.

TextBooks and References:

1. *Mechanical Vibrations – P. Srinivasan, TMH*
2. *Mechanical Vibrations – G. K. Groover, Jain Brothers, Roorkee*
3. *Mechanical Vibrations – W. T. Thomson*
4. *Mechanical Vibrations – JS Rao & K Gupta, New Age*
5. *Mechanical Vibrations – Tse, Morse & Hinkle*
6. *Mechanical Vibrations – V. Rama Murthy, Narosa Publications*
7. *Theory of Machines- S S Rattan, TMH Publications*

BME-024	Engineering and Managerial Economics	3L:0T:0P	3 credits

Pre-requisites: **None**

Course Objectives: The objectives of this course are to-

1. Acquire the knowledge of economics to facilitate the process of economic decision making
2. Acquire knowledge of management aspect of the process
3. Develop the skill to analyze the process of engineering.

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

CO1 Define basic terms related to the economics like demand, income, indirect cost, direct cost etc

CO2 Understand the market structure and integrations concept, cost elements of the product and its effect on decision making.

CO3 Estimate the cost analysis and find the profit margins

CO4 Analyze the concepts of financial management and smart investment.

CO5 Significance of benefit/cost, life cycle and Breakeven analyses of the production system, Micro and Macro economics

CO6 Perform and evaluate present worth, future worth and annual worth analyses on one or more economic alternatives

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3			2	2	2		1	2	1
CO2	1	2	3			2	2	2		1	2	1
CO3	1	2	3			2	2	2		2	2	1
CO4	1	2	3			2	2	2		2	2	1
CO5	1	1	2			2	2	1		2	2	1
CO6	1	1	1			1	2	1		1	1	1

Detailed Syllabus:

Module 1:
Introduction: Nature and Scope of Managerial Economics. Salient features of Science and Technology, Managerial Economics and its scope for engineers, Specific functions and responsibilities of a Managerial Economist.

Module 2:
Micro Economic Concepts: Law of Demand, Determinants of Demand. Price, Income and Cross Elasticity of Demand. Their uses in managerial decisions, Laws of Returns to Scale and Law of Diminishing Returns, Market structure- Price discrimination under Perfect Competition, Monopoly, Monopolistic Competition, Duopoly and Oligopoly.

Module 3:
Macro-Economic Concepts: Concept of National Income. Methods of measurement of National Income and difficulties in measurement Meaning of Inflation, types, causes and preventive measures, Phases of business cycles.

Text Books and References:

1. Managerial Economics by Geetika, Piyali Ghosh, Poorba Roy Choudhary. Tata Mcgraw Hill education.2008.
2. Managerial Economics 7E, by D N Dwivedi. Vikas Publishing Pvt. Ltd. 2009.

BOE-601	Introduction to Composite Materials	3L:1T:0P	4 credits

Pre-requisites: **None**

Course Objective: The various course objectives of this course are-

- To train students to be able to design composite structures,
- Select composite materials, conduct stress analyses of selected practical applications using

laminated plate theories and appropriate strength criteria,

- Be familiar with the properties and response of composite structure
- Enlighten the students in different types of reinforcements

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

CO1	Define materials, Composite materials, its uses and application
CO2	Understand the mechanical behavior of layered composites compared to isotropic materials.
CO3	Determine stress and strain relations in composite materials
CO4	Analyze the Lamina and Laminates of Composites**,** Apply constitutive equations in the composite laminates
CO5	Justify the significance of different types of composites
CO6	Explain the different methods of producing the composited and discuss the concept of the fracture in Composite materials

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2		1						2
CO2	3	3	3	3					2	1	3	2
CO3	2	1	3	1	1		2					1
CO4	2	2	3		1				2			1
CO5	1	2	1	2	3	2				2	1	2
CO6	1	1	3	2	1		3			3		1

Detailed Syllabus:

Module 1

Introduction to Composite materials. Classifications, terminologies use in various manufacturing processes (in brief).

Module 2

Macro-mechanical analysis of lamina – Hooke's law for anisotropic, monoclinic, orthotropic, transversely isotropic and isotropic materials–2D Unidirectional and angle ply lamina Strength theories of lamina.
Micromechanical analysis of lamina –Volume and mass fraction, density and void content – Evaluation of Elastic moduli, Ultimate strength of unidirectional lamina.

Module 3

Macro mechanical analysis of laminates – Laminate code, Stress strain relations – In-plane and Flexural modulus, Hygrothermal effects.

Module 4

Failure Analysis and Design – Special cases of laminates, symmetric, cross ply, angle ply and antisymmetric laminates, failure criteria and failure modes

Textbooks and References:

1. Jones, R M, *Mechanics of Composite Materials*, Scripta Book Co.
2. Agarwal, B D and Broutman, J. D, *Analysis and Performance of Fiber Composites*, New York, John Willey and Sons, 1990
3. Mallik, P. K, *Fiber reinforced composites : materials, manufacturing and design*, New York- Marcel and Dekker, 1993 (2ndedition)
4. Arthur, K Kaw, *Mechanics of Composite Materials*, CRC Press, 1997.
5. Reddy J N, *Mechanics of Laminated Composite Plates*, CRC Press
6. Mallik, P. K, *Composite Engineering Hand Book*, New York, Marcel and Dekker, 1997 (2nd edition)

BOE-602	**Additive Manufacturing Technology**	**3L:1T:0P**	**4 credits**

Course Objectives: The objectives of this course are-

- To introduce students the basics of additive manufacturing/rapid prototyping and its applications in various fields
- To familiarize students with different processes in rapid prototyping systems.
- To teach students about mechanical properties and geometric issues relating to specific rapid prototyping applications.

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

CO1	Define the basic terms like additive manufacturing, rapid prototyping, reverse engineering
CO2	Understand the computational aspects of additive methods of manufacturing, various additive manufacturing methods
CO3	Draw the flow chart for the AM, RP and describe the physics of AM.
CO4	Analyze the physics of different Rapid Prototyping techniques
CO5	Explain the process parameters used in additive manufacturing for a range of materials and applications

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	1	2	1	1	1	1			3	3	1	1
CO2	1	2	1	1	1	1			2	3	1	3
CO3	1	2	2	2	1	1			3	3	2	1
CO4	1	1	2	2	1	2			3		1	3
CO5	1	2	2	1	1	1			1	3	1	1

Detailed Syllabus:

Module 1

***Rapid Prototyping (RP)*:** Principle of RP, Various RP technologies (3D Printing, *Stereolithography Apparatus (SLA)*, *Selective Laser Sintering (SLS)*, *Fused Deposition Modeling (FDM)*, *Laminated Object Manufacturing (LOM)*, *Laminated Manufacturing (LM)*, etc.), Product accuracy and surface quality, Speed, Various materials (strength, homogeneity and isotropy), Economic analysis, Advancement in RP. Rapid Prototyping with Allied Technologies:

Module 2

Introduction to *Rapid Manufacturing (RM)*: RM of polymeric objects, Direct and indirect routes for RM of metallic & ceramic objects, Advancement in RM (Synergistic integration of hybrid processes and multiple technologies).

Module 3:

Computational Aspects of *Additive Manufacturing (AM)*: Introduction to STL format, Pre & Post-processing of STL files, Various slicing methods, Various area-filling methods, Overview of the algorithms for slicing and area-filling, Emerging trends. An Overview of Mathematical Modelling of AM Processes: Thermal cycle, Residual stress, Single bead and multi bead formation in cladding based AM processes

Module 4:

***Reverse Engineering (RE)*:** Introduction to RE, Digitizing methods, 3D reconstruction, Laboratory session: Making models on FDM machines, Measurement of surface quality and mechanical properties, Existing CAM packages for AM, Development of entry level AM software, Design for AM (Build orientation, Topology optimization, Conformal cooling channels).

Textbooks and References:

1. Ian Gibson, David Rosen, and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" Springer, New York, NY, 2015.
2. Frank W. Liou, Rapid Prototyping and Engineering Applications: A Toolbox for Prototype Development, CRC Press, Taylor and Francis Group, 2007.
3. Duc Pham, S.S. Dimov, "Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling", Springer-Verlag London, 2001.

BOE-603	Fracture Mechanics	3L:1T:0P	4 credits

Course Objective: The purpose of this course is for the student to acquire basic skills, to work professionally as an engineer. This means applying fracture mechanics theory and to calculate stress areas and the "energy release rate" around crack tips and crack growth due to fatigue. Failure of structural components will be examined from both the mechanics and micro structural points of view. To examine the concept of failure in members with pre-existing flaws,

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

CO1 Define fracture and the mechanics involved in the Facture of the material

CO2 Understand the ductile and brittle fracture mechanism in different materials

CO3 Estimate the energy release rate at crack tips and crack growth

CO4 Analyze the physics of Crack formation and various influence the fracture

CO5 Justify the fracture and toughening mechanism, brittle and ductile fracture

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	2	1				1			1
CO2	2	1	2	2	3							1
CO3	1	2	2	1	1			2		2		1
CO4	1	2	1		1	2		1				1
CO5	2	1	1	2	1				1		3	1

Course Content:

Module 1

Fracture criteria, Introduction to linear elastic fracture mechanics,

Module 2

Analysis of simple crack problems, Nucleation and propagation of cracks, Correlation between microstructure and fracture behavior in materials,

Module 3

Mechanisms of fracture, Mechanisms of fatigue crack initiation and propagation,

Module 4

Evaluation of fracture toughness, factors influencing fatigue strength, life prediction, prevention of fatigue failure

Textbooks And References

1. S.T. Rolfe and J.M Barson, Fracture and fatigue control in structures, Prentice Hall
2. David and Bruck, Elementary Engineering Fracture Mechanics, Norelho
3. N.E. Fros, et al, Metal fatigue, Clarendon Press
4. American Society for Metals, Case histories in failure analysis, ASM.