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FACULTY OF ENGINEERING AND TECHNOLOGY

OUTCOME BASED EDUCATION

Curriculum and Syllabus

B.Tech -Mechanical Engineering
(Part Time)

2022

DEPARTMENT OF MECHANICAL ENGINEERING

VISION AND MISSION

Department

Vision:

To educate, nurture and motivate the upcoming Engineering professionals with moral and ethical values to become a committed punctilious Engineers to the Nation.

Mission:

M1: Providing quality education through well structured curricula supplemented with practical training, guest lectures by eminent professionals, field visits to leading industries and also in-plant training.

M2: Enhancing skills through faculty development programmes.

M3: Providing ambience for innovative projects and extra-curricular activities

M4: Equipping the department with contemporary infra-structure and the state of art R&D centre to cater to the needs of research scholars and industries

M5: Providing training to students in emerging areas like robotics and CAD/CAM.

M6: Nurturing students having creative ideas to adopt innovative projects which can be subsequently commercialized.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO's)

PEO1: Graduates will learn and utilize the basics of science and engineering knowledge to excel in their Industrial, Academic, Research and entrepreneurship career.

PEO2: Graduates will contribute to the society as technically educated, ethical and responsible citizens with proven expertise.

PEO3: Graduates will fulfil their goals with thrive to pursue lifelong learning with creativity and innovation.

PROGRAM OUTCOMES

Engineering Graduates will be able to:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: 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.

PO3: 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.

PO4: 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.

PO5: 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.

PO6: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.

PO7: 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.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: 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.

PO11: 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.

PO12: 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.

Programme Specific Outcomes

PSO1: Students will have knowledge of Mechanics of Fluids, Thermal Energy and their applications.

PSO2: Students will learn to design Mechanisms and Mechanical Components.

PSO3: Students will learn the various concepts of Manufacturing in Industrial scenario.

PSO4: Students will be exposed to multi disciplinary subjects in Engineering field.

Table 2: Revision/modification done in syllabus content:

S.No	Course (Subject) Code	Course (Subject) Name	Concept/ topic if any, removed in current Curriculum	Concept/topic added in the new curriculum	% of Revision/ Modification done
1.	EBME22007	Thermal Engineering	Unit-IV- Cetane and Octane numbers of fuels, Combustion, Knocking and Detonation, Scavenging, Valve and port timing diagrams, Fuel supply, Ignition, Cooling and Lubrication System.– Performance & Testing– Heat balance calculations.	Unit-IV- Stages of combustion in IC engines- Knocking and Detonation- factors affecting knocking-ignition delay-factors affecting ignition delay- Supercharging and turbo charging- various types of loading devices.	20%
2.	EBME22ET1	Engineering Metrology	Unit –I & Unit-II Combined	Unit-I& Unit-II Combined- legal metrology- Calibration - Interchangeability and selective assembly	40%
			Unit-III changed as Unit-II: **Form measurement**	Unit-II-**Form measurement-** internal and External screw threads- Measurements of various elements of thread, Best size wire – Two and three wire method. Gears - Constant chord method - Base tangent method. Surface Finish: Surface topography definitions - Measurement of Surface Texture - Methods - Evaluation of Surface finish.	
			Unit-V: **Measurement of Power, Flow and Temperature- Introduced as new Unit**	**UNIT V: MEASUREMENT OF POWER, FLOW AND TEMPERATURE** Force, torque, power :-mechanical, pneumatic, hydraulic and electrical type-Flow measurement: Venturi, orifice, rotameter, pitot tube – Temperature: bimetallic strip, pressure thermometers, thermocouples, electrical resistance thermister.	
3	EBME22010	Design of Machine Elements-I	Unit-I Content expanded.	**The following topics are newly included** **UNIT- I**: Design for Variable loading –Gerber line, Goodman's line, and Soderberg's Line.- **Unit-II:** Keys- different types of keys- Design of Keys, keyways, failures of keys	50%

				Unit-III: Functions of springs- applications- spring materials- Belleville springs (disc) and torsion Spring **Unit-IV:** Threaded fasteners- stress in screwed threads, Bolted joints including eccentric loading- Welded Joints -merits and demerits of welded joints, Types of welded Joints, Weld symbols, Strength of parallel and fillet weld, strength of a welded joint, eccentrically loaded Welded joints. **Unit-V:** Lubrication in journal bearings - Types of fly wheels- Design of flywheels involving stresses in rim and arm	
4	EBME22ET2	Manufacturing Technology-II	**UNIT- V: POWDER METALLURGY AND PRECISION ENGINEERING** Powder metallurgy – production of metal powders, compaction, sintering, selective laser sintering, finishing of sintered parts. Precision machining and micro machining – diamond turning of parts to nanometer accuracy, stereo microlithography, machining of micronized components	**UNIT- V: SMART MANUFACTURING** Industry 4.0, Cyber Physical system, IoT and Cloud computing for manufacturing, Digital manufacturing, Additive manufacturing, Sustainable manufacturing, advanced simulation, Augmented reality Lab Components **Additive manufacturing**: Simple components design, slicing and fabrication using FDM machine	**20%**
5	EBME22011	Heat and Mass Transfer		Unit-IV: Heat exchangers- Classifications, parallel, counter and cross flow- Fouling factors- LMTD and NTU methods Unit-V: **Basic Concepts** Equimolar counter diffusion – isothermal evaporation. **Convective Mass Transfer** Sherwood number, Schmidt number, Stanton number- mass transfer coefficients- Laminar, turbulent and Laminar-turbulent conditions.	20%
6	EBME22013	Design of Machine Elements-II	**Uint-V: DESIGN OF SIMPLE MECHANISMS** Design of Ratchet and pawl mechanism, Geneva mechanism.	The following topics are newly included **UNIT II:** Tooth stresses –Dynamic effects-Fatigue strength-Factor of Safety-Gear materials- Equivalent number of teeth – Forces for helical gears. **UNIT- V: CLUTCHES AND**	30%

				BRAKES Design of plate clutches –Cone clutches – Centrifugal clutches- Electromagnetic clutches. Band and Block brakes- External shoe brakes – Internal expanding shoe brake.	
7	EBMA22008	Mathematics-IV (Probability and Statistics)		New course has been introduced	100%
8	EBCS22IDX	Artificial Intelligence and Machine Learning		New course has been introduced	100%
9	EBCS22ILX	Artificial Intelligence and Machine Learning Lab		New course has been introduced	100%
10	EBME22ET3	Virtual and Augmented Reality		New course has been introduced	100%
11	EBME22E01 (ELECTIVE)	Advanced IC Engines	UNIT IV: **ALTERNATIVE FUELS** **UNIT V: RECENT TRENDS**	Included in UNIT IV Flexible fuel vehicles-modifications-merits and demerits UNIT V: Hybrid electrical vehicles – series, parallel and series, parallel configuration – Design – Drive train, sizing of components. Fuel cells-types-construction and working.	20%
12	EBME22E02	Electric and Hybrid vehicles		New Elective course has been introduced	
13	EBME22E03	Automobile Engineering		Shifted from programme core to programme Elective	
14	EBME22E15	Design Thinking and Innovation		New Elective course has been introduced	
15	EBME22E19	Additive manufacturing		New Elective course has been introduced	
16	EBME22E23	System Modelling and Simulation		New Elective course has been introduced	
17	EBME22E29	Block chain Technology		New Elective course has been introduced	

DEPARTMENT OF MECHANICAL ENGINEERING

B.Tech. Mechanical Engineering (Part Time)Curriculum – 2022 Regulation

	I SEMESTER							
S.NO.	SUBJECT CODE	SUBJECT NAME	Ty/ Lb/ ETL/IE	L	T/ SLr	P/R	C	Category
1	EBMA22005	Mathematics III for Mechanical and Civil Engineers	Ty	3	1/0	0/0	4	BS
2	EBPH22002	Engineering Mechanics	Ty	3	0/0	0/0	3	BS
3	EBME22004	Manufacturing Technology - I	Ty	3	0/0	0/0	3	PC
4	EBCE22ID5	Fluid Mechanics and Machinery	Ty	3	0/0	0/0	3	ID
5	EBCE22IL4	Fluid Mechanics and Machinery Lab.	Lb	0	0/0	3/0	1	ID

Credits Sub Total: 14

	II SEMESTER							
S.NO.	SUBJECT CODE	SUBJECT NAME	Ty/ Lb/ ETL/IE	L	T/ SLr	P/R	C	Category
1	EBME22002	Engineering Metallurgy	Ty	3	0/0	0/0	3	PC
2	EBME22003	Engineering Thermodynamics	Ty	3	1/0	0/0	4	PC
3	EBME22006	Strength of Materials	Ty	3	1/0	0/0	4	PC
4	EBME22007	Mechanics of Machines -I	Ty	3	1/0	0/0	4	PC
5	EBME22L02	Engineering Metallurgy Lab	Lb	0	0/0	3/0	1	PC

Credits Sub Total: 16

Note:

Ty/Lb/ETL/IE: Theory/Lab/Embedded Theory and lab/Internal evaluation

L/T/SLr/P/R/C: Lecture/Tutorials/Supervised Learning/Practical/Research/Credit

HS:Humanities and Social Science,ES:Engg.Science.BS:Basic Science,PC:Program core,PE:Program Elective,OE:Open Elective,P:Project

	III SEMESTER							
S.NO.	SUBJECT CODE	SUBJECT NAME	Ty/ Lb/ ETL/IE	L	T/ SLr	P/R	C	Category
1	EBME22008	Thermal Engineering	Ty	3	0/0	0/0	3	PC
2	EBME22009	Mechanics of Machines -II	Ty	3	1/0	0/0	4	PC
3	EBME22012	Design of Machine Elements -I	Ty	3	1/0	0/0	4	PC
4	EBME22ET2	Engineering Metrology	ETL	2	0/0	2/0	3	PC
5	EBME22L04	Dynamics Lab	Lb	0	0	3/0	1	PC

Credits Sub Total: 15

	IV SEMESTER							
S.NO.	SUBJECT CODE	SUBJECT NAME	Ty/ Lb/ ETL/IE	L	T/ SLr	P/R	C	Category
1	EBME22014	Design of Machine Elements - II	Ty	3	1/0	0/0	4	PC
2	EBME22013	Industrial Automation	Ty	3	0/0	0/0	3	PC
3	EBME22ET3	Manufacturing Technology-II	ETL	2	0/0	2/0	3	PC
4	EBME22EXX	Program Elective 1	Ty	3	0/0	0/0	3	PC
5	EBME22L06	Thermal Engineering Lab-II	LB	0	0/0	3/0	1	PC

Credits Sub Total: 14

C: Credits L: Lecture T: Tutorial S.Lr: Supervised Learning P: Problem / Practical R: Research
Ty/Lb/ETL: Theory /Lab/Embedded Theory and Lab * Internal Evaluation

	V SEMESTER							
S.NO.	SUBJECT CODE	SUBJECT NAME	Ty/ Lb/ ETL/IE	L	T/ S.Lr	P/R	C	Category
1	EBME22010	Heat and Mass Transfer	Ty	3	1/0	0/0	4	PC
2	EBME22ET4	Virtual and Augmented Reality	ETL	2	0/0	2/0	3	PC
3	EBCC22ID1	Engineering Economics and Industrial Management	Ty	3	0/0	0/0	3	ID
4	EBME22EXX	Program Elective 2	Ty	3	0/0	0/0	3	PE
5	EBME22L09	Industrial Automation Lab	Lb	0	0/0	3/0	1	PC

Credits Sub Total: 14

	VI SEMESTER							
S.NO.	SUBJECT CODE	SUBJECT NAME	Ty/ Lb/ ETL	L	T/ S.Lr	P/R	C	Category
1	EBME22011	CAD,CAM & CIM	Ty	3	0/0	0/0	3	PC
2	EBME22015	Finite Element Method	Ty	3	1/0	0/0	4	PC
3	EBME22EXX	Program Elective 3	Ty	3	0/0	0/0	3	PE
4	EBME22L07	CAD/CAM Lab	Lb	0	0/0	3/0	1	PC
5	EBME22I05	Project Phase – I	IE	0	0/0	3/3	2	P

Credits Sub Total: 13

	VII SEMESTER							
S.NO.	SUBJECT CODE	SUBJECT NAME	Ty/ Lb/ ETL	L	T/ S.Lr	P/R	C	Category
1	EBME22EXX	Program Elective 4	Ty	3	0/0	0/0	3	PE
2	EBME22EXX	Program Elective 5	Ty	3	0/0	0/0	3	PE
3	EBME22L10	Project Phase – II	Lb	0	0/0	12/12	8	P

Credits Sub Total: 14

C: Credits L: Lecture T: Tutorial S.Lr: Supervised Learning P: Problem / Practical R: Research
Ty/Lb/ETL: Theory /Lab/Embedded Theory and Lab * Internal Evaluation

LIST OF ELECTIVE SUBJECTS

PROGRAM ELECTIVE –1 & 5								
S.NO.	SUBJECT CODE	SUBJECT NAME Elective: Thermal Engineering	Ty/Lb /ETL/IE	L	T/ SLr	P/R	C	Category
1	EBME22E01	Advanced IC Engines	Ty	3	0/0	0/0	3	PE
2	EBME22E02	Electric and Hybrid vehicles	Ty	3	0/0	0/0	3	PE
3	EBME22E03	Automobile Engineering	Ty	3	0/0	0/0	3	PE
4	EBME22E04	Sustainable Energy	Ty	3	0/0	0/0	3	PE
5	EBME22E05	Gas Dynamics and Jet Propulsion	Ty	3	0/0	0/0	3	PE
6	EBME22E06	Refrigeration and Air Conditioning	Ty	3	0/0	0/0	3	PE
7	EBME22E07	Computational Fluid Dynamics	Ty	3	0/0	0/0	3	PE
8	EBME22E08	Turbo Machines	Ty	3	0/0	0/0	3	PE
PROGRAM ELECTIVE –2								
S.NO.	SUBJECT CODE	SUBJECT NAME Elective: Design Engineering	Ty/Lb /ETL/IE	L	T/ SLr	P/R	C	Category
1	EBME22E09	Mechanical Vibrations	Ty	3	0/0	0/0	3	PE
2	EBME22E10	Design of Production Tools	Ty	3	0/0	0/0	3	PE
3	EBME22E11	Design of Material Handling	Ty	3	0/0	0/0	3	PE
4	EBME22E12	Applied Tribology	Ty	3	0/0	0/0	3	PE
5	EBME22E13	Design for Manufacture and Assembly	Ty	3	0/0	0/0	3	PE
6	EBME22E14	Mechanics of Fracture	Ty	3	0/0	0/0	3	PE
7	EBME22E15	Design Thinking and Innovation	Ty	3	0/0	0/0	3	PE
PROGRAM ELECTIVE –3								
S.NO.	SUBJECTCODE	SUBJECT NAME Elective: Manufacturing Engineering	Ty/Lb /ETL/IE	L	T/ SLr	P/R	C	Category
1	EBME22E16	Industrial Robotics	Ty	3	0/0	0/0	3	PE
2	EBME22E17	Non-Conventional Machining Techniques	Ty	3	0/0	0/0	3	PE
3	EBME22E18	Process planning and cost estimation	Ty	3	0/0	0/0	3	PE
4	EBME22E19	Additive manufacturing	Ty	3	0/0	0/0	3	PE
5	EBME22E20	Flexible Manufacturing Systems	Ty	3	0/0	0/0	3	PE
6	EBME22E21	Powder Metallurgy	Ty	3	0/0	0/0	3	PE

PROGRAM ELECTIVE –4								
S.NO.	SUBJECT CODE	SUBJECT NAME Elective: Industrial Engineering	Ty/Lb /ETL	L	T/ SLr	P/R	C	Category
1	EBME22E22	Enterprise Resource Planning	Ty	3	0/0	0/0	3	PE
2	EBME22E23	System Modeling and Simulation	Ty	3	0/0	0/0	3	PE
3	EBME22E24	Total Quality Management	Ty	3	0/0	0/0	3	PE
4	EBME22E25	Facilities Planning and Design	Ty	3	0/0	0/0	3	PE
5	EBME22E26	Quality Engineering	Ty	3	0/0	0/0	3	PE
6	EBME22E27	Industry 4.0	Ty	3	0/0	0/0	3	PE
7	EBME22E28	Supply Chain Management	Ty	3	0/0	0/0	3	PE
8	EBME22E29	Block chain Technology	Ty	3	0/0	0/0	3	PE

CREDIT SUMMARY

Semester: 1 : 14 Credits

Semester: 2 : 16 Credits

Semester: 3 : 15 Credits

Semester: 4 : 14 Credits

Semester: 5 : 14 Credits

Semester: 6 : 13 Credits

Semester: 7 : 14 Credits

TOTAL CREDITS: 100

SEMESTER - I

Subject Code: EBMA22005	Subject Name : Mathematics III for Mechanical and Civil Engineers	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Mathematics I & II	**Ty**	**3**	**1/0**	**0/0**	**4**

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- Basic mathematical tools and techniques which emphasize the development of rigorous logical thinking and analytical skills.
- Theory and applications of partial differential equation, its applications, Fourier series, transforms and Laplace transformation.

COURSE OUTCOMES (COs) : (3- 5) The students will be able to

CO1	Understand the concepts of Partial Differential equations
CO2	Determine the Fourier series solutions
CO3	Apply the concepts of PDE in Wave and Heat problems
CO4	Apply Laplace transforms in Engineering problems
CO5	Apply Fourier transforms in Engineering problems

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	2	1	1	3				
CO2	2	1	1	3				
CO3	2	1	1	3				
CO4	2	1	1	3				
CO5	2	1	1	3				

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
	✓											

Subject Code: EBMA22005	Subject Name : Mathematics III for Mechanical and Civil Engineers	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Mathematics I & II	Ty	3	1/0	0/0	4

UNIT- I: PARTIAL DIFFERENTIAL EQUATIONS **12**

Formation of PDE by eliminating arbitrary constants and eliminating arbitrary functions – Solutions of standard types of first order equations – Lagrange's equation – Linear partial differential equations of second and higher order with constant coefficients.

UNIT- II: FOURIER SERIES **12**

Dirichlet's conditions – General Fourier series – Half range Sine & Cosine series – Complex form of Fourier series – Parseval's identity – Harmonic Analysis.

UNIT- III: APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS **12**

Classification of second order linear partial differential equations – Solutions of one dimensional wave equation, one-dimensional heat equation – Steady state solution of two dimensional heat equations (Cartesian coordinates only) – Fourier series solutions.

UNIT- IV: LAPLACE TRANSFORMS **12**

Transforms of simple functions – Properties of Transforms – Inverse Transforms – Transforms of Derivatives and Integrals – Periodic functions – Initial and final value theorems – Convolution theorem – Applications of Laplace transforms for solving linear ordinary differential equations up to second order with constant coefficients and Linear simultaneous differential equations of first order with constant coefficients.

UNIT- V: FOURIER TRANSFORMS **12**

Statement of Fourier integral theorem – Fourier transform pairs – Fourier Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's theorem.

Total No. of Periods : 60

TEXT BOOKS

1) Veerarajan T. (2007), *Engineering Mathematics (for first year)*, Tata McGrawHill Publishing Co.,
2) Veerarajan T. (2005), *Engineering Mathematics (for semester III)*, Tata McGraw Hill Publishing Co.,

REFERENCES

1) Singaravelu (2009), Transforms and Partial Differential Equations, Meenakshi Agency.
2) Kreyszig E. (2011), Advanced Engineering Mathematics (9th ed.), John Wiley & Sons.
3) Grewal B.S. (2012), Higher Engineering Mathematics, Khanna Publishers.

Subject Code: EBPH22002	Subject Name : ENGINEERING MECHANICS (FOR AUTO, MECH, CIVIL &ROBOTICS)	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Physics	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- Basic principles of stress, strain and elastic constants.
- To draw shear force and bending moment diagram
- To find deflection of beams.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Articulate a strong foundation in understanding kinematics & Kinetics
CO2	Identify and use the fundamentals of mechanics, static and dynamic equilibrium
CO3	Enhance the problem solving skill in statics and dynamics
CO4	Develop analytical skills to identify different types of motion
CO5	Articulate models to acquire knowledge on mathematical, analytical skills

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1	1			2		1
CO2	3	3	1	2	2	1	1		1	2		1
CO3	3	3	3	3	2	2	2	1		2	1	1
CO4	3	3	3	3	2	2	1	1	3	2	1	1
CO5	3	2	2	2	2	1	1	1	2	2	1	1

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	1	2				
CO2	3	3	1	2				
CO3	3	3	1	2				
CO4	3	3	1	2				
CO5	3	3	1	2				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
	✓			✓								

Subject Code: EBPH22002	Subject Name : ENGINEERING MECHANICS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Physics	Ty	3	0/0	0/0	3

UNIT I STATICS OF PARTICLE **9**

Introduction – units and Dimensions – Laws of mechanics – concurrent forces in a plane-resolution and Composition of forces – equilibrium of the particle-resultant force. Forces in space – Equilibrium of a particle in space – Rigid body - Moments and couples -moment of a force about a point and about an axis – Equilibrium of rigid bodies

UNIT II PROPERTIES OF SURFACE AND SOLIDS **9**

Determination of Area and volume – Determination and derivation of First moment of area (Centroid), Second moment of area (Moment of Inertia) geometrical area Mass moment of inertia and polar moment of inertia.Principal moments of inertia of plane areas

UNIT IIIFRICTION **9**

Introduction – Laws of Dry Friction – Coefficient of friction – friction of a body lying on an inclined plane. Application of friction-Ladder friction-Wedge friction-Screw friction.

UNITIVDYNAMICS OF PARTICLES **9**

KINEMATICS: Displacement, Velocity-Constant and variable Acceleration, their relationship – linear and curvilinear motion- Projectile motion, relative motion**.**

KINETICS**:** Linear and Curvilinear motion- Impulse and Momentum, Impact-collision of Elastic bodies. Newton's law-D'Alemberts principle.

UNITV DYNAMICS OF RIGID BODIES **9**

KINEMATICS**:** Introduction-Rotation-Linear and Angular Velocity as well as acceleration. General plane motion-Absolute and Relative velocity in plane motion.

KINETICS**:** Relation between Translatory and Rotary motion of the body-Work energy equation of particles –D'Alemberts principle.

Total No. of Periods: 45

TEXT BOOKS & REFERENCE BOOKS

1. R.S.Khurmi. (2008), "*A Textbook of Engineering Mechanics"*, S.Chand& co Ltd.
2. S.Rajasekaran et.al. (2009), "*Fundamentals of Engineering Mechanics"*,Vikas Publishing House Pvt Ltd., 3rd Edition.
3. *Arthur.P.Boresi,Richard.J.Schmidt, "Engineering Mechanics : Statics &Dynamics", Thomson Brooks/Cole,Chennai.*
4. *Palanichamy M.S, Nagan.S, (2001), "Engineering Mechanics – Statics and Dynamics" Tata Mc Graw Hill.*
5. *Beer &Johnson et.al, (2010) "Vector Mechanics for Engineers (Statics and Dynamics)", Tata Mc Graw Hill*

Subject Code:	Subject Name: MANUFACTURING TECHNOLOGY - I	Ty/Lb /ETL	L	T/ S Lr	P/ R	C
EBME22004	Prerequisite: NIL	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Practical R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The purpose of study is to

- Impart knowledge in various manufacturing processes for metals and plastics
- Select the appropriate manufacturing process based on the application.

COURSE OUTCOMES (COs) : The student will be able to

CO1	Understand the various manufacturing processes for metals. (Level 2)
CO2	Demonstrate the operation of various manufacturing processes (Level 3)
CO3	Expose to advanced methods of manufacturing (Level 2)
CO4	Recommend the suitable manufacturing process depending on the requirement(Level 4)
CO5	Describe the manufacturing of plastic components/Products and their applications. (Level 3)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	2	3	2	3	3	3	2	2
CO2	3	2	1	-	2	3	2	3	3	3	2	2
CO3	3	2	1	-	2	3	2	3	3	3	2	2
CO4	3	2	1	-	2	3	2	3	3	3	2	2
CO5	3	2	1	-	2	3	3	3	3	3	2	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2
CO2	3	3	3	2
CO3	3	3	3	2
CO4	3	3	3	2
CO5	3	3	3	2

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓								

Subject Code: EBME22004	Subject Name : MANUFACTURING TECHNOLOGY - I	Ty/Lb /ETL/IE	L	T/ SLr	P/R	C
	Prerequisite: NIL	Ty	3	0/0	0/0	3

UNIT- I: METAL CASTING PROCESSES **9**

Introduction to Pattern making - Moulding sand - Melting furnaces - Special casting processes - Shell, Investment, Die casting, Full mould process - Defects in casting. Computers in casting processes.

UNIT- II: METAL FORMING PROCESSES **9**

Cold and hot working - Forging, Rolling, Extrusion, Drawing. . Introduction to sheet metal forming processes. High energy rate forming - Explosive forming, Electro-hydraulic, Electro magnetic forming, Dynapac machine, petro forge machines. Super plastic forming

UNIT- III: METAL JOINING PROCESSES **10**

Classification - Arc Welding –Sheet metal arc welding , Gas metal welding- - Submerged Arc , TIG, MIG, - Resistance welding -Electrode types – Specification- Special Types - Laser, Electron beam, Plasma Arc, Ultrasonic, Electro slag, Explosive welding and Friction welding - Thermit welding –inspection of welding- Defects in weld- Brazing and soldering

UNIT- IV: METAL CUTTING PROCESSES **9**

Lathe: Specification - Types - Mechanisms - Operations - Calculations - Capstan and turret lathe - Tooling with examples - Copy turning lathe. Drilling: Specification - Types - Feed Mechanism - Operations - Drill tool nomenclature - Mounting – Reamer and tap tools - Calculations.

UNIT- V: PROCESSING OF PLASTIC MATERIALS **8**

Types of Plastics - Types of moulding - Compression moulding - Transfer molding - Injection molding - Blow Moulding – Rota moulding - Film and sheet forming - Thermo forming - Reinforced plastic - Laminated plastics.

Total No. of Periods : 45

TEXT BOOKS

1) Sharma P.C. (2008), *"A Text Book of Production Technology"*, S.Chand & Company Ltd., New Delhi.
2) Serope Kalpakjian (2013), *"Manufacturing Engineering and Technology"*, Addison-wesley Pub.Co ,7th edition.

REFERENCES

1) *Rao P.N. (2007), "Manufacturing Technology - Foundry Forging & Welding", Tata McGraw Hill Publishing Co., New Delhi, 2nd edition.*
2) *R.K. Jain, (2001) "Production Technology", Khanna publisher.*
3) *O.P. Khanna, (1993), "Welding Technology", Dhanpat Rai & sons.*
4) *S. K. Hajra Choudry, S. K. Bose, (2010) "Elements of Workshop Technology -Volume I & II". Media promoters.*

Subject Code:	Subject Name : FLUID MECHANICS AND MACHINERY	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBCE22ID5	Prerequisite: Engineering Physics	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Practical R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE: The students will learn

- The basic properties of fluids.
- Flow behaviour in various sections with basic equations
- Working principles of hydraulic pumps and turbines

COURSE OUTCOMES (COs) : The students will be able to

CO1	Understand the various properties of fluids.(Level 1&**2**)
CO2	Apply the basic concepts of fluid flow behaviour in various sections and solve simple problems..(Level **3**)
CO3	Analyse the behaviours of fluid flow through circular conduits..(Level **4**)
CO4	Acquire the knowledge of construction and working principles of hydraulic turbines and pumps..(Level **2**)
CO5	Analyze the performance of hydraulic turbines and pumps.(Level **4**)

Mapping of Course Outcomes with Program Outcomes (POs):

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	2	2	2	2	2	1	2	-	3
CO2	3	3	3	3	2	2	2	2	1	3	-	2
CO3	3	3	2	2	2	2	2	2	1	3	-	2
CO4	3	2	3	2	2	2	2	2	1	2	-	3
CO5	3	2	3	2	2	2	2	2	1	3	-	1

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2
CO2	3	2	2	2
CO3	3	2	2	2
CO4	3	2	2	2
CO5	3	2	2	2

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
							✓					

Subject Code: EBCE22ID5	Subject Name : FLUID MECHANICS AND MACHINERY	Ty/Lb/ ETL/IE	L	T/ SLr	P/R	C
	Prerequisite: Engineering Physics	Ty	3	0/0	0/0	3

UNIT- I: PROPERTIES OF FLUIDS **7**

UNIT-s & Dimensions, Properties of fluids – density, specific Gravity, specific weight, viscosity. Surface tension and Capillarity, Compressibility & Bulk modulus, Vapour pressure, Measurement of pressure-Manometers, Mechanical gauges.

UNIT- II: FLUID FLOW CONCEPTS AND BASIC EQUATIONS **9**

Flow Characteristics, Concepts of System and Control Volume, Continuity, Energy equation- Euler equation-Bernoulli equation, Impulse momentum equation-applications.

UNIT- III: FLOW THROUGH CIRCULAR CONDUITS **9**

Laminar flow through circular tubes – Boundary layer thickness -Darcy equation on pipe roughness – Friction factor – Minor losses – Flow through pipes in series and in parallel, Equivalent pipes.

UNIT- IV: HYDRAULIC TURBINES **10**

Impact of free jets-work done and efficiency calculation, Classification of hydraulic turbines, Elementary working principles of Pelton, Francis, Kaplan turbine, Work done, Governing of turbines, Draft tube, Specific Speed.

UNIT- V: HYDRAULIC PUMPS **10**

Reciprocating pumps : Classification, Working, Single acting and Double acting, Slip, Indicator diagram, Air vessels. Centrifugal pumps :Classification, Components, Working, Velocity triangles, Losses & Efficiency of a centrifugal pump, Pumps in series & parallel, Specific speed, Separation, Cavitations, Priming.

Total No. of Periods : 45

TEXT BOOKS

1) Bansal S.K. (2012) *"Fluid Mechanics and Hydraulic Machines"*, Laxmi Publications (P) Ltd., New Delhi.
2) R.K.Rajput. (1998) *"Fluid Mechanics and Hydraulic Machines"*, S.Chand & Company Ltd., New Delhi.

REFERENCES

1) *L.Kumar. (2002), "Engineering Fluid Mechanics", Eurasia Publishing House (P) Ltd., New Delhi.*
2) *Roberson J.A. & Crowe C.T. (2001), "Engineering Fluid Mechanics", M/s Jaico Publishing Co., 9th edition*
3) *Streeter V.L. and Wylie E.B. (1983), "Fluid Mechanics", McGraw Hill.*
4) *Ramamirtham S. (1988), "Fluid Mechanics, Hydraulics and Fluid Machines", Dhanpat Rai & Sons, Delhi.*
5) *Yunus.A.Cengel, Robert H.Turner., "Thermal-Fluid Sciences", Tata McGraw Hill.*

Subject Code: EBCE22IL4	Subject Name : FLUID MECHANICS AND MACHINERY LAB	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Fluid Mechanics and Machinery	**Lb**	**0**	**0/0**	**3/0**	**1**

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- Different Methods of flow measurements
- To study the characteristics of hydraulic pumps.
- To study the characteristics of hydraulic turbines.

COURSE OUTCOMES (COs) :

CO1	Understand the concept of different methods of flow measurements
CO2	Determine the coefficient of discharge of Orifice and Venturimeter
CO3	Determine the friction factor for the pipes
CO4	Draw and analyze the performance characteristics curves of jet pump, gear pump, reciprocating pumps and centrifugal pumps
CO5	Draw and analyze the performance characteristics curves of hydraulic turbines

Mapping of Course Outcomes with Program Outcomes (Pos)

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

Cos / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3		2	
CO2	3		2	
CO3	2		3	
CO4	3	2	2	3
CO5	3	2	2	3

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
							✓		✓			

Subject Code: EBCE22IL4	Subject Name : FLUID MECHANICS AND MACHINERY LAB	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Fluid Mechanics and Machinery	**Lb**	**0**	**0/0**	**3/0**	**1**

LIST OF EXPERIMENTS:

1. Determination of coefficient of discharge of given orifice meter
2. Determination of coefficient of discharge of given venturimeter,
3. Determination of coefficient of discharge of given mouthpiece.
4. Determination of friction factor of given set of pipes
5. Performance test and drawing the characteristics curves of centrifugal pump
6. Performance test and drawing the characteristics curves of reciprocating pump
7. Performance test and drawing the characteristics curves of jet pump
8. Performance test and drawing the characteristics curves of gear pump
9. Experiments to draw the characteristic curves of pelton wheel.
10. Experiments to draw the characteristic curves of Francis turbine.

Total No. of Periods: 45

SEMESTER II

Subject Code: EBME22002	Subject Name : ENGINEERING METALLURGY	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Chemistry	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To understand different materials and their metallurgical properties.

COURSE OUTCOMES (COs) : (3- 5) Students will be able to

CO1	Understand the fundamentals of materials and characterization (Level 2)
CO2	Comprehend the properties and applications of ferrous and non ferrous metals (Level 2)
CO3	Demonstration about phase diagrams and applying the fundamentals of Heat treatment (Level 3)
CO4	Analyzing and comparing the mechanisms behind deformation ,strengthening and failure of metals (Level L4)
CO5	Evaluation and selection of Metals ,Non metals and newer materials (Level L5)

Mapping of Course Outcomes with Program Outcomes (Pos)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	1	1	-	1	1	1	-	1
CO2	2	1	2	1	-	2	2	2	2	1	-	1
CO3	3	3	3	3	2	3	3	2	3	2	-	1
CO4	3	3	3	3	3	3	3	2	3	2	-	1
CO5	2	3	2	2	2	2	2	2	2	2	2	1

Cos / PSOs	PSO1	PSO2	PSO3	PSO4			
CO1	1	2	1	1			
CO2	2	2	2	1			
CO3	3	2	3	2			
CO4	3	2	3	3			
CO5	2	2	2	2			

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓								

Subject Code: EBME22002	Subject Name : ENGINEERING METALLURGY	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Chemistry	Ty	3	0/0	0/0	3

UNIT- I: CRYSTALLOGRAPHY AND STRENGTHENING MECHANISMS **9**

Crystalline and amorphous solids - UNIT- cell and primitive cell - Miller indices BCC, FCC and HCP crystal structures and their packing factors –Crystallization- Crystal defects - Effect of crystal imperfections in mechanical properties-Dislocations- strengthening mechanisms for the improvement of mechanical properties.

UNIT- II: FERROUS AND NON FERROUS METALS **9**

Significance of Phase diagram-(Eutectic and Eutectoid alloy system)-Equilibrium and Non- Equilibrium cooling-Allotrophy of Iron-iron carbon phase diagram.

Classification of Steels and Cast Iron-Microstructure of Iron and Steel- Cast Irons - Grey, White malleable, spheroidal –Effect of alloying elements on steel - stainless and tool steels. Copper and Copper alloys - Brass, Bronze and Cupronickel –Aluminum and Al-Cu alloy

UNIT- III: HEAT TREATMENT AND TESTING **9**

Definition - Classification of heat treatment process - Purpose of heat treatment -Principles (fundamentals) of heat treatment - Annealing –Re-crystallization- Normalizing - Hardening-TTT-CCT Cooling curves- Tempering - Interrupted quenching - Testing of materials - Destructive testing - Tensile, Compression, Hardness, Impact, Torsion, Fatigue. Non-destructive testing - Visual inspection, Hammer test, Radiography, Ultrasonic inspection.

UNIT- IV: FAILURE MODES AND ITS PREVENTIONS **9**

Plastic deformation-Fracture - Mechanism of brittle fracture (Griffith's theory) and ductile fracture -Difference between brittle and ductile fractures - Fatigue failure and its prevention - Creep - different stages in creep curve - Factors affecting creep resistant materials -Mechanism of creep fracture.

UNIT- V: NON METALLIC AND NEWER MATERIALS **9**

Types, Properties and Application: Polymers, Ceramics and Metal matrix Composites –Super alloys, Nano-materials- carbon and metal based materials, Smart materials and their properties

Total No. of Periods: 45

TEXT BOOKS

1) Avner, (1997) *"Introduction to Physical Metallurgy"*, McGraw Hill International Book., second edition.
2) Williams D Callister, (2007) *"Material Science and Engineering",* Wiley India Pvt Ltd, Revised Indian Edition.

REFERENCES

1) *Raghavan, V., (2006) "Materials Science and Engineering", Prentice Hall of India Pvt., Ltd.," 5 th edition.*
2) *Muralidhara. M.K. (1998) "Material science and Process", Danpat Rai Publishing.*
3) *Nayak, S.P., (1985) "Engineering Metallurgy and Material Science", Character Publishing House, Anand, India.*
4) *Van Vlack, (1970) "Material Science for Engineers", Addison Wesley, 10985,*
5) *Arumugam, M., (1997) "Material Science", Anuradha Publishers.*
6) *O.P. Kanna (1999) "Material Science and Metallurgy", Prentice Hall of India Pvt., Ltd.*

Subject Code:	Subject Name : ENGINEERING THERMODYNAMICS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22003	Prerequisite: Engineering Physics	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial S Lr : Supervised Learning P : Practical R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE: OBJECTIVE: The students will learn

- The fundamentals of thermodynamics and thermodynamic relations
- Properties of Steam and its applications.
- Different thermodynamic cycles

COURSE OUTCOMES (COs) : The students will be able to

CO1	Understand the basic concepts and laws of thermodynamics.(Level 1&2)
CO2	Apply the first and second law of thermodynamics to the engineering processes and devices.(Level 3)
CO3	Understand the concepts of entropy and its engineering applications.(Level 2)
CO4	Apply the properties of pure substances in various applications. (Level 3)
CO5	Analyze the thermal performance of various power cycles.(Level 4)
CO6	Understand and apply the various thermodynamics relations in the engineering processes.(Level 2&3).

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	1	2	1	1	2	-	3
CO2	3	3	2	3	1	1	2	1	2	2	-	2
CO3	3	3	3	3	1	1	2	1	1	2	-	2
CO4	3	3	3	3	1	1	2	1	2	2	-	2
CO5	3	3	3	3	2	1	3	1	2	2	-	3
CO6	3	3	3	3	1	1	2	1	2	2	-	2

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	2	2	3				
CO2	3	2	2	2				
CO3	3	2	2	2				
CO4	3	2	2	2				
CO5	3	2	2	2				
CO6	3	2	2	2				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓								

Subject Code: EBME22003	Subject Name : ENGINEERING THERMODYNAMICS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Physics	Ty	3	1/0	0/0	4

UNIT- I: BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS **12**

Thermodynamics systems, Concepts of continuum, Thermodynamic properties, Equilibrium, Process, Cycle, Work, Heat, Temperature, and Zeroth law of thermo dynamics. First law of thermodynamics– Applications to closed and open systems, Internal energy, Specific heats, Enthalpy, Steady flow conditions.

UNIT- II: SECOND LAW OF THERMODYNAMICS **12**

Statements, Reversibility, Causes of irreversibility, Carnot cycle, Reversed Carnot cycle, Heat engines, Refrigerators, Heat pumps. Clausius inequality, Concept of Entropy, Principles of increase of entropy, Carnot theorem, Available energy, Availability, Introduction to exergy.

UNIT- III: WORKING FLUIDS **12**

Thermodynamic properties of pure substance, Property diagrams. PVT surface of water and other substances, calculation of properties. Applications of First law and second law analysis using tables and charts.

Properties of ideal and real gases, Equation of state, Gas laws. Van der-waal's equation of state, Compressibility. Daltons law of partial pressures, Internal Energy, enthalpy, Specific heat and molecular weight of gas mixtures.

UNIT- IV: POWER CYCLES **12**

Gas power cycles - Carnot, Otto, Diesel, Dual, Brayton Cycles. Vapour Power Cycles – Rankine, ModifiedRankine, Reheat, Ideal Regenerative cycle.

UNIT- V: THERMODYNAMIC RELATIONS **12**

Exact differentials, Maxwell relations, Tds relations, Difference and ratio of Heat Capacities, Energy Equation,Clausius - Clapeyron equations, Joule-Thomson coefficient.

Total No. of Periods: 60

Note: Standard and approved Steam Table, Mollier Chart are permitted in examination.

TEXT BOOKS

1) P.K.Nag, (2014) *"Engineering Thermodynamics" (Fifth Edition),* Tata McGraw Hill Education PublishingCompany Ltd., New Delhi.
2) Yunus A.Cengel, (2014) *"Thermodynamics-An Engineering. Approach"*, Tata McGraw Hill Education, 8th edition.

REFERENCES

1) *Spalding & Cole, (1973) "Engineering Thermodynamics", ELBS, 6th edition.*
2) *J.P.Holman, (2011) "Thermodynamics", McGraw Hill 109095, 10th edition,*
3) *Van Wylen & Sonntag, (1998) "Fundamentals of Classical Thermodynamics", Wiley Eastern, 5th Edition.*
4) *Rogers & Mathew, (1992) "Engineering Thermodynamics", Adison Wesley 1090909, 4th edition.*
5) *Michael Saad, (1966) "Thermodynamics", Prentice Hall 109097.*

Subject Code: EBME22006	Subject Name : STRENGTH OF MATERIALS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Mechanics	**Ty**	**3**	**1/0**	**0/0**	**4**

L : Lecture T : Tutorial SLr : Supervised Learning P : Practical R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE: **The student will learn**

- Basic principles of stress, strain and elastic constants
- To draw shear force and bending moment diagrams
- to find deflection of beams

COURSE OUTCOMES (COs) : The student will be able to

CO1	Understand the concepts of mechanics of solids (Level 2)
CO2	Analyze the stresses involved due to different types of loading (Level 4)
CO3	Apply the different theories of mechanics (Level 3)
CO4	Derive the expression for deflection and bending moment (Level 4)
CO5	Use mathematical approach to analyze the stresses involved (Level 4)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	2	2	2	3	3	2	2
CO2	3	3	3	2	3	2	2	2	3	3	2	2
CO3	3	3	3	2	3	2	2	2	3	3	2	2
CO4	3	3	3	2	3	2	2	2	3	3	2	2
CO5	3	3	3	2	3	2	2	2	3	3	2	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	2	2				
CO2	3	3	2	2				
CO3	3	3	2	2				
CO4	3	3	2	2				
CO5	3	3	2	2				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓								

Subject Code: EBME22006	Subject Name : STRENGTH OF MATERIALS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Mechanics	Ty	3	1/0	0/0	4

UNIT- I: STRESS, STRAIN AND DEFORMATION OF SOLIDS **12**

Rigid and Deformable bodies – Strength, Stiffness and Stability – Stresses; Tensile, Compressive and Shear – Deformation of simple and compound bars under axial load – Thermal stress – Elastic constants and their relationship – strain energy due to axial load – stress due to suddenly applied load and impact load.

UNIT- II: BEAMS - LOADS AND STRESSES **12**

Types of beams: Supports and Loads – Shear force and Bending Moment in beams – Cantilever, Simply supported beams and Overhanging beams Stresses in beams – Theory of simple bending – Stress variation alongthe length and in the beam section – Effect of shape of beam section on stress induced – Shear stress distribution in beams of different sections.

UNIT- III: TORSION OF SHAFTS AND SPRINGS 12

Theory of pure torsion- Torsion of circular and hollow shafts –Stepped shafts – Composite shaft – Stress due to combined bending and torsion. Type of springs - Stiffness- Springs in series-Springs in parallel - Stresses and deflections in helical springs and leaf springs – Design of helical springs- design of buffer Springs - leaf springs.

UNIT- IV: DEFLECTION OF BEAMS **12**

Double integration method- Macaulay's Method- Area Moment Theorems for Computations of slope and deflection in Beams. Columns – End conditions – Equivalent length of a column – Euler equation – Slenderness ratio – Rankine formula for columns.

UNIT- V: ANALYSIS OF STRESSES IN TWO DIMENSIONS **12**

Biaxial state of stresses – Thin cylindrical and spherical shells – Deformation in thin cylindrical and spherical shells – Biaxial stresses at a point-Stress as Tension. Stresses on inclined plane – Principal planes and Principal stresses – Mohr's circle for biaxial stresses – Maximum shear stress - Strain energy and Strain Energy Density.

Total No. of Periods: 60

TEXT BOOKS

1. Rajput R.K. "Strength of Materials (Mechanics of Solids)", S.Chand & company Ltd., New Delhi,2010.
2. S.Ramamruthum and R. Narayan, *"Strength of Materials"*, Dhanpat Rai & Sons,

REFERENCES:

1. *Beer F. P. and Johnston R, (2002) "Mechanics of Materials", McGraw-Hill Book Co, Third Edition*
2. *Egor P. Popov, "Engineering Mechanics of Solids", Prentice Hall of India, New Delhi.*

Subject Code: EBME22007	Subject Name: MECHANICS OF MACHINES-I	T / L/ ETL	L	T / S. Lr	P/ R	C
	Pre requisite: Engineering Mechanics	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial S Lr : Supervised Learning P : Practical R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The purpose of study is to understand and apply the different concepts of mechanics.

COURSE OUTCOMES (COs) : The student will be able to

CO1	Understand the fundamental concepts of mechanism and their applications. (Level 2)
CO2	Analyze the different links of a mechanism. (Level 4)
CO3	Draw the displacement, velocity and acceleration for different mechanisms. (Level 3)
CO4	Compare the different types of rigid transmission systems and their applications. (Level 3)
CO5	Illustrate the various frictions in machine drives. (Level 3)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	1	1	-	1	2	1	2
CO2	3	3	2	3	2	1	1	-	1	2	1	2
CO3	3	3	2	3	2	1	1	-	1	2	1	2
CO4	3	3	2	3	2	1	1	-	1	2	1	2
CO5	3	3	2	2	2	1	1	-	1	2	1	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2
CO2	3	2	2	2
CO3	3	2	2	2
CO4	3	2	2	2
CO5	3	2	2	2

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
			✓								

Subject Code: EBME22007	Subject Name : MECHANICS OF MACHINES -I	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Mechanics, Strength of Materials	Ty	3	1/0	0/0	4

UNIT I BASICS OF MECHANISMS 12

Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, Mobility – Kutzbach criterion, Gruebler's criterion – Grashof's Law – Kinematic inversions of four bar chain and slider crank chains – Limit positions – Mechanical advantage – Transmission Angle.

UNIT II KINEMATIC ANALYSIS OF MECHANISMS 12

Displacement, velocity and acceleration analysis of simple mechanisms –Velocity and acceleration polygons – analytical method and Kliens construction . Coincident points – Coriolis component of Acceleration.

UNIT III KINEMATICS OF CAM MECHANISMS 12

Classification of cams and followers – Terminology and definitions – Displacement diagrams –Uniform velocity, uniform acceleration and retardation, simple harmonic motions – Derivatives of follower motions – Layout of plate cam profiles.

UNIT IV GEARS AND GEAR TRAINS 12

Law of toothed gearing – Involutes and cycloidal tooth profiles –Spur Gear terminology and definitions–Gear tooth action – contact ratio – Interference and undercutting. Helical, Bevel, Worm, Rack and Pinion gears [Basics only]. Gear trains – Speed ratio, train value – Parallel axis gear trains – Simple Epicyclic Gear Trains.

UNIT V FRICTION IN MACHINE ELEMENTS 12

Bearings and lubrication – Pivot and collar bearings, Friction clutches – Belt and rope drives – Friction in brakes- Shoe brakes, Band brakes and band and block brakes-braking torque.

Total No. of Periods: 60

TEXT BOOKS:

1. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", 3rd Edition, Oxford University Press, 2009.
2. Rattan, S.S, "Theory of Machines", 3rd Edition, Tata McGraw-Hill, 2009.
3. Khurmi R. S, (2012) *"Theory of Machines"*, S.Chand Publications,.

REFERENCES

1) *Thomas Bevan, (2005) "Theory of Machines",CBS Publishers and Distributors ,5th Edition.*
2) *Shigley J.E and Uicker J.J., (1995) "Theory of Machines and Mechanisms", McGraw Hill Inc.*
3) *Rattan S.S., (2009) "Theory of Machines", Tata McGraw Hill Publishing Company Ltd., New Delhi.*
4) *Dr.V.P.Singh. (2005) "Theory of Machines", Dhanpat Rai and Co Private Limited.*

Subject Code: EBME22L02	Subject Name : ENGINEERING METALLURGY LAB	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Material Science, Engineering Metallurgy	**Lb**	**0**	**0/0**	**3/0**	**1**

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To impart knowledge and skill about microstructure and heat treatment processes
- Experimental methods of finding mechanical properties of materials

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COURSE OUTCOMES (COs) : (3- 5)

CO1	Understand the basic concept of specimen preparation for microstructure analysis
CO2	Describe the Time temperature transformation diagram (TTT) of different metals
CO3	Analyse the microstructure of non ferrous materials
CO4	Analyse the microstructure of ferrous materials
CO5	Determine the hardness of different materials

Mapping of Course Outcomes with Program Outcomes (Pos)

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

Cos / PSOs	PSO1	PSO2	PSO3	PSO4	PSO5			
CO1	1	2	3					
CO2	1	2	3					
CO3	1	2	3					
CO4	1	2	3					
CO5	1	2	3					

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓					✓			

Subject Code: EBME22L02	Subject Name : ENGINEERING METALLURGY LAB	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Material Science, Engineering Metallurgy	**Lb**	**0**	**0/0**	**3/0**	**1**

ENGINEERING METALLURGY LAB

STUDY EXPERIMENTS

1. Introduction to metallurgy
2. Specimen preparation
3. Metallurgical microscope
4. Iron carbon system
5. Time temperature transformation diagram (TTT)

MICROSTRUCTURE ANALYSIS

1. Brass
2. Copper
3. Gray cast-iron
4. Malleable cast-iron
5. Nodular iron
6. Mild-steel, Stainless-steel and High speed steel

HEAT TREATMENT PROCESS

1. Jominey quench test
2. Hardness of steel

Total No. of Periods: 45

SEMESTER III

Subject Code: EBME22008	Subject Name : THERMAL ENGINEERING	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Thermodynamics	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P : Practical R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE: **The student will learn**

- To integrate the concepts, laws and methodologies from the first course in thermodynamics into the analysis of cyclic process.
- To apply the thermodynamic concepts into various thermal applications like, IC engines Steam turbines, Gas Turbines.

COURSE OUTCOMES (COs) : The student will be able to

CO1	Demonstrate the working principles of steam generators, condensers and nozzles and solve the problems.(Level3)
CO2	Analyze the performance of single and multistage air compressors and gas turbines.(Level 4)
CO3	Construct the velocity diagram of steam turbine and determine its performance.(Level 3)
CO4	Acquire the knowledge of IC engines and estimate the performance parameters. (Level 2)
CO5	Understand the analyze the different refrigeration and air conditioning system. (Level 2& 4)

Mapping of Course Outcomes with Program Outcomes (Pos)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	2	1	1	CO1	3	3	2	2	1
CO2	3	3	2	2	1	1	CO2	3	3	2	2	1
CO3	3	3	2	2	1	1	CO3	3	3	2	2	1
CO4	3	2	2	2	1	2	CO4	3	2	2	2	1
CO5	3	2	2	2	1	2	CO5	3	2	2	2	1

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	2	2	2				
CO2	3	2	2	2				
CO3	3	2	2	2				
CO4	3	3	2	3				
CO5	3	3	2	3				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓								

Subject Code: EBME22008	Subject Name : THERMAL ENGINEERING	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Thermodynamics	Ty	3	0/0	0/0	3

UNIT- I: STEAM GENERATORS, CONDENSERS AND NOZZLE **9**

Types and Classifications, high pressure boilers – Benson, Lamont and Babcock-Wilcox Boiler- mountings and Accessories – Criteria for selection of a boiler. Steam Condensers-Classifications – Evaporative and surface condensers-

Steam nozzles–isentropic flow through nozzles-convergent, convergent divergent nozzles-critical pressure ratio-effect of friction.

UNIT- II: AIR COMPRESSORS AND GAS TURBINES **9**

Reciprocating Compressor – Single Stage and Multi-stage operations, Effect of clearance, Volumetric efficiency. Rotary Compressor –Construction & Working of centrifugal compressor.

Gas turbines- classifications-Methods for improvement of Thermal efficiency –Inter-cooling, Reheating, Regeneration, Gas turbine fuels-Applications.

UNIT- III: STEAM TURBINES **9**

Impulse and Reaction Principles – Compounding-velocity and pressure compounding- Velocity diagrams for single stage turbines, Speed regulations – Governing.

UNIT- IV: INTERNAL COMBUSTION ENGINES **9**

Working principles of IC Engines- Stages of combustion in IC engines- Knocking and Detonation- factors affecting knocking-ignition delay-factors affecting ignition delay-Supercharging and turbo charging- various types of loading devices.

UNIT- V: REFRIGERATION AND AIR-CONDITIONING **9**

Working principles of Vapour Compression refrigeration cycle –P-H & T-S diagrams, Calculation of COP, effect of sub-cooling and superheating, Vapour absorption refrigeration cycles – Refrigerants – Properties.

Introduction to Psychrometry – Psychrometric charts – Psychrometric processes - Principles of air-Conditioning– Types of a/c systems – Summer, Winter comfort and Year round air-conditioning.

Total No. of Periods: 45

***NOTE:** Use of approved Steam Tables, Refrigeration Tables and Psychrometric Charts are permitted in Examination.

TEXT BOOKS

1) Rajput R. K., (2012) *"Thermal Engineering"*, Laxmi Publications (P) Ltd.
2) C. P. Kothandaraman and S. Domkundwar, (2004) *"Thermodynamics and Thermal Engineering"* Dhanpat Rai & Co. (P) Ltd.

REFERENCES

2) P. L. Ballaney, (1994) "Thermal Engineering", Khanna Publishers, New Delhi.
3) W.P.Stoecker and J. W. Jones, "Refrigeration and Air Conditioning", Tata McGraw Hill Co. Ltd.,
4) Ganesan V., (2012) "Internal Combustion Engines", Tata McGraw Hill New Delhi, 4th edition.

Subject Code: EBME22009	Subject Name : MECHANICS OF MACHINES –II	T / L/ ETL	L	T / S.Lr	P/ R	C
	Prerequisite: Engineering Mechanics, Strength of Material	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial SLr : Supervised Learning P : Practical R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE: The purpose of study is to understand and apply the dynamic analysis of machineries.

COURSE OUTCOMES (COs) : The student will be able to

CO1	Understand the force analysis of reciprocating mechanisms and its application. (Level 2).
CO2	Classify the vibratory systems and identify the equations of different mechanical systems. (level 3)
CO3	Solve the problems of the vibratory systems. (Level 3).
CO4	Demonstrate the dynamic balancing of rotating and reciprocating masses.(level 3)
CO5	Distinguish the different speed governors and their characteristic curves (level 4).

Mapping of Course Outcomes with Program Outcomes (Pos)

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

Cos / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2
CO2	3	2	2	2
CO3	3	2	2	2
CO4	3	2	2	2
CO5	3	2	2	2

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓								

Subject Code: EBME22009	Subject Name : MECHANICS OF MACHINES –II	Ty/Lb/ ETL	L	T/ SLr	P/ R	C
	Prerequisite: Engineering Mechanics, Strength of Material	Ty	3	1/0	0/0	4

UNIT I FORCE ANALYSIS AND FLYWHEELS 12

Static force analysis of mechanisms – D ' Alemberts principle - Inertia force and Inertia torque – Dynamic force analysis - Dynamic Analysis in Reciprocating Engines – Gas Forces - Equivalent masses - Bearing loads - Crank shaft Torque–Engine shakingforces - Turning moment diagrams - Flywheels of engines and punch press.

UNIT II BALANCING 12

Static and dynamic balancing - Balancing of rotating masses in several planes - Partial Balancing o f a single cylinder Engine –Primary and secondary unbalanced forces.

UNIT III FREE VIBRATION 12

Basic features of vibratory systems - Basic elements and lumping of parameters - Degrees of freedom - Single degree of freedom – Longitudinal and transverse Free vibration - Equations of motion - natural frequency - Types of Damping -Damped free vibration –Whirling of shafts and critical speed -Torsional systems; Natural frequency of two and three rotor systems – torsionally equivalent shaft system.

UNIT IV FORCED VIBRATION 12

Response to periodic forcing - Harmonic Forcing – Forced vibration caused by unbalance - Support motion – Force transmissibility and amplitude transmissibility - Vibration isolation

UNIT V MECHANISMS FOR CONTROL 12

Governors - Types - Centrifugal governors - Gravity controlled and spring controlled centrifugal governors – Characteristics - Effect of friction - Controlling Force – Quality of governors – effect of friction.
Gyroscopes - Gyroscopic couple - Gyroscopic stabilization - Gyroscopic effects in aero plane, automobiles and ships.

Total No. of Periods: 60

TEXT BOOKS:

1. Ambedkar A. G., Mechanism and Machine Theory, Prentice Hall of India, New Delhi, 2007.

REFERENCES

1. *Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 1984.*
2. *Ghosh A. and Mallick A.K., "Theory of Mechanisms and Machines", Affiliated East-Press Pvt.Ltd., New Delhi, 1988.*
3. *Shigley J.E. and Uicker J.J., "Theory of Machines and Mechanisms", McGraw-Hill, Inc., 1995.*
4. *Rao J.S. and Dukkipati R.V., "Mechanism and Machine Theory ", Wiley-Eastern Limited, New Delhi, 1992.*
5. *John Hannah and Stephens R.C., "Mechanics of Machines", Viva low-Priced Student Edition, 1999.*
6. *Sadhu Singh "Theory of Machines" Pearson Education, 2002.*

Subject Code: EBME22012	Subject Name: DESIGN OF MACHINE ELEMENTS - I	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Strength ofMaterials	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.

COURSE OUTCOMES (COs) : The Students will be able to

CO1	Understand and perform the failure analysis based on theories of failure. (Level 2)
CO2	Develop design thinking process and define the problem. (Level 6)
CO3	Design the machine elements like Shafts, Keys, Couplings and Bearings. (Level 6)
CO4	Select the appropriate type of spring based on the requirements. (Level 5)
CO5	Compare the various types of fasteners on strength and application aspects. (Level 4)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3	3	2	3	2	2	2	2			2
CO2	3	3	3	2	3	2	2	2	2			2
CO3	3	3	3	2	3	2	2	2	2			2
CO4	3	3	3	2	3	2	2	2	2			2
CO5	3	3	3	2	3	2	2	2	2			2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4								
CO1		3	2	2								
CO2		3	2	2								
CO3		3	2	2								
CO4		3	2	2								
CO5		3	2	2								

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓								

Subject Code: EBME22012	Subject Name : DESIGN OF MACHINE ELEMENTS - I	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Strength ofMaterials	**Ty**	**3**	**1/0**	**0/0**	**4**

UNIT- I: INTRODUCTION TO DESIGN OF MACHINE ELEMENTS **12**

Introduction to the design process-factors influencing machine design, selection of materials based on mechanical properties - Principal stresses for various load -Factor of safety-Theories of failure- design based on strength and stiffness- stress concentration-Design for Variable loading –Gerber line, Goodman's line, and Soderberg's Line.

UNIT- II: SHAFTS AND COUPLINGS **12**

Design of solid and hollow shafts based on strength and rigidity, Keys- different types of keys- Design Of Keys, keyways, failures of keys-Couplings - Rigid coupling- flexible coupling

UNIT- III: DESIGN OF SPRINGS **12**

Functions of springs-applications- spring materials-Design of helical, Belleville springs (disc) and torsion Spring–Design of Leaf Spring.

UNIT- IV: TEMPORARY AND PERMANENT JOINTS **12**

Threaded fasteners- stress in screwed threads, Bolted joints including eccentric loading- Design of Knuckle and cotter joints- Design of Welded joints- merits and demerits of welded joints, Types of welded joints, Weld symbols, Strength of parallel and fillet weld, strength of a welded joint, eccentrically loaded Welded joints.

UNIT- V: DESIGN OF BEARINGS AND FLYWHEELS **12**

Introduction -Design of bearings - Sliding contact bearing – Design of journal bearings- Mckees equation- Lubrication in journal bearings -Rolling contact bearing (antifriction bearing). Types of fly wheels- Design of flywheels involving stresses in rim and arm.

Total No. of Periods: 60

***NOTE:** Use of PSG Design Data book is permitted in Examination

TEXT BOOKS

1) Shigley J.E and Mischke C. R., (2008) *"Mechanical Engineering Design"*, Sixth Edition, Tata McGraw Hill.
2) Bhandari V.B, (2010) *"Design of Machine Elements"*, Second Edition, Tata McGraw-Hill Book Co.

REFERENCE BOOK:

1. Sundararajamoorthy, T.V. and Shanmugan, Machine Design, Anuradha Agencies, 2003.
2. Shigley, J.E., Charles, R.M. and Richard, G.B., Mechanical Engineering Design, 7th ed., McGraw-Hill,
3. 2004.

Subject Code: EBME22ET2	Subject Name: ENGINEERING METROLOGY	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Physics	ETL	2	0/0	2/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- Technique of measurement using different types of precision measuring instruments

OURSE OUTCOMES (COs) :

CO1	Understand the fundamentals of precision measurements (Level 2)
CO2	Gain theoretical and practical knowledge about the linear and angular measurements (Level 3)
CO3	Demonstrate the different types of form measurements (Level 3)
CO4	Select the appropriate precision measuring instrument based on the component drawing (Level 4)
CO5	Exposed to the recent advancement in metrology (Level 2)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	3	3	2	2	3	2	2	2
CO2	3	2	2	-	3	3	2	2	3	2	2	2
CO3	3	2	2	-	3	3	2	2	3	2	2	2
CO4	3	2	2	-	3	3	2	2	3	2	2	2
CO5	3	2	2	-	3	3	2	2	3	2	2	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2
CO2	3	3	2	3
CO3	3	3	2	3
CO4	3	3	2	3
CO5	3	3	2	3

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓								

Subject Code:	Subject Name : ENGINEERING METROLOGY	Ty/Lb/ ETL	L	T/ SLr	P/ R	C
EBME22ET2	Prerequisite: Engineering Physics	Ty	2	0/0	2/0	3

UNIT- I: INTRODUCTION TO METROGY **10**

Basic concepts-Need for measurement – legal metrology-Precision and Accuracy - Reliability - Errors in Measurements – Types – Causes- Calibration - Interchangeability and selective assembly

Linear and angular measurements- Measurement of Engineering Components: Comparators- types--Mechanical, Optical, Electrical , electronics and pneumatic - Slip Gauges – Limit Gauges -Auto Collimator – Angle Decker - Alignment Telescope - Sine Bar - Bevel Protractor**.**

LAB COMPONENTS:

1.Angular Measurement using Sine Bar, Slip Gauge and Dial Gauge,
2.Measurement of Dimensions using Vernier Height Gauge
3.Measurement of Dimensions using Vernier Depth Micrometer
4.Angular Measurement using Vernier Height Gauge and Sine Bar
5.Angular measurement using Bevel Protractor
6.Calibration of Dial Gauge using Slip Gauge
7.Flatness of given work piece using Autocollimator

UNIT- II: FORM MEASUREMENTS **10**

Measurement of Screw Thread – internal and External screw threads- Measurements of various elements of thread - Best size wire – Two and three wire method.

Gears - Measurements of various elements - Constant chord method - Base tangent method.

Surface Finish: Surface topography definitions - Measurement of Surface Texture - Methods - Evaluation of Surface finish.

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Lab Components:

1.Measurement of Gear Nomenclature using Gear Tooth Vernier
2.Thread Measurement using Profile Projector

UNIT- III: LASER METROLOGY **7**

Precision instrument based on Laser: Use of Lasers - Principle - Laser Interferometer - Application in Linear and Angular measurements - Testing of machine tools using Laser Interferometer**.**

UNIT- IV: ADVANCES IN METROLOGY **9**

Co-ordinate Measuring Machine (CMM) - Constructional features - Types - Applications of CMM – CNC applications - Computer Aided Inspection (CAI) - Machine Vision - Applications in Metrology.

Lab Components:

1.Measurement of Dimensions using Tool Makers Microscope

UNIT V: MEASUREMENT OF POWER, FLOW AND TEMPERATURE **9**

Force, torque, power :-mechanical, pneumatic, hydraulic and electrical type-Flow measurement: Venturi, orifice, Rotameters, pitot tube –Temperature: bimetallic strip, pressure thermometers, thermocouples, electrical resistance thermister..

Total No. of Periods : 45

TEXT BOOK

1) R.K. Jain, (1994) *"Engineering Metrology"*, Khanna publishers, 109094.

REFERENCES

1) I.C. Gupta, *"A TEXT BOOK of Engineering Metrology"*, Dhanpat Rai & sons, 109096.
2) G.N. Galyer and C.R. Shotbolt, *"Metrology for Engineers"*, ELBS edition, 109090.
3) Thomas *"Engineering Metrology"*, Butthinson & co, 10984.

Subject Code: EBME22L04	Subject Name: DYNAMICS LAB	T / L/ ETL	L	T / S.Lr	P/ R	C
	Prerequisite: Mechanics of Machines-II	**Lb**	**0**	**0/0**	**3/0**	**1**

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- Working of simple mechanisms
- To find natural frequency of vibrating system at different models

COURSE OUTCOMES (COs) : The student will be able to	
CO1	Gain knowledge in kinematics and Dynamics of Machinery (Level 2)
CO2	Characterize the dynamic properties of component or equipments (Level 4)
CO3	Analyze the vibration characteristics (Level 4)
CO4	Apply various principles for dynamic solutions (Level 3)
CO5	Illustrate the method of static and dynamic balancing of masses (Level 4)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	2	3	3	2	2
CO2	3	3	3	3	3	2	2	2	3	3	2	2
CO3	3	3	3	2	3	2	2	2	3	3	2	2
CO4	3	3	3	2	3	2	2	2	3	3	2	2
CO5	3	3	3	2	3	2	2	2	3	3	2	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4			
CO1	3	3	2	3			
CO2	3	3	2	3			
CO3	3	3	2	3			
CO4	3	3	2	3			
CO5	3	3	2	3			

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓					✓			

Subject Code: EBME22L04	Subject Name : DYNAMICS LAB	T / L/ ETL	L	T / S.Lr	P/ R	C
	Prerequisite: Mechanics of Machines-II	Lb	0	0/0	3/0	1

KINEMATICS (Demonstration only)

1. Kinematics of four bar mechanisms - Slider Crank, Crank Rocker Mechanism.
2. Kinematics of Gears - Spur, Helical, Bevel, Worm.
3. Kinematics of Gear trains - Simple, Compound, Epicyclic & differential gear trains.

1. DYNAMICS

a. Motorized Gyroscope - Verification of Laws.
b. Connecting Rod and Flywheel - Determination of M.I. by oscillation.
c. Governors - Watts, Porter, Proell and Hartnell – Study of characteristics and determination of Sensitivity, effort etc.
d. Cam-profile of the cam-study of Jump phenomenon - Determination of Critical Speeds.

2. VIBRATING SYSTEMS

a. Helical Spring – Determination of natural frequency
b. Compound Pendulum - Determination of natural frequencies - moment of inertia.
c. Torsional vibration - Determination of natural frequencies – Single rotor system – Two rotor system
d. Flywheel - Determination of torsional natural frequencies – moment of inertia.
e. Whirling of shaft - Determination of critical speed of shaft.

3. BALANCING

Static and dynamic balancing of rotating masses

Total No. of Periods: 45

SEMESTER IV

Subject Code: EBME22014	Subject Name: DESIGN OF MACHINE ELEMENTS - II	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Strength of Materials, Design of Machine Elements - I	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.

COURSE OUTCOMES (COs) :

CO1	Understand and perform the failure analysis based on theories of failure. (Level 2)
CO2	Develop design thinking process and define the problem. (Level 6)
CO3	Design the machine elements like Shafts, Keys, Couplings and Bearings. (Level 6)
CO4	Select the appropriate type of spring based on the requirements. (Level 5)
CO5	Compare the various types of fasteners on strength and application aspects. (Level 4)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	3	2	2	2	2	2	2
CO2	3	3	3	2	3	3	2	2	2	2	2	2
CO3	3	3	3	2	3	3	2	2	2	2	2	2
CO4	3	3	3	2	3	3	2	2	2	2	2	2
CO5	3	3	3	2	3	3	3	2	2	2	2	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	3	2				
CO2	3	3	3	2				
CO3	3	3	3	2				
CO4	3	3	3	2				
CO5	3	3	3	2				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓								

Subject Code: EBME22014	Subject Name : DESIGN OF MACHINE ELEMENTS - II	Ty/Lb /ETL	L	T/ SLr	P/R	C
	Prerequisite: Strength of Materials, Design of Machine Elements - I	**Ty**	**3**	**1/0**	**0/0**	**4**

UNIT 1 DESIGN OF FLEXIBLE DRIVES **12**

Design of Flat belts and pulleys – Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys - Design of Transmission chains and Sprockets.

UNIT 2 SPUR GEARS AND PARALLEL AXIS HELICAL GEARS **12**

Speed ratios and number of teeth-Force analysis- Tooth stresses –Dynamic effects-Fatigue strength-Factor of Safety-Gear materials-Design of Straight tooth spur and helical gears based on strength and wear considerations- Pressure angle in the normal and transverse plane –Equivalent number of teeth – Forces for helical gears.

UNIT 3 BEVEL AND WORM GEARS **12**

Straight bevel gear: Tooth terminology- Design of pair of straight bevel gears - Tooth forces and stresses Worm Gear: Merits and demerits- Terminology. Design of the worm and gear - Forces and stresses, efficiency.

UNIT- IV: DESIGN OF SPEED REDUCERS **12**

Design of speed reducers –Geometric Progression – Standard Step ratio- Ray diagram – Kinematic arrangement of Gears -Number of teeth on gears.

UNIT- V: CLUTCHES AND BRAKES **12**

Design of plate clutches –Cone clutches – Centrifugal clutches- Electromagnetic clutches. Band and Block brakes- External shoe brakes – Internal expanding shoe brake.

Total No. of Periods 60

***NOTE:** Use of P.S.G Design Data Book is permitted in the University examination

TEXT BOOKS

1) Shigley J.E and Mischke C. R., (2003) *"Mechanical Engineering Design"*, Sixth Edition, Tata McGraw Hill.
2) Sundararajamoorthy T. V and Shanmugam .N, (2003) *"Machine Design"*, Anuradha Publications, Chennai.

REFERENCES

1) Maitra G.M. and Prasad L.V., "Hand book of Mechanical Design", II Edition, Tata McGraw Hill 10985.
2) Bhandari, V.B., "Design of Machine Elements", Tata McGraw Hill Publishing Company Ltd., 109094.
3) Prabhu. T.J., (2000) "Design of Transmission Elements", Mani Offset, Chennai.
4) Hamrock B.J., Jacobson B. and Schmid S.R., "Fundamentals of Machine Elements", Tata McGraw-Hill Book Co., 1090909.
5) Ugural A,C, (2003) "Mechanical Design, An Integrated Approach", Tata McGraw-Hill

Subject Code: EBME22013	Subject Name: INDUSTRIAL AUTOMATION	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Pre requisite: Manufacturing Technology-I & II,	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will gain

- knowledge in hydraulic, pneumatic and mechatronics system in Automation.

OURSE OUTCOMES (COs) :

CO1	Understand Pneumatic and hydraulic principles, components and functions (Level 2)
CO2	Analyze and Design the Pneumatic and hydraulic circuits for automation (Level 4)
CO3	Recognize the various components of mechatronics system (Level 2)
CO4	Discuss the various actuation systems and System models in automation (Level 3)
CO5	Design the Mechatronic system for the required automation (Level 4)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	3	2	3	3	3	3	2
CO2	3	3	3	3	3	3	2	3	3	3	3	2
CO3	3	3	2	2	3	3	2	3	3	3	3	2
CO4	3	3	2	2	3	3	2	3	3	3	3	2
CO5	3	3	3	3	3	3	2	3	3	3	3	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	2	3				
CO2	3	3	2	3				
CO3	3	3	2	3				
CO4	3	3	2	3				
CO5	3	3	2	3				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓								

Subject Code: EBME22013	Subject Name : INDUSTRIAL AUTOMATION	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Pre requisite: Manufacturing Technology-I & II	Ty	3	0/0	0/0	3

UNIT- I BASIC PRINCIPLES OF HYDRAULICS AND PNEUMATICS **8**

Hydraulic principles – Hydraulic pumps – pumping circuits - Hydraulic actuators – Characteristics – Hydraulic valves types and Applications – Hydraulic Fluids. Fundamentals of pneumatics – Control elements – logic circuits – position – pressure sensing – switching – Electro-pneumatic – Electro-hydraulic circuits. Symbols of hydraulic and pneumatic circuits.

UNIT- II DESIGN OF HYDRAULIC AND PNEUMATIC CIRCUITS **10**

Hydraulic circuits – Reciprocating – Quick-return – sequencing – synchronizing –Accumulators circuits – Safety circuits – Industrial circuits. Pneumatic circuits – classic – cascade – step counter – combination methods.
Design of Hydraulic and pneumatic circuits - Selection of components – Installation and Maintenance of Hydraulic and Pneumatic power packs.

UNIT-III MECHATRONICS, SENSORS AND TRANSDUCERS **8**

Introduction to Mechatronics Systems – Measurement Systems –Transducers – Performance Terminology – Sensors for Displacement, Position and Proximity; Velocity, Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, Light Sensors – Selection of Sensors.

UNIT- IV ACTUATION SYSTEM AND SYSTEM MODELS **8**

Hydraulic, Pneumatic and electrical actuation Systems – Mechanical Switches – Solid State Switches – Solenoids – D.C Motors – A.C Motors – Stepper Motors. Building blocks of Mechanical, Electrical, Fluid and Thermal Systems, Rotational – Translational Systems, Electromechanical Systems – Hydraulic – Mechanical Systems.

UNIT-V CONTROLLERS AND DESIGN OF MECHATRONICS SYSTEMS **11**

Continuous and discrete process Controllers –PID Controllers – Digital Controllers, Digital Logic Control – Micro Processors Control. Programmable Logic Controllers – Basic Structure – Input / Output Processing – Programming – Mnemonics – Timers, Internal relays and counters – Shift Registers – Master and Jump Controls. Stages in designing Mechatronics Systems -Case Studies of Mechatronics Systems, Pick and place robot – automatic Car Park Systems – Engine Management Systems.

Total No. of Periods: **45**

TEXT BOOKS

1) S.Ilango and V.Soundarrajan ,(2011) "*Introduction to Hydraulics and Pneumatics"*,Prentice hall india,2nd Edition.

2) K.Shanmugasundaram (2006) "*Hydraulic and Pneumatic control*" S.Chand &Co.

3) W. Bolton, "Mechatronics", Pearson Education, Second Edition, 1999.

REFERENCES

1) Michael B. Histand and David G. Alciatore, "Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 2000.

2) Bradley D. A., Dawson D., Buru N.C. and. Loader A.J, "Mechatronics", Chapman and Hall, 1993.

3) Lawrence J. Kamm, "Understanding Electro – Mechanical Engineering", An Introduction to Mechatronics, Prentice – Hall of India Pvt., Ltd., 2000.

4) Nitaigour Premchand Mahadik, "Mechatronics", Tata McGraw-Hill publishing Company Ltd, 2003

5) Anthony Esposito, (2008) "Fluid power with applications", Pearson education Pvt. Ltd, 7th edition.

6) W.Bolton, (2012) "Pneumatic and Hydraulic Systems", Butterworth, 3rd edition.

Subject Code: EBME22ET3	Subject Name : MANUFACTURING TECHNOLOGY - II	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Manufacturing Technology - I	ETL	2	0/0	2/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To impart knowledge and skill in metal cutting process and smart manufacturing technology

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COURSE OUTCOMES (COs) : (3- 5)

CO1	Understand the concepts of metal cutting and related information's (Level 2)
CO2	Acquire skill in special purpose machines (Level 4)
CO3	Select appropriate method of manufacturing based on the requirement (Level 4)
CO4	Understand the concepts and applications of smart manufacturing (Level 3)
CO5	Acquire skill in smart manufacturing techniques (Level 4)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	2	3	3	2	3	2	2	2
CO2	3	3	3	-	2	3	3	2	3	2	2	2
CO3	3	3	3	-	2	3	3	2	3	2	2	2
CO4	3	3	2	-	3	3	3	2	3	2	2	2
CO5	3	3	2	-	3	3	3	2	3	2	2	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4	PSO5			
CO1	3	3	2	3				
CO2	3	3	2	3				
CO3	3	3	2	3				
CO4	3	3	3	3				
CO5	3	3	3	3				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓								

Subject Code:	Subject Name : MANUFACTURING TECHNOLOGY - II	T / L/ ETL	L	T / S.Lr	P/ R	C
EBME22ET3	Prerequisite: Manufacturing Technology - I	ETL	2	0/0	2/0	3

UNIT- I: THEORY OF METAL CUTTING **9**

Metal cutting types - Mechanism of metal cutting - Cutting forces - Chip formation - Merchant's circle diagram -Calculations – Tool geometry - Machinability - Tool wear - Tool life - Cutting tool materials - Cutting fluids.

UNIT- II: SPECIAL PURPOSE MACHINES-I **10**

Shaper, Planer, slotter: Specification - Types - Mechanism – Calculations
Boring: Specification - Types - Operations - Boring tool - Jig Boring machine.
Broaching: Specification - Types - Tool nomenclature - Broaching process.

Lab Components

Shaping, and Slotting Practice: Cutting key ways and dove tail hexagonal machining using Shaper, Internal keyway using slotter

UNIT- III: SPECIAL PURPOSE MACHINES-II **10**

Milling: Specification - Types - Cutter nomenclature - Types of cutter - Milling processes - Indexing – Cam and thread milling.
Grinding: Types of grinding machine - Designation and selection of grinding wheel - Bonds – Reconditioning of grinding wheel – Lapping, honing and super finishing.

Lab Components

Grinding Practice: Cylindrical grinding, Surface grinding.

Milling Practice: Hexagonal milling, Contour milling

UNIT- IV: GEAR CUTTING MACHINES **8**

Kinematics of gear shaping and gear hobbing - Gear generation principles specifications – Cutters - Bevel geargenerator - Gear finishing methods.

Lab Components

Machining of helical gear using hobbing machine**,** Spur gear milling

UNIT- V: SMART MANUFACTURING **9**

Industry 4.0, Cyber Physical system, IoT and Cloud computing for manufacturing,
Digital manufacturing, Additive manufacturing, Sustainable manufacturing, advanced simulation, Augmented reality

Lab Components

Additive manufacturing: Simple components design, slicing and fabrication using FDM machine

Total No. of Periods: 45

TEXT BOOKS

1) S. K. Hajra Choudry, S. K. Bose, (2010) "Elements of Workshop Technology -Volume I & II". Media promoters.
2) P. C. Sharma, (2008) "A text book of Production Engineering", S. Chand and Co. Ltd., IV Edition.
3) Masoud Soroush, Michael Baldea, Thomas F. Edgar (2020) “Smart Manufacturing” Elsevier Science.

REFERENCES

2) H.M.T, (1990) “Production Technology – Handbook”, TMH.
3) Richara R. Kibbe, John E. Neely, Roland O. Meyer and Warrent T. White, (2009) "Machine Tool Practices", VI Edition, Prentice Hall of India.
4) N. K. Mehta, (2012) “Machine Tool Design and NC", Tata McGraw Hill Publishing Co. Ltd.
5) Jaeger R.C, (1988) “Introduction to microelectronics fabrication”, Addison Wesley pub. Co.,
6) C. Elanchezian, M. Vijayan, (2004) “Machine Tools” Anuradha Publications.

Subject Code: EBME22L06	Subject Name : THERMAL ENGINEERING LAB-II	Ty/Lb/ ETL	L	T/SLr	P/R	C
	Prerequisite: Thermal Engineering , Heat and Mass Transfer	**Lb**	**0**	**0/0**	**3/0**	**1**

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- To evaluate the performance of air compressor, air blower and refrigeration and air conditioning systems.
- To determine the properties of different liquid fuels.
- To study the different modes of heat transfer.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Calculate the performance of air compressor and blower and COP of a refrigeration system. (Level 3)
CO2	Determine the flash, fire point and viscosities of different oils (Level 3)
CO3	Determine the emissivity of a grey body. (Level 3)
CO4	Estimate the thermal conductivity of an insulating material and composite wall. (Level 4)
CO5	Measure the effectiveness of pinfin and parallel and counter flow heat exchanger. (Level 3)

Mapping of Course Outcomes with Program Outcomes (Pos)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	1	1	1	2	2	2	2	1
CO2	3	2	2	2	1	2	2	2	2	2	2	1
CO3	3	3	2	2	1	2	2	2	2	2	2	2
CO4	3	3	2	2	2	2	2	2	2	2	2	1
CO5	3	3	2	2	2	2	2	2	2	2	2	1
Cos / PSOs	3		3		2		2		2	2	2	2
CO1	3		2		2		2					
CO2	3		2		2		2					
CO3	3		2		2		3					
CO4	3		2		2		2					
CO5	3		2		2		3					

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓					✓			

Subject Code: EBME22L06	Subject Name : THERMAL ENGINEERING LAB-II	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Thermal Engineering , Heat and Mass Transfer	Lb	0	0/0	3/0	1

LIST OF EXPERIMENTS:

1. Performance test on reciprocating air compressor.
2. Performance test on a constant speed air blower.
3. Viscosity measurement using Redwood apparatus.
4. Viscosity measurement using Say bolt apparatus.
5. Determination of COP of a refrigeration system.
6. Determination of COP of air conditioning system.
7. Determination of flash point and fire point of the given lubricating oil sample.
8. Determination of thermal conductivity of an insulating material.
9. Determination of efficiency of a pin fin using natural and forced convection methods.
10. Determination of emissivity of a gray body using emissivity apparatus.
11. Determination of Stefan Boltzmann Constant.
12. Determination of effectiveness of a parallel flow and counter flow heat exchanger.
13. Determination of Heat Transfer in Drop and Film wise Condensation
14. Overall Heat Transfer Coefficient of Composite wall..

Total No. of Periods : 45

SEMESTER V

Subject Code: EBME22010	Subject Name : HEAT AND MASS TRANSFER	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Thermodynamics	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- Concept and modes of heat and mass transfer.
- Concept of various heat transfer correlations and their engineering calculations.
- Concept and types of heat exchangers

COURSE OUTCOMES (COs) : (3- 5)

CO1	Understand the knowledge of Conduction heat transfer and its applications. (Level 2)
CO2	Apply the concept of forced and free convection heat transfer and its applications. (Level 3)
CO3	Explore the applications of radiation heat transfer. (Level 3)
CO4	Understand the knowledge of phase change heat transfer and heat exchangers in engineering applications. (Level 2)
CO5	Apply the mass transfer concepts in real-time applications. (Level 3)

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**1**	**-**	**2**
CO2	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**-**	**2**
CO3	**2**	**3**	**2**	**1**	**2**	**2**	**2**	**1**	**1**	**2**	**-**	**2**
CO4	**3**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**-**	**2**
CO5	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**1**	**2**	**2**	**-**	**2**

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**2**	**2**	**3**
CO2	**3**	**2**	**2**	**3**
CO3	**3**	**2**	**2**	**3**
CO4	**3**	**2**	**2**	**3**
CO5	**3**	**2**	**2**	**2**

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Open Electives	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓								

Subject Code: EBME22010	Subject Name : HEAT AND MASS TRANSFER	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Thermodynamics	Ty	3	1/0	0/0	4

UNIT- I: CONDUCTION **13**

Introduction of heat transfer – Mode of Heat Transfer- Fourier' Law of Conduction - General Differential equation of Heat Conduction- Heat conduction through Plane Wall, Cylinders and Spherical systems – Composite Systems - Critical thickness of insulation - Extended surfaces (Fins).

UNIT- II: CONVECTION **13**

Basic Concepts – Boundary Layer Concept – Types of Convection – Forced Convection-External Flow- Flow over flat plates, Cylinders and Spheres- Internal Flow–Laminar and Turbulent Flow– Combined Laminar and Turbulent –Free Convection – Flow over Vertical Plate, Horizontal Plate and long horizontal cylinder.

UNIT- III: RADIATION **12**

Basic Laws of Radiation, Radiation shape factor, shape factor algebra for radiant heat exchange between black and gray bodies and Radiation shield-, Introduction to Radiosity and Irradiation.

UNIT- IV: PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER **12**

Boiling heat transfer phenomenon – modes of boiling, pool boiling regime-flow boiling thro horizontal pipes.- boiling empirical correlations. Condensation-film and drop wise condensation-Nusselt theory of condensation over vertical surface .

Heat exchangers- Classifications, parallel, counter and cross flow- Fouling factors- LMTD and NTU methods

UNIT- V: MASS TRANSFER **10**

Basic Concepts

Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion –Equimolar counter diffusion – isothermal evaporation.

Convective Mass Transfer

Convective Mass Transfer Correlations- Sherwood number, Schmidt number, Stanton number- mass transfer coefficients- Laminar, turbulent and Laminar-turbulent conditions.

Total No. of Periods : 60

***NOTE:** Use of approved HMT data book is permitted in the University Examination.

TEXT BOOKS

1) C.P.Kothandaraman, (2005) "Fundamentals of Heat and Mass Transfer", New age International (p) Ltd-109098.
2) R.C.Sachdeva (2010). "Fundamentals of Heat and Mass Transfer", New age International (p) Ltd -109098, 4th edition.
3) R.K.Rajput (2007) "Heat and Mass transfer", Chand Publishers

REFERENCES

1) J.P.Holman (2001) "Heat transfer", McGraw Hill Book Company, 9th edition.
2) Ozisik.N.M. (1998) "Heat transfer", McGraw Hill Book Company.
3) Michael A. Boles and Yunus A. Cengel (2002), "Thermodynamics: An Engineering Approach", McGraw-Hill.

SubjectCode: EBME22ET4	Subject Name :VIRTUAL AND AUGMENTED REALITY	Ty/Lb/ ETL	L	T/ S.Lr	P/R	C
	Prerequisite: Basic computer knowledge	ETL	2	0/0	2/0	3

L:LectureT:Tutorial SLr:SupervisedLearningP:ProjectR:ResearchC:Credits

T/L/ETL:Theory/Lab/EmbeddedTheoryandLab

OBJECTIVE:OBJECTIVE: Thestudentswilllearn

- To introduce the relevance of this course to the existing technology through demonstrations, case studies and applications with a futuristic vision along with socio-economic impact and issues
- To understand virtual reality, augmented reality and using them to build Biomedical engineering applications

COURSEOUTCOMES(COs) : The students will be able to

CO1	Understand the physical principles of VR & AR
CO2	Create a comfortable, high-performance VR application using Unity
CO3	Analyze and understand the working of various state of the art VR & AR devices.
CO4	Analyze & Design a system or process to meet given specifications with realistic engineering constraints
CO5	Create and deploy a VR & AR application.

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs /PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3
CO2	3	3	3	3
CO3	3	3	3	3
CO4	3	3	3	3
CO5	2	3	3	3

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓								

Subject Code: EBME22ET4	Subject Name: VIRTUAL AND AUGMENTED REALITY	Ty / Lb/ETL	L	T /S.Lr	P/ R	C
	Prerequisite: Basic computer knowledge	ETL	2	0/0	2/0	3

UNIT I INTRODUCTION **9**

The three I's of virtual reality-commercial VR technology and the five classic components of a VR system – Input Devices: (Trackers, Navigation, and Gesture Interfaces): Three-dimensional position trackers, navigation and manipulation-interfaces and gesture interfaces-Output Devices: Graphics displays-sound displays & haptic feedback.

Lab components:

1.Installation of Unity and Visual Studio, setting up Unity for VR development

2.Demonstration of the working of HTC Vive

UNIT II VR DEVELOPMENT PROCESS **9**

Geometric modeling - kinematics modeling- physical modeling - behaviour modeling - model Management.

Lab components:

1.Demonstration of the working of Google Cardboard

2.Develop a scene in Unity that includes a cube, plane and sphere

UNIT III CNTENT CREATION CONSIDERATION FOR VR **9**

Methodology and terminology-user performance studies-VR health and safety issues-Usability of virtual reality system- cyber sickness -side effects of exposures to virtual reality environment

Lab components:

1. Change the colour and material of Game object

2. Change the texture of Game object

UNIT IV VR ON THE WEB & VR ON THE MOBILE **9**

JS-pros and cons-building blocks (WebVR, WebGL, Three.js, device orientation events)- frameworks (A-frame, React VR)-Google VR for Android-Scripts, mobile device configuration, building to android-cameras and interaction-teleporting-spatial audio-Assessing human parameters-device development and drivers-Design Haptics

Lab components:

1.Create an immersive environment (living room)

2.Create an immersive environment (tennis court)

UNIT V APPLICATIONS OF VR &AR

Mechanical applications-Robotics applications- Advanced Real time Tracking- other applications- games, movies, simulations.

Lab components:

1.Assembly of Gear box using VR & AR

2. Assembly of tailstock using VR & AR

TEXT BOOKS:

1. C. Burdea& Philippe Coiffet, "Virtual Reality Technology", Second Edition, Gregory, John Wiley & Sons, Inc.,2008
2. Jason Jerald. 2015. The VR Book: Human-Centred Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool, New York, NY, USA.

REFERENCES:

1. Augmented Reality: Principles and Practice (Usability) by Dieter Schmalstieg& Tobias Hollerer, Pearson Education (US), Addison-Wesley Educational Publishers Inc, New Jersey, United States, 2016. ISBN: 9780321883575

2. Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability),Steve Aukstakalnis, Addison-Wesley Professional; 1 edition, 2016.

3. The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will Change Everything, Robert Scoble&Shel Israel, Patrick Brewster Press; 1 edition, 2016.

Subject Code: EBCC22ID1	Subject Name : ENGINEERING ECONOMICS AND INDUSTRIAL MANAGEMENT	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Nil	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab./Embedded Theory and Lab.

OBJECTIVE: The student will learn:

- Concepts of industrial management and economics

COURSE OUTCOMES (COs) : The student will be able to

CO1	Understand the various concepts of organizations and economics related to it (Level 2)
CO2	Expose to the behavior of the human in the organization (Level 2)
CO3	Analyze the demand and supply patterns and costs related to it (Level 4)
CO4	Illustrate the various methods of production with cost effectiveness (Level 3)
CO5	Identify the effect of cost on macro economics (Level 2)

Mapping of Course Outcomes (COs) with Program Outcomes (POs) & Program Specific Outcomes (PSOs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	-	3	2	-	3	3	3	3	2
CO2	2	2	2	-	3	2	-	3	3	3	-	2
CO3	2	2	2	-	3	2	-	2	3	3	3	2
CO4	2	2	2	-	3	2	-	2	3	3	3	2
CO5	2	2	2	-	3	2	-	2	3	3	3	2

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	3
CO2	2	3	3	3
CO3	2	3	3	3
CO4	2	3	3	3
CO5	2	3	3	3

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
							✓					

Subject Code:	Subject Name : ENGINEERING ECONOMICS AND INDUSTRIAL MANAGEMENT	Ty/Lb/ ETL/IE	L	T/ SLr	P/R	C
EBCC22ID1	Prerequisite: Nil	Ty	3	0/0	0/0	3

UNIT - I Introduction to Management **9**

The Nature of Management –Management: Science or Art – Difference between administration and management - Evolution of management thought - Roles of managers– F.W.Taylor and Henri Fayol contribution to the management- Organization and the environmental factors.

UNIT - II Managing Organizational Behavior **9**

Definition- need and Importance of Organizational Behavior – Nature and Scope of Organizational Behavior - Role of managers – Contributing disciplines to Organizational Behavior - Frame work of Organizational Behavior.

UNIT – III Demand & Supply Analysis **9**

Meaning of demand, the demand curve, Elasticity of demand, types of elasticity of demand. Supply –Meaning, the supply curve, equilibrium with supply and demand curves.

UNIT IV Theory of Production **9**

Meaning of Production, Basic concepts- total, average, and marginal product, short run and long run production Function, Law of Variable Proportion. Production function with two variable inputs – Isoquants – Meaning, Properties, ISO cost Lines, All variable inputs – Returns to Scale, Cost Analysis: Determinants of Costs, types of Cost.

UNIT V Macro Economic Concepts **9**

National income concepts, Inflation, Balance of Payment, Circular flow of income Monetary and Fiscal Policy,Demonetization, Exchange Rates

Total No. of Periods 45

REFERENCE BOOKS:

1. *Meenakshi Gupta - Principles of Management - PHI Learning Pvt. Ltd.-2009.*
2. *L.M.Prasad - Principles and Practice of Management - Sultan Chand & Sons - 7th Edition - 2007.*
3. *Harold Koontz - Principles of Management - Tata McGraw Hill - 2004.*
4. *Mithani, D.M, Managerial Economics- Theory &applications, Himalaya pub.*
5. *Mehta, P, L, Managerial Economics. Analysis, problem & cases, Sultan Chand*

Subject Code: EBME22L09	Subject Name: INDUSTRIAL AUTOMATION LAB	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Pre requisite: Industrial automation	Lb	0	0/0	3/0	1

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- To practice simple programs on microprocessors and micro controllers.
- To design and implement pneumatic and hydraulic circuits with automation studio software and with kits

OURSE OUTCOMES (COs) :

CO1	Recognize the various components of Hydraulics and Pneumatic circuits (Level 2)
CO2	Design and implement hydraulic circuits with automation studio software and kit (Level 4)
CO3	Design and implement pneumatic circuits with automation studio software and kit (Level 4)
CO4	Understand the concepts and applications of robots (Level 2)
CO5	Write programming for controllers in automation (Level 4)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	3	2	3	3	3	3	2
CO2	3	3	3	3	3	3	2	3	3	3	3	2
CO3	3	3	3	3	3	3	2	3	3	3	3	2
CO4	3	3	2	2	3	3	2	3	3	3	3	2
CO5	3	3	3	3	3	3	2	3	3	3	3	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3
CO2	3	3	2	3
CO3	3	3	2	3
CO4	3	3	2	3
CO5	3	3	2	3

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓					✓			

Subject Code: EBME22L09	Subject Name : INDUSTRIAL AUTOMATION LAB	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Industrial automation	Lb	0	0/0	3/0	1

LIST OF EXPERIMENTS:

a. Exercises in PLC Trainer Kit.
b. Exercises in Pneumatic / Hydraulic Trainer Kit.
c. Exercises in Electro Pneumatic kit.
d. Exercises in Industrial Robot.
e. Exercises in microprocessors and micro controllers.
f. Design of pneumatic and hydraulic circuits using Automation Studio software.

Total No. of Periods: 45

SEMESTER VI

Subject Code: EBME22011	Subject Name : CAD,CAM & CIM	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Design of Machine Elements, Manufacturing Technology	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To provide an overview of how computers are being used in design, development of Manufacturing plans and manufacture
- To understand the need for integration of CAD,CAM and CIM

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COURSE OUTCOMES (COs) : (3- 5)	
CO1	Understand the concepts and uses of various CAD devices (Level 2)
CO2	Apply various CAD modeling techniques (Level 3)
CO3	Understand the CNC machines and integeration of CAD/CAM (Level 2)
CO4	Analyze and write down part programming for lathe and milling operations (Level 4)
CO5	Apply group technology and computer aided process planning and understand the FMS concept and functions (Level 3)

Mapping of Course with Program Outcomes (Pos)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2		3							
CO2	3	3	2		3							
CO3	3	3	2		3							
CO4	3	3	2		3							
CO5	3	3	2		3							

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1		3	3	2				
CO2		3	3	2				
CO3		3	3	2				
CO4		3	3	2				
CO5		3	3	2				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓								

Subject Code: EBME22011	Subject Name : CAD,CAM & CIM	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Design of Machine Elements, Manufacturing Technology	Ty	3	0/0	0/0	3

UNIT- I INTRODUCTION **9**

A typical product cycle, CAD tools for the design process of product cycle, CAD / CAM system evaluation criteria, Input / Output devices;

Graphics Displays: Refresh display, DVST, Raster display, pixel value and lookup table, estimation of graphical memory, LCD, LED fundamentals. Concept of Coordinate Systems: Working Coordinate System, Model Coordinate System, Screen Coordinate System. Graphics exchange standards.

UNIT- II GEOMETRIC TRANSFORMATIONS AND MODELING **9**

Homogeneous representation; Translation, Scaling, Reflection, Rotation, Shearing in 2D and 3D;. Window to View-port transformation. Geometry and Topology, Comparison of wireframe, surface and solid models, Properties of solid model, properties of representation schemes, Concept of Half-spaces, Boolean operations. Schemes: B-rep, CSG, Sweep representation, ASM, Primitive instancing, Cell Decomposition and Octree encoding

UNIT- III COMPUTER AIDED MANUFACTURING **9**

CAM Concepts, Objectives & scope, Nature & Type of manufacturing system, Evolution, Benefits of CAM, Role of management in CAM, Concepts of Computer Integrated Manufacturing, Impact of CIM on personnel, Role of manufacturing engineers, CIM Wheel to understand basic functions.

NC and CNC Technology: Types, Classification, Specification and components, Construction Details-Axis designation, NC/CNC tooling. Fundamentals of Part programming, Types of format, Part Programming for drilling, lathe and milling machine operations.

UNIT- IV GROUP TECHNOLOGY AND CAPP **9**

Introduction, part families, part classification and coding systems: OPITZ, PFA, FFA, Cell design, rank order clustering, composite part concepts, Benefits of group technology. Approaches to Process Planning, Different CAPP system, application and benefits

UNIT- V FLEXIBLE MANUFACTURING SYSTEM **9**

Introduction & Component of FMS, Needs of FMS, general FMS consideration, Objectives, Types of flexibility and FMS, FMS lay out and advantages. Automated material handling system: Types and Application, Automated Storage and Retrieval System, Automated Guided Vehicles, Cellular manufacturing, Tool Management, Tool supply system, Tool Monitoring System, Flexible Fixturing, Flexible Assembly Systems.

Total No. of Periods: 45

TEXT BOOKS

1) Chris McMohan and Jimmie Browne, *"CAD/CAM"*, Addison Wesley Publications, 2nd Ed.
2) HMT, (2000) *"Mechatronics"*, Tata McGraw –Hill Ed.
3) Mikkel. P.Groover, (2007) *"Automation, Production and Computer Integrated Manufacturing"*, PHI., Pvt Ltd.

REFERENCE BOOKS

1. Mikell P Groover, "Automation, Production Systems and Computer Integrated Manufacturing" , Pearson Education
2. Rao, Tewari, Kundra, "Computer Aided Manufacturing", McGraw Hill.
3. P. Radhakrishnan , "Computer Numerical Control", New Central Book Agency

Subject Code: EBME22015	Subject Name: FINITE ELEMENT METHOD	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Strength of Materials, Design of Machine Elements-I	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- Fundamentals of finite element analysis and their applications.
- Method of solving one, two and iso-parametric elements.

OURSE OUTCOMES (COs) :

CO1	Understand the basic concepts in Finite Element Method. (Level 2)
CO2	Identify the application and characteristics of Finite Element Analysis elements. (Level 2)
CO3	Develop the element characteristic equations and generation of global equations. (Level 6)
CO4	Analyze the suitable boundary conditions to a global equation of FEA elements. (Level 4)
CO5	Apply FEA software to analyze the machine elements. (Level 3)

Mapping of Course Outcomes with Program Outcomes (POs)

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

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	2	3				
CO2	3	3	2	3				
CO3	3	3	2	3				
CO4	3	3	2	3				
CO5	3	3	2	3				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code: EBME22015	Subject Name : FINITE ELEMENT METHOD	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Strength of Materials, Design of Machine Elements-I	Ty	3	1/0	0/0	4

UNIT- I INTRODUCTION **12**

Historical Background – Mathematical Modeling of field problems in Engineering –Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT- II ONE-DIMENSIONAL PROBLEMS **12**

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors-Assembly of Matrices - Solution of problems from solid mechanics including thermal stresses-heat transfer. Natural frequencies of longitudinal vibration and mode shapes. Fourth Order Beam Equation –Transverse deflections and Transverse Natural frequencies of beams.

UNIT- III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS **12**

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements and Quadrilateral elements- Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts.

UNIT- IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS **12**

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Constitutive matrices and Strain displacement matrices – Stiffness matrix – Stress calculations - Plate and shell elements.

UNIT- V ISOPARAMETRIC FORMULATION AND ADVANCED TOPICS **12**

Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One and two dimensions – Serendipity elements – Numerical integration - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software- Introduction to Non Linearity.

TEXT BOOKS: **Total No. of Periods: 60**

1. J.N.Reddy, "An Introduction to the Finite Element Method", 3rd Edition, Tata McGrawHill,2005
2. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., NewDelhi, 2007.

REFERENCES:

1. *Logan, D.L., "A first Subject in Finite Element Method", Thomson Asia Pvt. Ltd., 2002.*
2. *Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2002.*
3. *Rao, S.S., "The Finite Element Method in Engineering", 3rd Edition, Butter worth Heinemann, 2004.*
4. *Chandrupatla and Belagundu, "Introduction to Finite Elements in Engineering", 3rd Edition, Ibrahim Zeid, "Introduction to CAD/CAM", Tata McGraw Hill Co.*

Subject Code: EBME22L07	Subject Name: CAD/CAM LAB	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Pre requisite: CAD/CAM/CIM, Machine Drawing	Lb	0	0/0	3/0	1

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will

- Get practical knowledge through practice on CNC Machines and related software

OURSE OUTCOMES (COs) :

CO1	Understand the concepts of metal cutting and related information (Level 2)
CO2	Acquire skill in special purpose machines (Level 4)
CO3	Select appropriate method of manufacturing based on the requirement (Level 4)
CO4	Understand the concepts and applications of powder metallurgy (Level 3)
CO5	Expose to various advanced manufacturing processes of precision components (Level 3)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	2	3	3	2	3	2	2	2
CO2	3	3	3	-	2	3	3	2	3	2	2	2
CO3	3	3	3	-	2	3	3	2	3	2	2	2
CO4	3	3	2	-	3	3	3	2	3	2	2	2
CO5	3	3	2	-	3	3	3	2	3	2	2	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	2	3				
CO2	3	3	2	3				
CO3	3	3	2	3				
CO4	3	3	3	3				
CO5	3	3	3	3				

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
				✓					✓			

Subject Code: EBME22L07	Subject Name : CAD / CAM LAB	Ty/Lb/ETL	L	T/SLr	P/R	C
	Prerequisite: CAD,CAM&CIM, Machine Drawing	Lb	0	0/0	3/0	1

List of Experiments

CAD LAB

1. Introduction to computer Aided Design and Drafting Packages.
2. 2D – Drawing using Auto CAD/ Solid works or CATIA Software
3. 2D sectional views, part drawing, assembly drawing, detailed drawing.
4. Dimensioning, annotations, symbols – Welding, Surface finish, threads, Text, Bill of Materials, Title Block.
5. Exercises – Knuckle joint, Gib & Cotter joint, Screw Jack, Foot step bearing.
6. Orthographic views, Isometric views.
7. Solid modeling features-Boolean operations.

CAM LAB

NC part programme with G and M codes should be generated, tool path simulation and execution to be done for the following machines.

1. Exercises in CNC lathe.
2. Step Turning
3. Taper Turning
4. Thread Cutting
5. Eccentric Turning

1. Exercises in CNC milling machines.
    1. Contour Milling
    2. Hexagonal Milling

Total No. of Periods: 45

Subject Code: EBME22I05	Subject Name: PROJECT PHASE-I	Ty/Lb/ ETL/IE	L	T/ SLr	P/R	C
	Pre requisite: All Courses	IE	0	0/0	3/3	2

Students are expected to do the Project in a group of 3 to 4 students. They should identify the area/topic of the Project and should collect the literatures related to the project. Students intending to do Industrial projects will approach the industries with the support of the university, identify the industrial problem and finalize the project. In case of Industrial projects apart from Industry guide, a guide has to be appointed by the department. At the end of the Semester the students should submit their Project Phase - I report to the Department and Viva -Voce examination will be conducted by the examiners duly appointed by the Head of the department.

SEMESTER VII

Subject Code: EBME22L10	Subject Name: PROJECT PHASE-II	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Pre requisite: Project Phase-I	Lb	0	0/0	12/12	8

To make the students to make use of the knowledge and skill developed during their four years of study and to apply them for making an innovative product/process for the development of society and industries.

Students are expected to do a Project work either in an Industry or at the University in the field of relevant Engineering /inter-disciplinary /multi-disciplinary area in a group of 3 or 4 students. The work to be carried out in Phase II should be continuation of Phase I. Each group will be allotted a guide based on the area of Project work. In case of industrial Project external guide has to be allotted from Industry. Inter disciplinary/multi-disciplinary project can be done with students of different disciplines as a group. Monthly reviews will be conducted during the semester to monitor the progress of the project by the project review committee. Students have to submit the Project thesis at the end of the semester and appear for the Project Viva-Voce examination conducted by the examiners duly appointed by the Controller of Examination. In case of industrial project certificate in proof has to be included in the report along with the bonofide certificate

ELECTIVE SUBJECTS

ELECTIVE:
THERMAL ENGINEERING

Subject Code: EBME22E01	Subject Name : ADVANCED IC ENGINES	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Thermodynamics and Thermal Engineering	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Practical R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE: The Student will learn

- Recent advancements of I.C Engines
- Various alternative fuels for I.C engines.

COURSE OUTCOMES (COs) : The Student will be able to

CO1	Understand and apply the knowledge of fuel injection systems and combustion process of IC engines.(Level 2&3)
CO2	Distinguish the types of combustion chambers used in CI engine.(Level 1)
CO3	Analyze the pollution formations mechanism and control in IC engines.(Level 4)
CO4	Understand and apply the knowledge of various alternative fuels in IC engines.(Level 2&3)
CO5	Apply the recent trends techniques in IC engines.(Level 3)

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	1	1	3	1	1	1	-	1
CO2	2	3	1	1	1	1	2	1	1	1	-	1
CO3	2	3	2	2	1	1	3	1	1	1	-	1
CO4	2	3	2	1	1	1	3	1	1	1	-	1
CO5	3	2	2	2	1	1	1	1	1	1	-	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	2	2	2				
CO2	3	2	2	2				
CO3	3	2	2	2				
CO4	3	2	2	2				
CO5	3	2	2	2				

3/2/1 indicates Strength of Correlation: 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code: EBME22E01	Subject Name : ADVANCED IC ENGINES	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Thermodynamics and Thermal Engineering	Ty	3	0/0	0/0	3

UNIT- I: SPARK IGNITION ENGINES **9**

Spark Ignition Engine Mixture Requirements - Fuel- Injection Systems-Monopoint and Multi point Injection – Stages of Combustion-Normal and Abnormal Combustion-factors Affecting Knock-Combustion Chambers.

UNIT- II: COMPRESSION IGNITION ENGINES **9**

States of Combustion in C.I.Engine – Direct and Indirect Injection Systems - Combustion Chambers – Fuel Spray Behavior and Structure-Spray Penetration and Evaporation-Air Motion - Turbo charging.

UNIT- III: POLLUTANT FORMATION AND CONTROL **9**

Pollutant –Global warming- Sources and Types –Formation of NOx - Hydro-Carbon Emission Mechanism - Carbon Monoxide. Formation-Particulate Emissions-Methods of Controlling Emissions - Catalytic Converters and Particulate Traps-EGR technique.

UNIT- IV: ALTERNATIVE FUELS **9**

Bio-fuel – Vegetable oil – Bio diesel -Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas-Properties, Suitability, Engine Modifications, Merits and Demerits as Fuels-Flexible fuel vehicles-modifications-merits and demerits

UNIT- V: RECENT TRENDS **9**

Lean Burn Engines-Stratified Charge Engines-Homogeneous ChargeCompression Ignition –Common rail direct injection engine, Hybrid electrical vehicles – series, parallel and series, parallel configuration – Design – Drive train, sizing of components. Fuel cells-types-construction and working.

Total No. of Periods: 45

TEXT BOOK

1) V.Ganesan, (2008) "*Internal combustion engines"*, Tata McGraw Hill.

REFERENCES

1) *Mathur and Sharma, (1990) "Internal combustion engines".*
2) *John Heywood, (1988) "Internal combustion engines fundamentals", Tata McGraw Hill Co.*
3) *Benson and White house (1983) "Internal combustion engines Vol I & Vol II", Pergamon press.*
4) *Domkundwar, "Internal combustion engines" Dhanpat Rai & Co. (P) Ltd.*

Subject Code:	Subject Name : ELECTRIC AND HYBRID VEHICLES	Ty/Lb/ ETL/IE	L	T/ SLr	P/R	C
EBME22E02	Prerequisite: Basic Electrical and Electronics Engineering	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- Recent advancements of I.C Engines
- Various alternative fuels for I.C engines.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Understand the electrical vehicles concepts and vehicle kinetics and dynamics
CO2	Design the battery pack for the types of electric vehicle based on its capacity
CO3	Understand the working of DC & AC electrical motors
CO4	Apply the knowledge of gears, differential and clutches to the transmission of electric vehicles
CO5	Design the drive train of hybrid vehicles

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**	2	2	2	3	**2**	**3**	2	2	2		1
CO2	2	2	2	2	3	**2**	**3**	2	2	2		1
CO3	2	2	**2**	2	3	2	**3**	2	2	2		1
CO4	2	2	2	**2**	3	2	**3**	2	2	2		1
CO5	2	2	2	2	3	2	**3**	2	2	2		1

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	**3**	2		2				
CO2	3	**2**		2				
CO3	3	2		**2**				
CO4	**3**	**2**		2				
CO5	**3**	**2**		2				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code:	Subject Name : ELECTRIC AND HYBRID VEHICLES	Ty/Lb/ ETL/IE	L	T/ SLr	P/R	C
EBME22E02	Prerequisite: Basic Electrical and Electronics Engineering	Ty	3	0/0	0/0	3

UNIT I ELECTRIC VEHICLES **9**

Introduction, Components, vehicle mechanics – Roadway fundamentals, vehicle kinetics, Dynamics ofvehicle motion - Propulsion System Design.

UNIT II BATTERY **9**

Basics – Types, Parameters – Capacity, Discharge rate, State of charge, state of Discharge, Depth ofDischarge, Technical characteristics, Battery pack Design, Properties of Batteries.

UNIT III DC & AC ELECTRICAL MACHINES **9**

Motor and Engine rating, Requirements, DC machines, Three phase A/c machines, Induction machines,permanent magnet machines, switched reluctance machines.

UNIT IV ELECTRIC VEHICLE DRIVE TRAIN **9**

Transmission configuration, Components – gears, differential, clutch, brakes regenerative braking, motorsizing.

UNIT V HYBRID ELECTRIC VEHICLES **9**

Types – series, parallel and series, parallel configuration – Design – Drive train, sizing of components.

Text books:

1. Iqbal Hussain, “Electric & Hybrid Vehicles – Design Fundamentals”, Second Edition, CRC Press, 2011.
2. James Larminie, “Electric Vehicle Technology Explained”, John Wiley & Sons, 2003.

Reference Books:

1. *Mehrdad Ehsani, Yimin Gao, Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles:Fundamentals”, CRC Press, 2010.*
2. *Sandeep Dhameja, “Electric* Vehicle Battery Systems”, Newnes, 2000
.http://nptel.ac.in/courses/108103009/

Subject Code: EBME22E03	Subject Name : AUTOMOBILE ENGINEERING	T / L/ ETL	L	T / S.Lr	P/ R	C
	Prerequisite: Thermodynamics and Thermal Engineering-I	T	3	0	0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE: The student will learn

- Various automobile parts, power transmission from engine to various parts of the automobile, engine cooling, lubrication and also about various pollutants and its control.

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COURSE OUTCOMES (COs) : (3- 5)

CO1	Gain the knowledge of vehicle structures.(Level 2)
CO2	Apply the skill of auxiliary systems in IC engines.(Level 3)
CO3	Demonstrate the power transmissions systems.(Level 3)
CO4	Apply the knowledge of steering, brakes and suspension systems.(Level 3)
CO5	Understand the concept of the fuel cells and hybrid vehicles.(Level 2)

Mapping of Course Outcomes with Program Outcomes (Pos)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	1	1	1	1	1	-	1
CO2	3	2	2	2	-	1	2	1	1	2	-	2
CO3	2	2	1	1	-	1	1	1	1	1	-	1
CO4	2	2	2	2	-	1	1	1	1	2	-	1
CO5	2	1	1	1	-	2	2	1	1	1	-	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	2	2	2				
CO2	3	2	2	2				
CO3	3	2	2	2				
CO4	3	2	2	2				
CO5	3	2	1	3				

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					✓							

Subject Code: EBME22E03	Subject Name: AUTOMOBILE ENGINEERING	T / L/ ETL	L	T / S.Lr	P/ R	C
	Prerequisite: Thermodynamics and Thermal Engineering	T	3	0/0	0/0	3

UNIT- I: VEHICLE STRUCTURE AND ENGINES **9**

Vehicle construction –types-chassis layout- body-integral and chassis mounted body- vehicle specifications-power and torque requirements- choice of engine for different applications. Engine types and construction –cylinder arrangement-piston- cylinder head connecting rod – crank shaft-valves- liners-manifolds.

UNIT- II: ENGINE AUXILIARY SYSTEMS AND POLLUTION CONTROL **9**

Fuel supply system to SI and CI engines–injection timing. Lubrication system-cooling system-ignition system-Spark timing-firing order, electronic fuel injection system-types. Pollution from engines and their control-Indian emission standards-supercharging-turbo charging.

UNIT- III: TRANSMISSION SYSTEMS **9**

Clutches –need-types-single& multi plate –diaphragm-fluid coupling-torque converter Gear boxes-manual-sliding mesh- constant mesh-synchro mesh- epicyclic gear boxes-automatic transmission. Universal joint-propeller shaft-Hotchkiss drive- torque tube drive. Differential-need-types- construction. Four wheel drive-rear axle.

UNIT- IV: STEERING AND SUSPENSION SYSTEMS **9**

Principle of steering-steering geometry and wheel alignment-steering linkages-steering gear boxes-power steering. Wheel and tyre construction-type and specification-tyre wear and causes-front axles arrangements. Suspension system-need and types-independent systems-coil-leaf spring-torsion bar-shock absorbers-air suspension**.**

UNIT- V: BRAKE SYSTEMS **9**

Auto Electrical Components and Alternative Power Plants. Brake –need –types-mechanical-hydraulic-pneumatic-power brake-trouble shooting of brakes. Principles of modern electrical systems-battery-dynamo- starting motor-lighting- automobile conditioning. Electric hybrid vehicle and fuel cells.

Total No. of Periods: 45

TEXT BOOKS

1) K.K.Ramalingam, (2007) "*Automobile Engineering"*, SciTech Publications.
2) Kirpal Singh, (2012) *"Automobile Engineering vol-I&II".*
3) R.B.Gupta, (2013) "*Automobile Engineering"*, Satya Prakashan Publishing.

REFERENCES

1. Joseph Heitner, "Automotive Mechanics", Affiliated East West Press Ltd.
2. "Newton and Steeds, Motor Vehicles", ELBS –13 EDITION.
3.William Crouse, (2007) "Automotive Mechanics", Tata McGraw Hill.

Subject Code: EBME22E04	Subject Name : SUSTAINABLE ENERGY	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Thermodynamics and Thermal Engineering	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: Students will learn

- The concept, principles and characteristics of different renewable energy systems.
- Energy conversion techniques

COURSE OUTCOMES (COs) : (3- 5)

CO1	Understand the basic concepts of solar radiation and their utilizations. .(Level 2)
CO2	Apply the solar knowledge in various practical applications..(Level 3)
CO3	Carryout out constructions of different energy conversion techniques..(Level 2)
CO4	Explain the principles of energy conversion from earth and ocean..(Level 3)
CO5	Demonstrate the working of MHD and concept of Fuel cells..(Level 3)

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	1	2	2	2	1	1	-	2
CO2	3	2	2	2	1	2	2	2	1	2	2	2
CO3	3	2	2	1	1	1	1	2	1	1	1	2
CO4	3	2	2	2	1	1	1	2	1	2	-	1
CO5	3	2	2	1	1	1	1	1	1	1	-	1

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1
CO2	3	2	2	2
CO3	3	1	1	2
CO4	3	1	1	1
CO5	3	1	1	1

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code: EBME22E04	Subject Name : SUSTAINABLE ENERGY	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Thermodynamics and Thermal Engineering	Ty	3	0/0	0/0	3

UNIT- I PRINCIPLES OF SOLAR RADIATION: **9**

Role and Potential of new and renewable source, the solar energy option, Environmental impact of solar power,Solar constant, extra-terrestrial and terrestrial solar radiation, solar radiation on titled surface, Instruments for measuring solar radiation and sun shine, solar radiation data.

UNIT- II SOLAR ENERGY **9**

SOLAR ENERGY COLLECTION**:** Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

SOLAR ENERGY STORAGE**:** Different methods, sensible, latent heat and stratified storage, solar ponds.

Solarapplications - solar heating/cooling techniques, solar distillation and drying, photovoltaic energy conversion.

UNIT- III WIND ENERGY AND BIOMASS **9**

WIND ENERGY**:** Sources and potentials, horizontal and vertical axis windmills, performance characteristics.

BIOMASS**:** Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-Gas digestors, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation, economic aspects.

UNIT- IV GEOTHERMAL,TIDAL AND WAVE ENERGY **9**

GEOTHERMAL ENERGY**:** Resources, types of wells, methods of harnessing

OTEC**:** Principles, utilization, setting of OTEC plants, thermodynamic cycles.

TIDAL AND WAVE ENERGY**:** Potential and conversion techniques, mini hydel power plants, and their economics.

UNIT- V:DIRECT ENERGY CONVERSION **9**

Need for DEC, Carnot cycle, limitations, principles of DEC. Thermo-electric generators, MHD Power generators, principles, working.

Fuel cells: principle, working -types - Selection of fuels and operating conditions.

Total No. of Periods : 45

TEXT BOOKS

1) G.D.Rai, (2004) *"Non-Conventional Energy Sources*" Khanna Publishers.
2) Ashok V Desai, (2003) "*Non-Conventional Energy"*, Wiley Eastern.
3) K.M.Mittal, (2007) "*Non-Conventional Energy Systems"*, Wheeler Publishing.
4) Ramesh & Kumar, (2007) "*Renewable Energy Technologies"*, Narosa Publishing House.

REFERENCES

1) Twidell & Weir, (2006) "Energy Sources", Taylor & Francis
2) Sukhame, (2009) "Solar Energy".
3) B.S.Magal Frank Kreith, (2010) "Solar Power Engineering"

Subject Code:	Subject Name : GAS DYNAMICS AND JET PROPULSION	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E05	Prerequisite: Engineering Thermodynamics	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Practical R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- The basic difference between incompressible and compressible flow.
- The phenomenon of shock waves and its effect on flow.
- Basic knowledge about jet propulsion and Rocket Propulsion.

COURSE OUTCOMES (COs) : The student will be able to

CO1	Gain the fundamental knowledge of compressible flow and its properties. (Level 2)
CO2	Solve the problems in constant and variable area ducts. (Level 3)
CO3	Analyze the flow properties in different ducts. (Level 4)
CO4	Understand the phenomenon of different shock waves and their effects. (Level 1&2)
CO5	Apply the knowledge of propulsions in rockets and jets. (Level 3)

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	2	2	2				
CO2	3	2	2	2				
CO3	3	2	2	2				
CO4	3	2	2	2				
CO5	3	2	2	2				

3/2/1 indicates Strength of Correlation: 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code:	Subject Name : GAS DYNAMICS AND JET PROPULSION	Ty/Lb/ ETL/IE	L	T/ SLr	P/R	C
EBME22E05	Prerequisite: Engineering Thermodynamics	Ty	3	0/0	0/0	3

UNIT- I: COMPRESSIBLE FLOW – FUNDAMENTALS **9**

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

UNIT- II: FLOW THROUGH VARIABLE AREA DUCTS **9**

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

UNIT- III: FLOW THROUGH CONSTANT AREA DUCTS **9**

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

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

UNIT- IV: NORMAL SHOCK **9**

Governing equations, variation of flow parameters like static pressure, static temperature, density, stagnation pressure and entropy across the normal shocks. Prandtl Meyer equation, flow in convergent and divergent nozzle with shock

UNIT- V: PROPULSION **9**

Theory of jet propulsion –Types of Jet engines- principles and working of pulse jet, ram jet, turbojet, turbofan and turbo prop engines. Types of rocket engines –Liquid and Solid propellant rocket- Propellants-feeding systems –Cryogenic rocket engine.

Total No. of Periods: 45

***NOTE:** Use of approved Gas tables permitted in the University Examination

TEXT BOOK

1) Yahya S.M., (2005) "*Fundamental of Compressible flow*", New Age International (P) Ltd., New Delhi. Third edition reprint.

REFERENCES

1) *Patrick & William, (1997) "Fundamentals Of Compressible Flow", McGraw Hill-Inc.*
2) *Ganesan.V, (2010) "Gas Turbines" , Tata McGraw Hill Publishing Company, New Delhi.*

Subject Code:	Subject Name : REFRIGERATION AND AIR CONDITIONING	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E06	Prerequisite: Thermodynamics, Thermal Engineering	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: Students will learn

- The working principle of refrigerators and air conditioning systems.
- Different cycles used in refrigeration.
- Alternate refrigerants to reduce global warming **.**

COURSE OUTCOMES (COs) : (3- 5)

CO1	Gain the basic knowledge of various refrigeration cycles and refrigerants..(Level 2)
CO2	Analyze the various refrigeration cycles using thermodynamic concepts..(Level 4)
CO3	Understand the design and working principles of various components of refrigeration and air-conditioning systems.(Level 2)
CO4	Apply the psychrometry knowledge to calculate the cooling and heating load..(Level 3)
CO5	Understand the fundamental concepts of cryogenic engineering and low-temperature of properties of materials.(Level 2)

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1	3	3	3	2	2	-	3
CO2	2	3	3	3	2	2	2	2	2	3	-	2
CO3	3	2	2	2	1	2	2	2	2	2	-	3
CO4	2	2	2	2	1	2	2	2	2	3	-	2
CO5	2	3	3	3	2	2	2	2	2	3	-	2

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3
CO2	3	3	3	3
CO3	3	2	2	2
CO4	3	3	3	3
CO5	3	2	2	2

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project
					✓				

Subject Code:	Subject Name : REFRIGERATION AND AIR CONDITIONING	Ty/Lb /ETL/IE	L	T/ SLr	P/R	C
EBME22E06	Prerequisite: Thermodynamics, Thermal Engineering	Ty	3	0/0	0/0	3

UNIT- I: REFRIGERATION CYCLES AND REFRIGERANTS **9**

Vapour Compression Réfrigération Cycle-Simple Saturated Vapour Compression Réfrigération Cycle. Thermodynamic Analysis of the above. Refrigerant Classification, Designation, Alternate Refrigerants, Global Warming Potential & Ozone Depleting Potential Aspects.

UNIT- II: SYSTEM COMPONENTS **9**

Refrigerant Compressors – Reciprocating Open & Hermetic Type, Screw Compressors and Scroll Compressors – Construction and Operation Characteristics. Evaporators – DX Coil, Flooded Type Chillers Expansion Devices - Automatic Expansion Valves, Capillary Tube & Thermostatic Expansion Valves. Condensing UNIT-s and Cooling Towers.

UNIT- III: CYCLING CONTROLS AND SYSTEM BALANCING **9**

Pressure and Temperature Controls. Range and Differential Settings. Selection and Balancing of System Components-Graphical Method.

UNIT- IV: PSYCHROMETRY & AIR CONDITIONING **9**

Moist Air Behavior, Psychrometric Chart, Different Psychrometric Process Analysis**.**
Summer and Winter Air-conditioning, Cooling Load Calculations, Air Distribution Patterns, Dynamic and Frictional Losses in Air Ducts, Equal Friction Method, Fan Characteristics in Duct Systems.

UNIT- V: INTRODUCTION TO CRYOGENIC ENGINEERING **9**

Introduction to cryogenic engineering-applications of cryogenics in various fields-low temperature properties of materials- mechanical, thermal, electrical and magnetic properties- properties of cryogenic fluids-cryogenic fluid storage and transfer systems- cryogenic insulation.

Total No. of Periods : 45

TEXT BOOKS

1) W.F.Stocker and J.W.Jones, (2009) *"Refrigeration & Air Conditioning"*, McGraw Hill Book Company.
2) Randall F.Barron, (1985) *"Cryogenic systems"*, Oxford University press.

REFERENCES

1) R.J.Dossat, (2005) "Principles of Refrigeration", John Wiley and Sons Inc., 6th edition.
2) Manohar Prasad, (2009) "Refrigeration and Air Conditioning", Wiley Eastern Ltd.

Subject Code:	Subject Name : COMPUTATIONAL FLUID DYNAMICS	Ty/Lb /ETL/IE	L	T/ SLr	P/R	C
EBME22E07	Prerequisite: Thermodynamics, Heat and Mass transfer and Fluid Mechanics	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: Students will learn

- Governing equation of fluid dynamics.
- Methods of solving the equations by Finite element and Finite Volume methods

COURSE OUTCOMES (COs) : (3- 5)

CO1	Understand the fundamental knowledge of governing equations and boundary conditions.(Level 2)
CO2	Analyze the conduction problems using finite difference method.(Level 4)
CO3	Solve the fluid flow problems in diffusion using finite volume method.(Level3)
CO4	Apply the one dimensional equation to solve convection problems using finite volume method.(Level 3)
CO5	Calculate the fluid flow field using finite volume method .(Level 4)

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	2	1	1	2	2	2	-	1
CO2	3	3	2	2	2	2	2	2	2	2	-	1
CO3	3	3	2	2	2	2	2	2	2	2	-	1
CO4	3	2	2	2	2	2	2	2	2	2	-	1
CO5	3	2	2	2	2	2	2	2	2	2	-	1

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2
CO2	3	3	2	3
CO3	3	3	2	3
CO4	3	3	2	3
CO5	3	3	2	3

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code:	Subject Name : COMPUTATIONAL FLUID DYNAMICS	Ty/Lb /ETL/IE	L	T/ SLr	P/R	C
EBME22E07	Prerequisite: Thermodynamics, Heat and Mass transfer and Fluid Mechanics	Ty	3	0/0	0/0	3

UNIT- I: GOVERNING EQUATIONS AND BOUNDARY CONDITIONS **8**

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behavior of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

UNIT- II: FINITE DIFFERENCE METHOD **9**

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – solution methods for finite difference equations – Elliptic equations – Iterative solution Methods – Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations.

UNIT- III: FINITE VOLUME METHOD (FVM) FOR DIFFUSION **9**

Finite volume formulation for steady state One, Two and Three -dimensional diffusion problems. One dimensional unsteady heat conduction through Explicit, Crank – Nicolson and fully implicit schemes.

UNIT- IV: FINITE VOLUME METHOD FOR CONVECTION DIFFUSION **10**

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes-properties of discretization schemes – Conservativeness, Boundedness, Trasnportiveness, Hybrid, Power-law, QUICK Schemes.

UNIT- V: CALCULATION FLOW FIELD BY FVM **9**

Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants. Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models

Total No. of Periods: 45

TEXT BOOKS

1) Ghoshdastidar , P.S., (1998) "*Computer Simulation of flow and heat transfer"*, Tata McGraw Hill Publishing Company Ltd.
2) Versteeg, H.K., and Malalasekera, W., (1998) *"An Introduction to Computational Fluid Dynamics: The finite volume Method"*, Longman.

REFERENCES

1) *Patankar, S.V. (2004) "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation.*
2) *Muralidhar, K., and Sundararajan, T., (1995) "Computations Fluid Flow and Heat Transfer", Narosa Publishing House, NewDelhi.*

Subject Code:	Subject Name : TURBO MACHINES	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E08	Prerequisite: Fluid Mechanics, Thermal Engineering	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE: The course aims at giving an overview of different types of turbo machinery used for energy transformation, such as pumps, fans, compressors, as well as hydraulic, steam and gas-turbines.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Understand the concepts of turbo machines and its applications. (Level 2)
CO2	Analyze the performance of turbo machines using first law of thermodynamics. (Level 4)
CO3	Solve the turbo machines problems using velocity triangle concepts. (Level 3)
CO4	Understand the working principles of centrifugal and axial flow and radial flow compressors (Level 2)
CO5	Calculate stage losses, stage efficiency and pressure ratio in axial flow and radial flow turbine . (Level 3)

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	-	1	1	1	1	1	-	1
CO2	3	3	2	1	-	1	1	1	1	2	-	1
CO3	3	3	3	1	-	1	1	1	1	2	-	1
CO4	3	3	2	-	-	1	1	1	1	1	-	1
CO5	3	3	2	1	-	1	1	1	1	2	-	1

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1
CO2	3	2	2	1
CO3	3	2	2	1
CO4	3	2	2	1
CO5	3	2	2	1

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code:	Subject Name : TURBO MACHINES	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E08	Prerequisite: Fluid Mechanics Thermal Engineering	Ty	3	0/0	0/0	3

UNIT- 1 INTRODUCTION **9**

Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Application of first and second laws of thermodynamics to turbo machines.

UNIT- 2 ENERGY EXCHANGE IN TURBOMACHINES **9**

Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor.

UNIT- 3 CENTRIFUGAL COMPRESSORS **9**

Construction details, types, impeller flow losses, slip factor, diffuser analysis losses and performance curves.

UNIT- 4 AXIAL AND RADIAL FLOW COMPRESSORS **9**

Axial and radial flow compressors and pumps– general analysis, Effect of blade discharge angle on performance, Theoretical head – capacity relationship.

UNIT- 5 AXIAL AND RADIAL FLOW TURBINES **9**

Velocity diagrams, losses and coefficients, blade design principles, testing and performance characteristics.

Total No. of Periods 45

TEXT BOOKS:

1. Gas Turbine, V.Ganesan, Tata McGraw Hill Co. Ltd., 3rd edition, 2010
2. Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw HillCo. Ltd., 2nd edition, 2002

REFERENCE BOOKS:

2. D. G. Shepherd, "Principals of Turbo machines" , the Macmillan Company (1964).
3. , S. L.Dixon, "Fluid Mechanics & Thermodynamics of Turbo machines", Elsevier (2005).
4. B.K.Venkanna, "Turbomachine", PHI, New Delhi 2009.
5. M. S. Govindgouda and A. M.Nagaraj, "A Text Book of Turbomachines", , M. M. Publications, 4Th Ed, 2008.
6. V. Kadambi and Manohar Prasad, "An Introduction to Energy Conversion, Volume III, Turbo machinery", New Age International Publishers, reprint 2008.

PROGRAM ELECTIVE
DESIGN ENGINEERING

Subject Code: EBME22E09	Subject Name: MECHANICAL VIBRATIONS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Pre requisite: Strength of materials; Mechanics of Machines- II.	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- Multi degree of freedom system in different modes.
- Vibration measurement techniques.

OURSE OUTCOMES (COs) :

CO1	Understand the fundamentals of vibration systems. (Level 2)
CO2	Evaluate the Natural frequency of Longitudinal and Transverse vibration system. (Level 5)
CO3	Analyze the torsional vibration system at different modes.(Level 4)
CO4	Solve free, damped and forced vibration systems of single, Two and multi degree of freedom. (Level 3)
CO5	Acquire knowledge in various vibration measurement systems.(Level 2)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	1	1	1	1	-	-	-	2	2	-	2
CO2	3	3	3	3	2	-	-	-	2	2	1	2
CO3	3	3	3	3	2	-	-	-	2	2	1	2
CO4	3	2	3	3	2	-	-	-	2	2	1	2
CO5	3	2	1	1	1	-	-	-	2	2	-	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	2	2	1				
CO2	3	2	2	2				
CO3	3	2	2	2				
CO4	3	2	2	2				
CO5	3	2	2	1				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code:	Subject Name : MECHANICAL VIBRATIONS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E09	Prerequisite: Strength of Materials, Mechanics of Machines-II	Ty	3	0/0	0/0	3

UNIT- I:INTRODUCTION **9**

Relevance of and need for vibration Analysis- Mathematical Modelling of Vibrating Systems – Discrete and Continuous Systems – Review of Single degree of Freedom Systems – Free and Forced Vibrations, Various Damping Models

UNIT- II:TWO DEGREE-OF-FREEDOM SYSTEMS **9**

General Solution to Free vibration problem-Damped Free Vibration, Forced Vibration of un-damped System – Dynamic Vibration Absorbers-Technical Applications.

UNIT- III:MULTI-DEGREE OF FREEDOM SYSTEMS **9**

Free and Forced Vibrations of multi-degree of freedom systems in longitudinal, torsional and lateral modes – Matrix methods of solution – normal modes – orthogonal principle- energy methods, Introduction to vibration of plates.

UNIT- IV: CONTINOUS SYSTEMS **9**

Torsional vibrations – Longitudinal vibrations of rods – Transverse vibrations of beams- Governing equations of motion – Natural frequencies and normal modes – energy methods.

UNIT- V:VIBRATION MEASUREMENT **9**

Vibration monitoring-Data Acquisition- Vibration parameter selection – vibration sensors-accelerometers-Performance characteristics-sensor location-signal pre-amplification – vibration meters-vibration signatures-standards-vibration testing equipment-in-site, Balancing of rotors.

Total No. of Periods: 45

TEXT BOOK

1) J.S.Rao and K.Gupta, (1999)"Introductory Subject on Theory and Practice of Mechanical Vibrations", Wiley Eastern Ltd.

REFERENCES

1) *P.Srinivasan, (1990)"Mechanical Vibration Analysis", Tata-McGraw Hill, New Delhi.*
2) *G.K.Grover, (2006)"Mechanical Vibrations", New Chand and Bros, Roorkey.*

Subject Code:	Subject Name: DESIGN OF PRODUCTION TOOLS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E10	Prerequisite: Manufacturing Technology, Design of machine elements	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- The design of jigs and fixtures.
- Different types of press tools and various elements of a press tools.
- To impart knowledge in basics, design and drawing of production tools

COURSE OUTCOMES (COs) :

CO1	Understand the different elements and principles of jigs and fixtures (Level 2)
CO2	Select and create a jig for a given component (Level 7)
CO3	Select and create a fixture for a given component (Level 7)
CO4	Understand the sheet metal operations, elements and die design process (Level 4)
CO5	Select and create a press tool for a given component (Level 7)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	3	3	2	2	3	2	3	2
CO2	3	3	3	3	3	3	2	2	3	2	3	2
CO3	3	3	3	3	3	3	2	2	3	2	3	2
CO4	3	2	2	-	3	3	2	2	3	2	3	2
CO5	3	3	3	3	3	3	2	2	3	2	3	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3
CO2	3	3	2	3
CO3	3	3	2	3
CO4	3	3	2	3
CO5	3	3	2	3

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code:	Subject Name : DESIGN OF PRODUCTION TOOLS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E10	Prerequisite: Manufacturing Technology, Design of machine elements	Ty	3	0/0	0/0	3

UNIT- I: LOCATING AND CLAMPING PRINCIPLES **9**

OBJECTIVES of tool design- Function and advantages of Jigs and fixtures , Basic elements-principles of location .Locating methods and devices , Principles of clamping Mechanical actuation ,pneumatic and hydraulic actuation. Standard parts , Drill bushes and Jig buttons , Tolerances and materials used.

UNIT- II: JIGS **9**

Design and development of jigs and fixtures for given component- Types of Jigs -Post, Turnover, Channel, latch, box, pot, angular post jigs , Indexing jigs ,automatic drill jigs- rack and pinion operated air operated jigs - Design and drawing of channel, box, indexing and angular post jigs

UNIT- III: FIXTURES **9**

General principles of milling, Lathe, boring, broaching and grinding fixtures and shaping fixtures .Assembly, Inspection and Welding fixtures , Modular fixtures . Design and drawing of turning, milling and grinding fixtures

UNIT- IV: PRESS WORKING **9**

Press Working Terminologies - operations ,Types of presses , press accessories , Computation of press capacity , Strip layout , Material Utilization , Shearing action ,Clearances ,Press Work Materials , Center of pressure, recent trends in tool design- computer Aids for sheet metal forming Analysis

UNIT- V: ELEMENTS OF CUTTING, BENDING, FORMING AND DRAWING DIES **9**

Design of various elements of dies, Die Block, Punch holder, Die set, Stops, Strippers, Pilots - Selection of Standard parts. Design and drawing of simple blanking, piercing, compound and progressive dies.

Total No. of Periods: 45

TEXT BOOKS

1) Joshi, P.H. (2004) *"Jigs and Fixtures"*, Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi.
2) Donaldson, Lecain and Goold, (2000) "*Tool Design"*, III rd Edition, Tata McGraw Hill.

REFERENCES

1) K.Venkataraman, (2005) "Design of Jigs Fixtures & Press Tools", Tata McGraw Hill, New Delhi.
2) Kempster, (1974) " Jigs and Fixture Design", Hoddes and Stoughton " Third Edition.
3) Joshi, P.H. Press Tools (2006) "Design and Construction", Wheels publishing, 2 edition
4) Hoffman, "Jigs and Fixture Design", Thomson Delmar Learning, Singapore
5) "Design Data Hand Book", PSG College of Technology, Coimbatore.

Subject Code:	Subject Name : DESIGN OF MATERIAL HANDLING EQUIPMENTS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E11	Prerequisite: Design of Machine Elements.	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- Design of different types of material handling systems used for engineering and process industries.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Understand the basic principles of material handling equipments. (Level 2)
CO2	Apply the design knowledge of various drives for material handling equipments. (Level 3)
CO3	Differentiate various types of material handling device based on application. (Level 4)
CO4	Design and application of Hoist, Cranes, Conveyors and Elevators. (Level 6)
CO5	Selection of material handling device for different applications. (Level 5)

Mapping of Course with Program Outcomes (Pos)

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

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	3	2				
CO2	3	3	3	2				
CO3	3	3	3	2				
CO4	3	3	3	2				
CO5	3	3	3	2				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code:	Subject Name : DESIGN OF MATERIAL HANDLING EQUIPMENTS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E11	Prerequisite: Design of Machine Elements.	Ty	3	0/0	0/0	3

UNIT- I: INTRODUCTION TO MATERIALS HANDLING EQUIPMENT **9**

Overview - consideration in material handling system design, ten principles of material handling. Types of material handling equipments-trolleys, industrial trucks, AGV, monorails and other rail guided vehicles, conveyors, cranes, hoists and elevators.

UNIT- II: DESIGN OF HOISTS **9**

Design of hoisting elements: Welded and roller chains - Hemp and wire ropes - Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs - lifting magnets - Grabbing attachments - Design of arresting gear - Brakes: shoe, band and cone types.

UNIT- III: DRIVES OF HOISTING GEAR **9**

Hand and power drives - Travelling gear - Rail travelling mechanism - cantilever and monorail cranes - slewing, jib and luffing gear - cogwheel drive - selecting the motor ratings.

UNIT- IV: CONVEYORS **9**

Types - description - design and applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors.

UNIT- V: ELEVATORS **9**

Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices - Design of fork lift trucks.

Total No. of Periods: 45

***NOTE:** Use of Approved Data Book is permitted in examination

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TEXT BOOKS:

1. Rudenko, N. (1970) *Materials handling equipment*. ELnvee Publishers
2. Mikell Groover, P. (2006) *Automation, Production system and computer integrated Manufacturing*. Second Edition, Prentice Hall of India Pvt. Ltd

REFERENCES

1. *Alexandrov, M. (1981) Materials Handling Equipments. MIR Publishers*
2. *Boltzharol, A. (1958) Materials Handling Handbook. The Ronald Press Company*
3. *P.S.G. Tech, (2003) Design Data Book. Kalaikathir Achchagam*
4. *Lingaiah. K. and Narayana Iyengar, (1983) Machine Design Data Hand Book. Vol.1 & 2, Suma Publishers*
5. *Spivakovsy, A.O. and Dyachkov, V.K. (1985) Conveying Machines. Volumes I and II, MIR Publishers*

Subject Code:	Subject Name : APPLIED TRIBOLOGY	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E12	Prerequisite: Engineering Mechanics, Fluid Mechanics and Machineries	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE: The student will learn

- To impart knowledge in the friction , wear and lubrication aspects of machine components.
- To understand the material properties which influence the tribological characteristics of surfaces.
- To understand the analytical behavior of different types bearings and design of bearings based on analytical /theoretical approach.

COURSE OUTCOMES (COs) : (3- 5) The student will able to

CO1	Understand the fundamental concepts of friction wear and surface treatments. (Level 2)
CO2	Apply the knowledge of wear and surface treatment in metals and non-metals. (Level 3
CO3	Expose to lubrication in hydrodynamic and hydrostatic bearings. (Level 2)
CO4	Analyze the theory of elasto-hydrodynamic lubrication. (Level 4)
CO5	Illustrate the behavior of tribological components using different working conditions. (Level 3)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**1**	**2**	**1**	**1**	**1**	**-**	**1**	**1**	**1**	**1**
CO2	**3**	**3**	**1**	**3**	**1**	**1**	**1**	**-**	**1**	**1**	**1**	**1**
CO3	**3**	**3**	**1**	**3**	**1**	**1**	**1**	**-**	**1**	**1**	**1**	**1**
CO4	**3**	**3**	**1**	**3**	**1**	**1**	**1**	**-**	**1**	**1**	**1**	**1**
CO5	**3**	**3**	**1**	**3**	**1**	**1**	**1**	**-**	**1**	**1**	**1**	**1**
Cos / PSOs	**PSO1**		**PSO2**		**PSO3**		**PSO4**					
CO1	**3**		**2**		**1**		**2**					
CO2	**3**		**2**		**1**		**2**					
CO3	**3**		**2**		**1**		**2**					
CO4	**3**		**2**		**1**		**2**					
CO5	**3**		**2**		**1**		**2**					

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project
					✓				

Subject Code:	Subject Name : A P P L I E D TRIBOLOGY	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E12	Prerequisite: Engineering Mechanics, Fluid Mechanics and Machineries	Ty	3	0/0	0/0	3

UNIT- I - SURFACE INTERACTION AND FRICTION **9**

Topography of Surfaces – Surface features-Properties and measurement – Surface interaction –Adhesive Theory of Sliding Friction –Rolling Friction-Friction properties of metallic and non-metallic materials.

UNIT- II WEAR AND SURFACE TREATMENT **9**

Types of wear – Mechanism of various types of wear – Laws of wear –Theoretical wear models-Wear of Metals and Non-metals – Surface treatments – Surface modifications – surface coatings methods

UNIT- III LUBRICANTS AND LUBRICATION REGIMES **9**

Lubricants and their physical properties- Viscosity and other properties of oils –Additives-and selection of Lubricants- Lubricants standards ISO,SAE,AGMA, BIS standards – Lubrication Regimes.

UNIT- IV THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION **9**

Reynolds Equation,-Assumptions and limitations-One and two dimensional Reynolds Equation-Reynolds and Somerfield boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic and Hydrostatic bearings.

UNIT- V HIGH PRESSURE CONTACTS **9**

Rolling contacts of Elastic solids- contact stresses – Hertzian stress equation- Spherical and cylindrical contacts- Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubrication Theory-Soft and hard EHL-Reynolds equation for elasto hydrodynamic lubrication

Total No. of Periods: 45

TEXT BOOKS:

1. Rabinowicz.E, “Friction and Wear of materials”, John Willey &Sons ,UK,1995
2. Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981

REFERENCES

1. *Halling, J. (Editor) – “Principles of Tribology “, Macmillian – 1984.*
2. *Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994.*
3. *S.K.Basu, S.N.Sengupta & B.B.Ahuja ,”Fundamentals of Tribology”, Prentice –Hall of India Pvt Ltd , New Delhi, 2005*
4. *G.W.Stachowiak & A.W .Batchelor , Engineering Tribology, Butterworth-Heinemann, UK, 2005*

Subject Code:	Subject Name: DESIGN FOR MANUFACTURE AND ASSEMBLY	T/L/ETL	L	T/ SLr	P/R	C
EBME22E13	Pre requisite: Strength of Materials, Design of Machine Elements-I, Manufacturing Technology-I	T	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Practical R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The purpose of study is to impart the general design, manufacturing and assembly principles in ease of manufacturing.

COURSE OUTCOMES (COs) : The students will be able to

CO1	Understand the basic principles of Manufacturability. (Level 2)
CO2	Distinguish the various types of form design in casting, forging and machining. (Level 4)
CO3	Analyze and redesign the component for the ease of manufacturing. (Level 4)
CO4	Exposure to modern tool like Computer aided Design for Assembly. (Level 2)
CO5	Analyze and evaluate Design for assembly through case studies. (Level 4)

Mapping of Course Outcomes with Program Outcomes (POs)

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

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	2	2				
CO2	3	3	2	2				
CO3	3	3	2	2				
CO4	3	3	2	2				
CO5	3	3	2	2				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code:	Subject Name : DESIGN FOR MANUFACTURE AND ASSEMBLY	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E13	Prerequisite: Manufacturing Technology-I	Ty	3	0/0	0/0	3

UNIT- I: INTRODUCTION **9**

General design principles for manufacturability - strength and mechanical factors, Process capability - Feature tolerances - Geometric tolerances - Assembly limits -Datum features - Tolerance stacks.

UNIT- II: FORM DESIGN - CASTING **9**

Production methods on form design - Casting considerations - Requirements and rules - Redesign of components for castings and Case studies.

UNIT- III: FORM DESIGN - FORGING **9**

Forging considerations - Requirements and rules - Redesign of components for forging and Case studies.

UNIT- IV: FORM DESIGN - MACHINING **9**

Machining considerations - Requirements and rules -Redesign of components for Machining and Case studies.

UNIT- V: DESIGN FOR ASSEMBLY METHODS **9**

Approaches to design for assembly - Qualitative evaluation procedures, knowledge based approach, Computer aided DFA methods. Assemblability measures. Boothroyd - Dewhurst DFA method - Redesign of a simple product - Case studies.

Total No. of Periods: 45

TEXT BOOKS:

1. Harry Peck, (1983) Design *for Manufacture*. Pittman Publication
2. Alan Redford and Chal, (1994) *Design for Assembly - Principles and Procedures*. McGraw Hill International

REFERENCES

1. *Robert Matousek, (1963) Engineering Design - A Systematic Approach. Blackie & Sons Ltd*
2. *James G. Bralla, (1986) Hand Book of Product Design for Manufacturing. McGraw Hill Co*
3. *Swift, K.G. (1987) Knowledge Based Design for Manufacture.*

Subject Code:	Subject Name: MECHANICS OF FRACTURE	Ty/Lb/ ETL/IE	L	T/ SLr	P/R	C
EBME22E14	Pre requisite: Strength of Materials, Engineering Metallurgy	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- Solid mechanics of cracked components of different modes by which these components fail under static and fatigue load conditions.

OURSE OUTCOMES (COs) : The student will be able to

CO1	Identify the various failure mechanisms in different materials. (Level 2)
CO2	Evaluate fracture toughness using linear fracture tests. (Level 5)
CO3	Apply the crack driving force in linear and non-linear materials. (Level 4)
CO4	Estimate the life of fatigue crack growth for both linear and nonlinear materials. (Level 3)
CO5	Employ the knowledge of fracture mechanics in engineering application. (Level 3)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	2	2	-	2	2	1	2
CO2	3	3	3	3	2	2	2	-	2	2	1	2
CO3	3	3	3	3	2	2	2	-	2	2	1	2
CO4	3	3	3	3	2	2	2	-	2	2	1	2
CO5	3	3	3	3	2	2	2	-	2	2	1	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2
CO2	3	3	1	2
CO3	3	3	1	2
CO4	3	3	1	2
CO5	3	3	1	2

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code: EBME22E14	Subject Name : MECHANICS OF FRACTURE	Ty/Lb/ ETL/IE	L	T/ SLr	P/R	C
	Prerequisite: Strength of Materials, EngineeringMetallurgy	Ty	3	0/0	0/0	3

UNIT- I ELEMENTS OF SOLID MECHANICS **9**

The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation - limit analysis – Airy's function – field equation for stress intensity factor.

UNIT- II STATIONARY CRACK UNDER STATIC LOADING **9**

Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation - plastic zone size – Dugdaale model – determination of J integral and its relation to crack opening displacement.

UNIT- III ENERGY BALANCE AND CRACK GROWTH **9**

Griffith analysis – stable and unstable crack growth –Dynamic energy balance – crack arrest mechanism –K1c test methods - R curves - determination of collapse load.

UNIT- IV FATIGUE CRACK GROWTH CURVE **9**

Empirical relation describing crack growth law – life calculations for a given load amplitude – effects of changing the load spectrum -- rain flow method– external factors affecting the K1c values.- leak before break analysis.

UNIT- V APPLICATIONS OF FRACTURE MECHANICS **9**

Crack Initiation under large scale yielding – thickness as a design parameter – mixed mode fractures - crack instability in thermal and residual stress fields - numerical methods

Total No. of Periods: 45

TEXT BOOKS:

1. David Broek, "Elementary Engineering Fracture Mechanics ", Fifthoff and Noerdhoff International Publisher, 1978.
2. 2. Kare Hellan, "Introduction of Fracture Mechanics", McGraw-Hill Book Company, 1985.

REFERENCES:

1. Preshant Kumar, "Elements of Fracture Mechanics", Wheeler Publishing, 1999.
2. John M.Barson and Stanely T.Rolfe Fatigue and fracture control in structures Prentice hall Inc. Englewood, 1977.
3. Tribikram Kundu, "Fundamentals of Fracture Mechanics", Ane Books Pvt. Ltd. New Delhi/ CRC Press, 2012

Subject Code:	Subject Name: DESIGN THINKING AND INNOVATION	Ty/Lb/ ETL/IE	L	T/ SLr	P/R	C
EBME22E15	Pre requisite:	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- Solid mechanics of cracked components of different modes by which these components fail under static and fatigue load conditions.

OURSE OUTCOMES (COs) :

CO1	Understand the fundamental concepts of design thinking
CO2	Apply the knowledge of design thinking process in product development
CO3	Innovate the new idea for product creations
CO4	Develop the product design and strategies
CO5	Create a new business idea for a startup.

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2	3	2			2		2
CO2	3	3	2	3	2	3	2			2		2
CO3	3	3	2	3	2	3	2			2		2
CO4	3	3	2	3	2	3	2			2		2
CO5	3	3	2	3	2	3	2			2		2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4								
CO1	2	3	3	2								
CO2	2	3	3	2								
CO3	2	3	3	2								
CO4	2	3	3	2								
CO5	2	3	3	2								

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code:	Subject Name: DESIGN THINKING AND INNOVATION	Ty/Lb/ ETL/IE	L	T/ SLr	P/R	C
EBME22E15	Pre requisite:	Ty	3	0/0	0/0	3

Unit I Introduction to Design Thinking **9**

Introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry.

Unit II Design Thinking Process **9**

Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking -person, costumer, journey map, brain storming, product developmentActivity:Every student presents their idea in three minutes, Every student can present design process in the form of flow diagram or flow chart etc. Every student should explain about product development.

Unit III Innovation **9**

Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations. Creativity to Innovation. Teams for innovation, Measuring the impact and value of creativity. Activity: Debate on innovation and creativity, Flow and planning from idea to innovation, Debate on value-based innovation.

Unit IV Product Design **9**

Problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications. Innovation towards product design Case studies. Activity: Importance of modeling, how to set specifications, Explaining their own product design.

Unit V Design Thinking in Business Processes

Design Thinking applied in Business & Strategic Innovation, Design Thinking principles that redefine business –Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization. Design thinking to meet corporate needs. Design thinking for Startups. Defining and testing Business Models and Business Cases. Developing & testing prototypes. Activity: How to market our own product, About maintenance, Reliability and plan for startup.

Text Books

1. Change by design, Tim Brown, Harper Bollins (2009)
2. Design Thinking for Strategic Innovation, Idris Mootee, 2013, John Wiley & Sons.

Reference Books

1. Design Thinking in the Classroom by David Lee, Ulysses press
2. Design the Future, by Shrrutin N Shetty, Norton Press
3. Universal principles of design-William lidwell, kritinaholden, Jill butter.
4. The era of open innovation –chesbrough.H

PROGRAM ELECTIVE
MANUFACTURING ENGINEERING

Subject Code:	Subject Name : INDUSTRIAL ROBOTICS	Ty/Lb/ETL	L	T/SLr	P/R	C
EBME22E16	Prerequisite: Industrial Automation	Ty	3	0/0	0/0	3

L : Lecture T : TutorialSLr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: To give an understanding to the student with respect to:

- Basic components of an industrial robot and Sensors used in robots
- Robot programming methods and Robot applications

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COURSE OUTCOMES (COs) :

CO1	Understand the basic concepts of a robot (Level 2)
CO2	Identify and apply the different components and operation with respect to robot (Level 3)
CO3	Recognize the various types of sensors and machine vision concepts and its applications (Level 3)
CO4	Write programme for robot (Level 4)
CO5	Design the robot cell and state its applications (Level 4)

Mapping of Course Outcomes with Program Outcomes (Pos)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	3	2	2	3	3	3	2
CO2	3	3	3	3	3	3	2	2	3	3	3	2
CO3	3	3	2	2	3	3	2	2	3	3	3	2
CO4	3	3	3	3	3	3	2	2	3	3	3	2
CO5	3	3	3	3	3	3	2	2	3	3	3	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	2	3				
CO2	3	3	2	3				
CO3	3	3	2	3				
CO4	3	3	2	3				
CO5	3	3	2	3				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code: EBME22E16	Subject Name : INDUSTRIAL ROBOTICS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Industrial Automation	Ty	3	0/0	0/0	3

UNIT- I:INTRODUCTION **9**

Definition of a Robot – Basic Concepts –- Robot components –manipulator-configurations –joints- degree of freedom. Types of Robot Drives – Basic Robot Motion types – Point to Point Control – Continuous Path Control.

UNIT- II:COMPONENTS AND OPERATIONS **9**

Basic Control System Concepts – open loop and closed loop control-Control System Analysis – Robot Actuation and Feed Back, Manipulators – Direct and Inverse Kinematics, Co-ordinate Transformation – Brief Robot Dynamics, Types of Robot and Effectors – Grippers – Tools as End Effectors – Robot / End Effort Interface.

UNIT- III:SENSING AND MACHINE VISION **9**

Range Sensing – Proximity Sensing – Touch sensing – Force and Torque Sensing. Introduction to Machine Vision – functions and applications.

UNIT- IV:ROBOT PROGRAMMING **9**

Methods – Languages –programming for pick and place applications-palletizing. Capabilities and Limitation – Artificial Intelligence – Knowledge Representation – Search Techniques – AI and Robotics.

UNIT- V:ROBOT CELL DESIGN AND APPLICATIONS **9**

Robot cell design-types and control.

Applications of Robots –process applications in welding and painting – Assembly applications– Material Handling applications.

Total No. of Periods : 45

TEXT BOOK

1) K. S. Fu, R. C. Gonalez, C.S.G. Lee, *"Robotics Control Sensing Vision and Intelligence"*, McGraw Hill International Edition, 10987.

REFERENCES

1) *Mikell P. Groover, Mitchell Weiss, (2008) "Industrial Robotics, Technology, Programming and Application", Tata McGraw Hill International Editions, 10986.*
2) *Richard D. Klafter, Thomas A. Chonieleswski and Michael Negin, (1989) "Robotic Engineering – An Integrated Approach", Prentice Hall Inc., Englewoods Cliffs, NJ, USA, 109809.*

Subject Code:	Subject Name: NON-CONVENTIONAL MACHINING TECHNIQUES	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E17	Prerequisite: Manufacturing Technology I & II	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- To understand basics of Non conventional machining techniques
- To impart knowledge on various non conventional machining process
- To know the applications of non conventional machining techniques in various fields

COURSE OUTCOMES (COs) :

CO1	Explain the principle, advantage and limitations of different Non conventional machining processes. (Level 2)
CO2	Compare the different non conventional processes for their capability (Level 4)
CO3	Understand the different process parameters and its effect on material removal (Level 2)
CO4	Incorporate the hybrid processes to take advantages of different processes (Level 4)
CO5	Identify and use a suitable machining process based on their requirement (Level 3)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	2	3	2	3	2	3	2
CO2	3	3	2	2	3	2	3	2	3	2	3	2
CO3	3	3	2	2	3	2	3	2	3	2	3	2
CO4	3	3	2	2	3	2	3	2	3	2	3	2
CO5	3	3	2	2	3	2	3	2	3	2	3	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	2	3				
CO2	3	3	2	3				
CO3	3	3	2	3				
CO4	3	3	2	3				
CO5	3	3	2	3				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code:	Subject Name : NON CONVENTIONAL MACHINING TECHNIQUES	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E17	Prerequisite: Manufacturing Technology I & II	Ty	3	0/0	0/0	3

UNIT- I: INTRODUCTION, ELECTRICAL DISCHARGE MACHINING **10**

Need For Unconventional Processes – Classification - Electrical Discharge Machining Processes, Operating Principles – Dielectric – Electrode Material – Tool/Wear – Processes Parameters – Metal Removal Rate – Applications – Current Developments In EDM.

UNIT- II: ELECTRO CHEMICAL MACHINING **8**

Electro Chemical Machining Process – Principles – Equipments – Metal Removal Analysis - Tool Material – Insulation – Process Parameters – ECH,ECG Etc., – Applications.

UNIT- III: ELECTRON BEAM, LASER BEAM AND PLASMA ARC MACHINING **9**

EBM process - principle - Gun construction - vacuum and non-vacuum technique – applications. LBM process, principles, pumping processes, Types of Emission- Beam control – Applications.

UNIT- IV: ULTRASONIC MACHINING **8**

Ultrasonic Machining Processes – Working Principles – Transducers – Concentrators - Nodal Point Clamping - Feed Mechanism - Metal Removal Rate – Process Parameters – Applications.

UNIT- V: ABRASIVE, WATER JET AND HYBRID MACHINING **10**

AJM Processes – Principle – Equipment – Metal Removal Rate – Process Parameters – Applications. WJM Process – Principle – Equipment – Applications. Introduction to hybrid machining-Electro Chemical Discharge Machining, Abrasive electrical discharge grinding-Principle, advantages, limitations and applications.

Total No. of Periods : 45

TEXT BOOKS

1) P.K.Mishra (1997) *"Non Conventional Machining"*. The Institution Of Engineers (India) text book Series
2) Vijay.K. Jain (2007) *"Advanced Machining Processes"* Allied Publishers Pvt. Ltd., New Delhi

REFERENCES

1) *Benedict. G.F. (1987) "Nontraditional Manufacturing Processes" Marcel Dekker Inc., New York.*
2) *Pandey P.C. and Shan H.S. (2007) "Modern Machining Processes" Tata McGraw-Hill, New Delhi.*
3) *Mc Geough, (1998) "Advanced Methods of Machining" Chapman and Hall, London.*
4) *Paul De Garmo, J.T.Black, and Ronald.A.Kohser, (2001) "Material and Processes in Manufacturing", Prentice Hall of India Pvt. Ltd., New Delhi ,8th Edition.*
5) *P.C.Sharma, (1995) "TEXT BOOK of Production Engineering".*

Subject Code: EBME22E18	Subject Name: PROCESS PLANNING AND COST ESTIMATION	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: **Manufacturing Technology I & II**	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- Process planning activities
- Various elements of cost of a product.
- Methods of computer aided process planning

COURSE OUTCOMES (COs) :

CO1	Understand the method of planning the various machining processes (Level 2)
CO2	Analyze and describe the step by step procedure for manufacturing (Level 4)
CO3	Apply computers for advanced process planning (Level 3)
CO4	Discuss the various cost involved in manufacturing of component or product (Level 2)
CO5	Evaluate and identify the economic method of manufacturing (Level 6)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	3	3	3	3	2
CO2	3	3	3	3	3	2	2	3	3	3	3	2
CO3	3	3	3	3	3	2	2	3	3	3	3	2
CO4	3	3	3	3	3	2	2	3	3	3	3	2
CO5	3	3	3	3	3	2	2	3	3	3	3	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	3	3				
CO2	3	3	3	3				
CO3	3	3	3	3				
CO4	3	3	3	3				
CO5	3	3	3	3				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code:	Subject Name : PROCESS PLANNING AND COST ESTIMATION	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E18	Prerequisite: Manufacturing Technology I & II	Ty	3	0/0	0/0	3

UNIT- I: PROCESS PLANNING **9**

Definition – OBJECTIVES – Scope – approaches to process planning- Process planning activities – Finished part requirements- operating sequences- machine selection –material selection parameters- Set of documents for process planning- Developing manufacturing logic and knowledge- production time calculation – selection of cost optimal processes.

UNIT- II: COMPUTER AIDED PROCESS PLANNING **9**

Variant process planning - Generative approach -Forward and Backward planning, Input format, Logical Design of a Process Planning - Implementation considerations. Application of computer software's in process planning.

UNIT- III: ELEMENTS OF COST **9**

Introduction - Importance and aims of Cost estimation - Estimation procedure. Material Cost - Determination of Material Cost Labour Cost - Determination of Direct Labour Cost - Expenses - Cost of Product (Ladder of cost) - Illustrative examples. Analysis of overhead expenses - Factory expenses - Depreciation - Causes of depreciation - Methods of depreciation - Administrative expenses - Selling and Distributing expenses - Allocation of overhead expenses.

UNIT- IV: PRODUCT COST ESTIMATION **9**

Estimation in forging shop - Losses in forging - Forging cost - Illustrative examples. Estimation in welding shop - Gas cutting - Electric welding - illustrative examples. Estimation in foundry shop - Estimation of pattern cost and casting cost - Illustrative examples.

UNIT- V: ESTIMATION OF MACHINING TIME AND COST **9**

Estimation of machining time and cost for Lathe operations - Estimation of machining time and cost for drilling, boring, shaping, planning, milling and grinding operations - Illustrative examples. Value engineering - cost reduction

Total No. of Periods : 45

TEXT BOOKS

1) M.Adithan and B.S. Pabla, (1989) *"Estimating and Costing"*, Konark Publishers Pvt. Ltd.
2) V.Jayakumar (2012) *"Process Planning and Cost Estimation"*, Lakshmi Publication.

REFERENCES

1) *Nanua Singh, (1996) "System approach to Computer Integrated Design and Manufacturing",John Wiley & Sons, Inc.*
2) *Joseph G. Monks, (1982) "Operations Management, Theory & Problems", McGraw Hill Book Company.*
3) *T.R. Banga and S.C. Sharma, (2011) "Estimating and Costing", Khanna Publishers, 16thEdition*
4) *Sadhu singh, (2002) "Computer aided Design and manufacturing", Khanna publisher ,new delhi, second edition.*

Subject Code:	Subject Name: ADDITIVE MANUFACTURING	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E19	Prerequisite: Manufacturing Technology I & II	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- To understand the fundamental concepts of Additive Manufacturing (i.e. Rapid Prototyping) and 3-D printing, its advantages and limitations
- To classify various types of Additive Manufacturing Processes and know their working principle, advantages, limitations etc
- To have a holistic view of various applications of these technologies in relevant fields such as mechanical, Bio-medical, Aerospace, electronics etc

COURSE OUTCOMES (COs) :

CO1	Describe various CAD issues for 3D printing and rapid prototyping and related operations for STL model manipulation
CO2	Formulate and solve typical problems on reverse engineering for surface reconstruction from physical prototype models through digitizing and spline-based surface fitting.
CO3	Formulate and solve typical problems on reverse engineering for surface reconstruction from digitized mesh models through topological modelling and subdivision surface fitting.
CO4	Explain and summarize the principles and key characteristics of additive manufacturing technologies and commonly used 3D printing and additive manufacturing systems.
CO5	Describe and summarize typical rapid tooling processes for quick batch production of plastic and metal parts.

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	3	2	2	-	-	2	2	-	2
CO2	2	2	2	3	3	2	-	-	2	2	-	2
CO3	2	2	-	3	2	2	-	-	2	2	-	2
CO4	2	2	3	3	2	2	-	-	2	2	-	2
CO5	2	2	3	3	2	2	-	-	2	2	-	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	-
CO2	2	3	3	3
CO3	1	2	2	3
CO4	3	3	3	2
CO5	3	3	3	2

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Ca	Basic Science	Engineering	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code:	Subject Name: ADDITIVE MANUFACTURING	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E19	Prerequisite: Manufacturing Technology I & II	Ty	3	0/0	0/0	3

UNIT – I Introduction: **9**

Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, Commonly used Terms, Classification of RP process, Rapid Prototyping Process Chain: Fundamental Automated Processes.

UNIT – II Liquid-based Rapid Prototyping Systems: 9

Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, Photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies Solid-based Rapid Prototyping Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT – III Powder Based Rapid Prototyping Systems: **9**

Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification; Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, Investment Casting, Spin Casting, Die casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling : Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP

UNIT – IV Rapid Prototyping Data Formats: **9**

STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Rapid Prototyping Software's: Features of various RP software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL view 3 Data Expert and 3 D doctor.

UNIT – V RP Applications: **9**

Application – Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules.

Text Books

1.Rapid prototyping; Principles and Applications /Chua C.K., Leong K.F. and LIM C.S/World Scientific Publications
2. Rapid Manufacturing /D.T. Pham and S.S. Dimov/Springer

Reference Books

1. Terry Wohlers, Wholers Report 2000, Wohlers Associates
2. Rapid Prototyping and Manufacturing /PaulF.Jacobs/ASME

Subject Code:	Subject Name: FLEXIBLE MANUFACTURING SYSTEMS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E20	Prerequisite: Manufacturing Technology I & II; Industrial Automation; CAD/CAM	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- To understand the Modern manufacturing systems
- To understand the concepts and applications of flexible manufacturing systems

COURSE OUTCOMES (COs) :

CO1	Understand the concepts of flexible manufacturing systems (FMS) (Level 2)
CO2	Apply the use of computers in FMS (Level 3)
CO3	Apply the simulation and data base management in FMS (Level 3)
CO4	Justify the implementation of FMS (Level 4)
CO5	Understand the future factory with the application of FMS concepts (Level 2)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	3	2	2	3	3	3	2
CO2	3	3	2	2	3	3	2	2	3	3	3	2
CO3	3	3	3	3	3	3	2	2	3	3	3	2
CO4	3	3	3	3	3	3	2	2	3	3	3	2
CO5	3	3	2	2	3	3	2	2	3	3	3	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	2	3				
CO2	3	3	2	3				
CO3	3	3	2	3				
CO4	3	3	2	3				
CO5	3	3	2	3				

/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code:	Subject Name : FLEXIBLE MANUFACTURING SYSTEMS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E20	Prerequisite: Manufacturing Technology I & II; Industrial Automation; CAD/CAM	Ty	3	0/0	0/0	3

UNIT- I PLANNING, SCHEDULING AND CONTROL OF FLEXIBLE MANUFACTURING SYSTEMS 9

Introduction to FMS - development of manufacturing systems - benefits - major elements of FMS - types of flexibility - FMS application and flexibility –single product, single batch, n - batch scheduling problem - knowledge based scheduling system.

UNIT- II COMPUTER CONTROL AND SOFTWARE FOR FLEXIBLE MANUFACTURING SYSTEMS 9

Introduction - composition of FMS - hierarchy of computer control - computer control of work center and assembly lines - FMS supervisory computer control - types of software specification and selection - trends.

UNIT- III FMS SIMULATION AND DATA BASE 9

Application of simulation - model of FMS - simulation software - limitation - manufacturing data systems - data flow - FMS database systems - planning for FMS database.

UNIT- IV GROUP TECHNOLOGY AND JUSTIFICATION OF FMS 9

Introduction - matrix formulation - mathematical programming formulation - graph formulation - knowledge based system for group technology - economic justification of FMS - application of possibility distributions in FMS systems justification.

UNIT- V APPLICATIONS OF FMS AND FACTORY OF THE FUTURE 9

FMS application in machining, sheet metal fabrication, prismatic component production - aerospace application - FMS development towards factories of the future - artificial intelligence and expert systems in FMS - design philosophy and characteristics for future.

Total No. of Periods: 45

TEXT BOOK:

1. Jha.N.K., “Handbook of flexible manufacturing systems”, Academic Press Inc., 1991.

REFERENCES:

1. Groover M.P., “Automation, production systems and computer integrated manufacturing”, Prentice Hall of India Pvt., New Delhi, 2007.

2. Kalpakjian S., “Manufacturing Engineering and Technology”, Addison-Wesley Publishsing Co., 2013.

3. Radhakrishnan P. and Subramanyan S., “CAD/CAM/CIM”, Wiley Eastern Ltd., New Age International Ltd., 1994.

4. Raouf A. and Daya B.M., “Flexible manufacturing systems: recent development”, Elsevier Science, 1995.

5. Ohno T., “Toyota production system: beyond large-scale production”, Productivity Press (India) Pvt. Ltd., 1992.

Subject Code:	Subject Name: POWDER METALLURGY	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E21	Prerequisite: Materials Science; Engineering Metallurgy	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- To understand basics of powder metallurgy
- To expose various powder metallurgy techniques
- To know the application of powder metallurgy in various fields

COURSE OUTCOMES (COs) : The student will be able to

CO1	Understand the fundamentals of powder metallurgy (Level 2)
CO2	Interpret the characterization parameters of metal powders (Level 3)
CO3	Comparing the different manufacturing methods of components by powder metallurgy(Level 3)
CO4	Analyzing the different sintering theories (Level 4)
CO5	Differentiating and comparing different applications of powder metallurgy (Level 3)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	3	1	2	2	2	2	1	2
CO2	3	2	2	1	3	3	3	2	2	2	-	2
CO3	3	2	2	1	3	3	3	2	2	2	-	2
CO4	3	2	2	1	3	3	3	2	2	2	-	2
CO5	3	2	2	1	3	3	3	2	2	2	3	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	3
CO2	3	2	3	3
CO3	2	2	2	2
CO4	3	2	3	2
CO5	3	2	3	3

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code:	Subject Name :POWDER METALLURGY	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E21	Prerequisite: Engineering Metallurgy	Ty	3	0/0	0/0	3

UNIT- I INTRODUCTION OF POWDER METALLURGY AND PRODUCTION OF METAL POWDERS **9**

Historical and modern developments in Powder Metallurgy. Advantages, limitations, applications and basic steps involved in Powder Metallurgy. Manufacture of metal powders: Conventional methods and modern methods of metal powder manufacture. Purity of metal powders. Blending techniques.

UNIT- II POWDER CHARACTERIZATION **9**

Powder characterization: problem of size determination. Method of size analysis and surface area assessment.Powder conditioning, fundamentals of powder compaction, density distribution in green compacts, compressibility, green Strength, pyrophorocity and toxicity. Apparent density and flowabilitymeasurement.

UNIT- III POWDER COMPACTION **9**

Powder compaction: Mechanical, thermal and thermomechanical compacting processes. Presses used for transmission. Die design and tooling for consolidation of powders. New methods of consolidation. E.g. Powder rolling, Powder forging, Isostatic pressing. Advantages and limitations of these methods.

UNIT- IV SINTERING PROCESS **9**

Theories of sintering: Sintering mechanism, Roll of diffusion, Recrystallization, Por emigration, Pore-growth and coalescence. Liquid phase sintering and related processes. Effect of compacting pressure, sintering temperature and time on sintered properties. Type of sintering furnaces. Sintering atmospheres.

UNIT- V APPLICATIONS OF POWDER METALLURGY **9**

Manufacturing and application of important P/M components: Porous bearing, Electrical contact materials, Metallic filters, Cemented carbides, magnets, Friction materials and Composites.

Total No. of Periods: 45

Text Books:

1. A. K. Sinha, "*Introduction to Powder Metallurgy"*, Dhanpatrai Publication
2. P. C. Angelo and R. Subramanian, "*Powder Metallurgy: Science, Technology and Applications*",

Reference Books

1. Powder Metallurgy-ASM Vol. II
2. Powder Metallurgy-Sands and Shakespeare
3. Powder Metallurgy-Dixtor R.H. and Clayton.
4. Cemented Tungsten carbide Production, properties and testing-Gopal S. Upadhayay

PROGRAM ELECTIVE
INDUSTRIAL ENGINEERING

Subject Code: EBME22E22	Subject Name: ENTERPRISE RESOURCE PLANNING	Ty/Lb /ETL	L	T/ SLr	P/ R	C
	Pre requisite: Manufacturing Technology I & II; Application of Computer Science Engineering	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial S Lr : Supervised Learning P : Practical R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn:

- Building of business model for resource planning; Impact of IT in ERP

COURSE OUTCOMES (COs) : The student will be able to

CO1	Understand the concepts of ERP (Level 2)
CO2	Build the business Model and implement ERP (Level 4)
CO3	Understand the principles of organizational transformation (Level 2)
CO4	Examine the global Industrial Competition and use Information Technology (Level 4)
CO5	Describe the concepts of Supply Chain Management (Level 2)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	3	2	2	3	3	3	3	2
CO2	3	3	3	3	3	2	2	3	3	3	3	2
CO3	3	2	2	2	3	2	2	3	3	3	3	2
CO4	3	3	3	3	3	2	2	3	3	3	3	2
CO5	3	2	2	2	3	2	2	3	3	3	3	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4			
CO1	3	3	3	3			
CO2	3	3	3	3			
CO3	3	3	3	3			
CO4	3	3	3	3			
CO5	3	3	3	3			

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code:	Subject Name : ENTERPRISE RESOURCE PLANNING	Ty/Lb /ETL	L	T/ SLr	P/R	C
EBME22E22	Prerequisite: Nil	Ty	3	0/0	0/0	3

UNIT- I: INTRODUCTION TO ERP **9**

Integrated Management Information, Seamless Integration - Supply Chain Management- Integrated Data Model- Benefits Of ERP - Business Engineering And ERP- Definition Of Business Engineering - Principle of business engineering - Business engineering with information technology.

UNIT- II: BUSINESS MODELING FOR ERP **9**

Building The Business model - ERP implementation – An Overview – Role Of Consultant, Vendors and Users, Customization – Precautions - ERP Post implementation options ERP Implementation Technology – Guidelines for ERP Implementation.

UNIT- III: INTRODUCTION TO ORGANIZATIONAL TRANSFORMATION **9**

Fundamental elements of organizational transformation - Principles-Methodology -Models (LMI CIP, DSMCQ & PMP) - Process improvements in models (Moen & Nolan strategy, NPRDC, LMI CIP) - Tools and Techniques.

UNIT- IV:GLOBAL INDUSTRIAL COMPETITION AND INFORMATION TECHNOLOGY 9

Coping with competition – the impact and value of IT Systems – impact and value of IT – Value chain of a firm and strategic use of IT – development trends of IT. Introduction to SAP and its applications in ERP.

UNIT- V: SUPPLY CHAIN MANAGEMENT **9**

The concept of supply chain, logistics, customer and supply chain relation, role of IT in supply chain management – strategy and structure of supply chain – factors of supply chain – stages in supply chain progress.

Total No. of Periods: 45

TEXT BOOKS

1) Leon, (2014) "*Enterprise Resource Planning*", McGraw Hill, New Delhi
2) P. N. Rastogi, *"Re-Engineering And Re-inventing the Enterprise*" , Wheeler Publishing
3) Dr. J. A. Edosomwan , (1995) "*Organizational transformation and Process Re-Engineering"* 1 edition.

REFERENCES

1. Jose Antonio Fernandz, (2005) "The SAP R/3 Handbook", TMH, 3 edition
2.Vinod Kumar Garg and N.K.Venkita Krishnan, (2004) "Enterprise Resource Planning Concepts and Practice", PHI. Publishing Co.

Subject Code:	Subject Name: SYSTEM MODELING AND SIMULATION	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E23	Pre requisite:	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn:
The basic system concept and definitions of system;
Different techniques to model and to simulate various systems;
Analyze a system and to make use of the information to improve the performance.

OURSE OUTCOMES (COs) : The students will be able to

CO1	Explain the system concept and apply functional modeling method to model the activities of a static system
CO2	Describe the behavior of a dynamic system and create an analogous model for a dynamic system;
CO3	Simulate the operation of a dynamic system and make improvement according to the simulation results.
CO4	Identify the distribution of data from the collected data
CO5	Create a model building and validate the performance of the model

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	1	1	1		2	2	2	2
CO2	2	2	1	1	1	1	1		2	2	2	2
CO3	2	2	2	1	2	1	1		2	2	2	2
CO4	2	2	1	1	1	1	1		2	2	2	2
CO5	2	2	1	1	1	1	1		2	2	2	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4								
CO1			2	2								
CO2			2	2								
CO3			2	2								
CO4			2	2								
CO5			2	2								

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code:	Subject Name: SYSTEM MODELING AND SIMULATION	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E23	Pre requisite:	Ty	3	0/0	0/0	3

UNIT I Introduction **9**

When simulation is the appropriate tool and when it is not appropriate, Advantages and disadvantages of Simulation; Areas of application, Systems and system environment; Components of a system; Discrete and continuous systems, Model of a system; Types of Models, Discrete-Event System Simulation Simulation examples: Simulation of queuing systems. General Principles.

UNIT II Statistical Models in Simulation **9**

Statistical Models in Simulation:

Review of terminology and concepts, Useful statistical models, Discrete distributions. Continuous distributions, Poisson process, Empirical distributions. General Principles.

Queuing Models:

Characteristics of queuing systems, Queuing notation, Long-run measures of performance of queuing systems, Long-run measures of performance of queuing systems cont…,Steady-state behavior of M/G/1 queue, Networks of queues,

UNIT III Random-Number Generation **9**

Random-Number Generation:

Properties of random numbers; Generation of pseudo-random numbers, Techniques for generating random numbers, Tests
for Random Numbers,

Random Variate Generation:

Inverse transform technique Acceptance-Rejection technique.

UNIT IV Input Modeling **9**

Input Modeling:

Data Collection; Identifying the distribution with data, Parameter estimation, Goodness of Fit Tests, Fitting a non-stationary Poisson process, Selecting input models without data, Multivariate and Time-Series input models.

Estimation of Absolute Performance:

Types of simulations with respect to output analysis ,Stochastic nature of output data, Measures of performance and their estimation, Contd..

UNIT V Measures of performance and their estimation **9**

Measures of performance and their estimation,Output analysis for terminating simulations Continued..,Output analysis for steady-state simulations. Verification, Calibration And Validation: Optimization: Model building, verification and validation, Verification of simulation models, Verification of simulation models,Calibration and validation of models, Optimization via Simulation.

Total No. of Periods: 45

Textbooks:

1. Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicol: Discrete-Event System Simulation, 5th Edition, Pearson Education, 2010.

Reference Books:

1. Lawrence M. Leemis, Stephen K. Park: Discrete – Event Simulation: A First Course, Pearson Education, 2006.

2. Averill M. Law: Simulation Modeling and Analysis, 4 th Edition, Tata McGraw-Hill, 2007

Subject Code: EBME22E24	Subject Name: TOTAL QUALITY MANAGEMENT	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Pre requisite: Manufacturing Technology I & II	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn
Various Principles and Tools of TQM; ISO Standards

OURSE OUTCOMES (COs) :

CO1	Understand the various quality tools and techniques (Level 2)
CO2	Demonstrate the customer satisfaction techniques (Level 3)
CO3	Exposed to quality auditing systems and procedures (Level 2)
CO4	Implement TQM and TPM (Level 4)
CO5	Implement Kaizen and conduct FMEA. (Level 3)

Mapping of Course Outcomes with Program Outcomes (POs)

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

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	2	3				
CO2	3	3	2	3				
CO3	3	3	2	3				
CO4	3	3	2	3				
CO5	3	3	2	3				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code: EBME22E24	Subject Name : TOTAL QUALITY MANAGEMENT	Ty/Lb/ETL	L	T/SLr	P/R	C
	Prerequisite: Manufacturing Technology I & II	Ty	3	0/0	0/0	3

UNIT- I: INTRODUCTION **9**

Definition of Quality, Dimensions, Planning of quality, conformance to specification, Quality costs-. Basic concepts and evolution of Total Quality Management, Principles of TQM, Deming Philosophy Deming prize MBNQA. Barriers to TQM Implementation.

UNIT- II: TQM PRINCIPLES **9**

Customer satisfaction-Customer Perception of Quality, Customer Complaints. Service Quality, Customer Retention. Employee Involvement- Motivation, Empowerment, Teams. Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement-Juran Triology, PDSA Cycle,58,Kaizen.Supplier Partnership- Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures-Basic Concepts. Strategy, Performance Measure.

UNIT- III: STATISTICAL QUALITY CONTROL **9**

The Seven Tools Of Quality, Statistical Fundamentals, Control Charts For Variables And Attributes, Process Capability, Concept Of Six Sigma, Phases And Defective UNIT-s Of Six Sigma .Overview Of GB,BB,MBB Leadership Characteristics ,Leadership Concept , Role Of Senior Management, Lean Management Principle, Strategic Planning New Seven Management Tools.

UNIT- IV: TQM TOOLS **9**

Benchmarking-Reasons to Benchmark, Benchmarking Process. Quality Function Deployment (QFD), pareto, process flow diagram, check sheets and histogram Taguchi Quality Loss Function. Total Productive Maintenance (TPM)-Concept, Improvement Needs, FMEA-Stages of FMEA.

UNIT- V: QUALITY SYSTEMS **9**

Need For ISO 09000 and Other Quality Systems, ISO 09000 – 2000 Quality System -Elements. Implementation Of Quality System, Documentation , Quality Auditing, Quality Council, Quality statements ,Quality Management System TS 1609409, ISO 14000 Concept, Requirements And Benefits. Introduction To Capability Material Management (CMM), People Capability Management (PCM).

Total No. of Periods : 45

TEXT BOOK

1) Dale H Besterfied , "*Total Quality Management"*, Prentice Hall Publishing House

REFERENCES

1) *S.Ramachandran,Dn.S.Jose, "Total Quality Management", Airwalk Publications, First Edition, December.*
2) *Kulneet Suri, (2004 – 05) "Total Quality Management: Priciples & Practce, Tools & Techniques", S.K. Kateria & sons, First Edition,*
3) *James R.Evans & William M.Lidsay, "The Management and Control of Quality", (^{5th} Edition), South Western(Thomson Learning),2002(ISBN 0-324-06680-5).*
4) *Feigenbaum.A.V. "Total Quality Management", Tata Mcgraw-Hill, 109091.*
5) *Oakland.J.S. "Total Quality Management", Butterworth-Heinemann Ltd.,Oxford,109809*
6) *R.S.Nagarajan, A.A.Arivalagar, "Total Quality Management", New Age International (p) Ltd., Publishers, First Edition.*

Subject Code:	Subject Name : FACILITIES PLANNING AND DESIGN	Ty/Lb /ETL	L	T/ SLr	P/R	C
EBME22E25	Prerequisite: Manufacturing Technology-I& II	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab./Embedded Theory and Lab.

OBJECTIVES: The student will learn

- To explain project management for entrepreneurs

COURSE OUTCOMES (COs) : The student will be able to

CO1	Understand the need for Facilities requirement planning, selection of optimum location for the plant/plant layout/material handling system (Level 2)
CO2	Illustrate plant layout & material handling system (Level 3)
CO3	Compare the pros and cons of alternate locations for the plant, plant layouts & material handling systems (Level 4)
CO4	Critically examine/explore the options for plant location, layout & material handling system (Level 5)
CO5	Judge which option is better compared to the rest for: Plant location, Plant layout & material handling system (Level 4)

Mapping of Course Outcomes (COs) with Program Outcomes (POs) & Program Specific Outcomes (PSOs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	3	2	2	2	1	2	2	1
CO2	1	2	2	1	3	1	1	-	-	3	1	1
CO3	3	1	3	2	2	1	1	1	1	3	1	1
CO4	3	3	2	1	2	1	1	-	1	2	1	1
CO5	3	2	1	2	3	1	1	1	1	2	2	1

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	3	2	1	1
CO3	3	2	1	1
CO4	3	2	1	1
CO5	3`	2	1	1

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code:	Subject Name : FACILITIES PLANNING AND DESIGN	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E25	Prerequisite: Manufacturing Technology-I& II	Ty	3	0/0	0/0	3

UNIT I: INTRODUCTION **5**

Facilities planning, significance, objectives, requirement, process, product and schedule design, need for layout study – types of layout

UNIT II: PLANT LOCATION **10**

Plant location analysis – factors, costs, location decisions – single facility location models, multi facility location models- set covering problem – warehouse location problems

UNIT III: LAYOUT DESIGN **10**

Design cycle – SLP procedure, nadler's ideal approach, flow and activity analysis, computerized layout planning procedure – ALDEP, CORELAP, CRAFT

UNIT IV: GROUP TECHNOLOGY AND LINE BALANCING **10**

Group technology – Production Flow analysis (PFA), ROC (Rank Order Clustering) – Line balancing, single, multi and mixed mode, parallel line and parallel station

UNIT V: MATERIAL HANDLING **10**

Principles, unit load concept, material handling system design, handling equipment types, selection and specification, handling cost, containers and packaging

Total No. of Periods: 45

REFERENCES

1. *Tompkins, J.A. and J.A.White,(2003) "Facilities planning", John Wiley*
2. *Richard Francis.L. and John A.White,(2002) "Facilities Layout and location - an analytical approach", PHI*
3. *James Apple.M,(1977) "Plant layout and Material Handling", John Wiley*
4. *Pannerselvam,R,(2007) "Production and Operations Management", PHI*

Subject Code: EBME22E26	Subject Name : QUALITY ENGINEERING	Ty/Lb/ETL	L	T/ SLr	P/R	C
	Prerequisite: Nil	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab./Embedded Theory and Lab.

OBJECTIVE: The student will learn:

- Basic conceptual idea of Supply Chain Management systems and its internal structural systems; also focused the theory and applications of SCM Networks with simple case study

COURSE OUTCOMES (COs) :

CO1	Recall/Explain basic Quality concepts, foundation for this course (Level 2)
CO2	Illustrate Control Charts for Variables/Attributes for real life scenarios (Level 3)
CO3	Examine Process Capability (Level 4)
CO2	Compare Sample Inspection systems (Level 4)
CO3	Recall/Explain TQM concepts, TQM tools (Level 2)

Mapping of Course Outcomes (COs) with Program Outcomes (POs) & Program Specific Outcomes (PSOs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	1	-	-	-	1	1	-	1
CO2	1	1	-	1	1	1	-	-	1	1	-	1
CO3	1	1	-	1	1	1	-	-	1	1	-	1
CO2	1	1	-	1	1	1	-	2	2	2	3	1
CO3	1	-	2	1	2	2	2	2	3	2	2	2

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	-
CO2	3	2	2	1
CO3	3	2	2	1
CO2	3	2	2	1
CO3	3	2	2	2

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code: EBME22E26	Subject Name : QUALITY ENGINEERING	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Nil	Ty	3	0/0	0/0	3

UNIT I: QUALITY CONCEPTS **6**

Quality, History of Quality, Quality Control, Quality Assurance, Quality Costs, Optimum Quality, Opportunity Loss, Taguchi's Quality loss function

UNIT II: CONTROL CHARTS FOR VARIABLES & PROCESS CAPABILITY **10**

Statistical Process Control (SPC), Control Charts for Variables, Action & Warning Limits in Control Charts, Process Capability, Process Capability Indices, Process Capability Studies, Problems in Control Charts for Variables

UNIT III: OTHER CONTROL CHARTS **8**

Control Charts for Attributes, Special Control Charts – Group Control Chart, Moving Averages/Moving Range Control Charts, Difference Control Charts, Mid-Range and Median Control Charts & Cumulative Sum Control Charts

UNIT IV: SAMPLING ISPECTION **9**

Economics of Sampling, Sampling Methods, Sampling Plans, OC Curves, Quality Indices, Standard tables used in Sampling Inspection - Dodge-Romig & ABC Standard

UNIT V: TOTAL QUALITY MANAGEMENT (TQM) **12**

Main Concepts of TQM, Quality Dimensions, TQM concepts in depth - KAIZEN, POKA YOKE, Six Sigma, 5S & Kano's Model, TQM Tools – Benchmarking, QFD & FMEA

Total No. of Periods: 45

REFERENCES:

1. *Douglas C. Montgomery, (2007) "Introduction to Statistical Quality Control", John Wiley & Sons*
2. *Grant E.L. and Leavenworth R.S.,(2000), "Statistical Quality Control", TMH*
3. *Dale H. Besterfield, (2002) "Total Quality Management", Pearson Education Asia*

Subject Code:	Subject Name: INDUSTRY 4.0	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E27	Pre requisite: Manufacturing Technology I & II	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn conceptualizes rapid change to technology, industries, and societal patterns and processes in the 21st century due to increasing interconnectivity and smart automation.

OURSE OUTCOMES (COs) :

CO1	Describe Industry 4.0 and scope for Indian Industry
CO2	Demonstrate conceptual framework and road map of Industry 4.0
CO3	Describe Robotic technology and Augmented reality for Industry 4.0
CO4	Demonstrate obstacle and framework conditions for Industry 4.0
CO5	Understand the role of augmented reality in the age of Industry 4.0

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1		1			2	2	2	2	2	2	2
CO2	1		1			2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2	2	2
CO4	1	2	2	1	2	1	1	1		1	2	2
CO5	1	1	1	1	1	1	1	1	1	1	1	1

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1			2	1				
CO2			2	1				
CO3			2	1				
CO4			2	1				
CO5			2	1				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code:	Subject Name: INDUSTRY 4.0	Ty/Lb/ ETL	L	T/ SLr	P/R	C
EBME22E27	Pre requisite: Manufacturing Technology I & II	Ty	3	0/0	0/0	3

Unit-1: Introduction to Industry 4.0 **9**

Introduction, core idea of Industry 4.0,origin concept of industry 4.0,Industry 4.0 production system, current state of industry 4.0, Technologies, How is India preparing for Industry 4.0

Unit-2: A Conceptual Framework for Industry 4.0 **9**

Introduction, Main Concepts and Components of Industry 4.0, State of Art, Supportive Technologies, Proposed Framework for Industry 4.0.

Unit-3: Technology Roadmap for Industry 4.0 **9**

Introduction, Proposed Framework for Technology Roadmap, Strategy Phase, Strategy Phase, New Product and Process Development Phase.

Unit-4: Advances in Robotics in the Era of Industry 4.0 **9**

Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly.

Unit-5: The Role of Augmented Reality in the Age of Industry 4.0 **9**

Introduction, AR Hardware and Software Technology, Industrial Applications of AR: Obstacles and Framework Conditions for Industry 4.0-Lack of A Digital Strategy alongside Resource Scarcity, Lack of standards and poor data security, Financing conditions, availability of skilled workers, comprehensive broadband infra- structure, state support, legal framework, protection of corporate data, liability, handling personal data.

Total No. of Periods: 45

Reference Books:

1. Alp Ustundag and Emre Cevikcan,"Industry 4.0: Managing the Digital Transformation".
2. Bartodziej, Christoph Jan,"The Concept Industry 4.0".
3. Klaus Schwab,"The Fourth Industrial Revolution".
4. Christian Schröder ,"The Challenges of Industry 4.0 for Small and Medium-sized Enterprises".

List of Open Source Software/learning website:
1. www.nptel.ac.in/

Subject Code: EBME22E28	Subject Name: SUPPLY CHAIN MANAGEMENT	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Pre requisite: Manufacturing Technology I & II	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S Lr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn:
Basic Conceptual idea of supply chain management system; Theory and application SCM networks with simple case study

OURSE OUTCOMES (COs) :

CO1	Understand the various concepts of supply chain management. (Level 2)
CO2	Analyze and decide the proper logistics. (Level 4)
CO3	Develop proper network to locate source and distribution centers at a optimal pricing. (Level 4)
CO4	Coordinate the supply chain management network. (Level 3)
CO5	Use information technology in supply chain management. (Level 3)

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	1	2	2	-	2	2	1	2
CO2	3	3	3	1	3	2	2	3	3	3	3	2
CO3	3	3	3	1	3	2	2	3	3	3	3	2
CO4	3	2	2	-	2	2	2	3	3	3	2	2
CO5	3	2	2	-	3	2	2	2	3	3	2	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	1	2				
CO2	3	3	3	3				
CO3	3	3	3	3				
CO4	3	3	3	3				
CO5	3	3	3	3				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Categ	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code: EBME22E28	Subject Name : SUPPLY CHAIN MANAGEMENT	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Manufacturing Technology I & II	Ty	3	0/0	0/0	3

UNIT- I: INTRODUCTION **9**

Definition of logistics and SCM: evolution, scope, importance& decision phases = drivers of SC performance and obstacles.

UNIT- II: LOGISTICS MANAGEMENT **9**

Factors – Modes of Transportation - Design options for Transportation Networks-Routing and Scheduling – Inbound and outbound logistics- Reverse Logistics – 3PL- Integrated Logistics Concepts- Integrated Logistics Model – Activities - Measuring logistics cost and performance – Warehouse Management - Case Analysis

UNIT- III: SUPPLY CHAIN NETWORK DESIGN **9**

Distribution in Supply Chain – Factors in Distribution network design –Design options-Network Design in Supply Chain – Framework for network Decisions - Managing cycle inventory and safety.

UNIT- IV: SOURCING AND PRICING IN SUPPLY CHAIN **9**

Supplier selection and Contracts - Design collaboration - Procurement process. Revenue management in supply chain

UNIT- V: COORDINATION AND TECHNOLOGY IN SUPPLY CHAIN **9**

Supply chain coordination - Bullwhip effect – Effect of lack of co-ordination and obstacles – IT and SCM - supply chain IT frame work. E Business & SCM. Metrics for SC performance – Case Analysis

Total No. of Periods: 45

REFERENCES

1. *Sunil Chopra and Peter Meindl,(2007) "Supply Chain Management, Strategy, Planning, and operation", (2nd ed.), PHI*
2. *David J.Bloomberg, Stephen Lemay and Joe B.Hanna,(2002), " Logistics", PHI*
3. *Martin Christopher, "Logistics and Supply Chain Management –Strategies for Reducing Cost and Improving Service", (2nd ed.), Pearson Education Asia*
4. *Jeremy F.Shapiro, Thomson Duxbury, (2002) " Modeling the supply chain"*
5. *James B.Ayers,(2000) "Handbook of Supply chain management", St.Lucle Press*

Subject Code: EBME22E29	Subject Name: BLOCK CHAIN TECHNOLOGY	Ty/Lb/ETL	L	T/ SLr	P/R	C
	Prerequisite: Nil	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits

T/L/ETL : Theory/Lab./Embedded Theory and Lab.

OBJECTIVE: The student will learn:

- Understand how blockchain systems (mainly Bitcoin and Ethereum) work, To securely interact with them,
- Design, build, and deploy smart contracts and distributed applications,
- Integrate ideas from blockchain technology into their own projects

COURSE OUTCOMES (COs) :

CO1	Understand the design principles of Bitcoin, Ethereum and Nakamoto consensus
CO2	Evaluate security, privacy, and efficiency of a given block chain system.
CO3	Explain the Simplified Payment Verification protocol.
CO2	Interact with a block chain system by sending and reading transactions.
CO3	Design, build, and deploy a distributed application.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) & Program Specific Outcomes (PSOs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2	1	1		1			2	2	3	2
CO2	1	1	2	2	3	1			1	2	2	1
CO3				2	2					2	2	2
CO2				2	2					2	2	2
CO3				2	2					2	2	2

COs / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1			2					
CO2			2					
CO3			2					
CO2			2					
CO3			2					

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Science	Engineering Science	Humanities and social Science	Program Core	Program elective	Open Elective	Inter Disciplinary	Skill Component	Practical /Project			
					✓							

Subject Code: EBME22E29	Subject Name: BLOCK CHAIN TECHNOLOGY	Ty/Lb/ETL	L	T/ SLr	P/R	C
	Prerequisite: Nil	Ty	3	0/0	0/0	3

Unit I: Basics **9**

Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete. • Cryptography: Hash function, Digital Signature - ECDSA, Memory Hard Algorithm, Zero Knowledge Proof.

Unit II: Blockchain **9**

Introduction, Advantage over conventional distributed database, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Private and Public block chain.

Unit III: Distributed Consensus **9**

Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate.

Unit IV: Crypto currency **9**

History, Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin

Unit V: Crypto currency Regulation **9**

Stakeholders, Roots of Bit coin, Legal Aspects-Crypto currency Exchange, Black Market and Global Economy. Applications: Internet of Things, Medical Record Management System, Domain Name Service and future of Block chain.

Tutorial & Practical: Naive Block chain construction, Memory Hard algorithm - Hash cash implementation, Direct Acyclic Graph, Play with Go-ethereum, Smart Contract Construction, Toy application using Block chain, Mining puzzles

Total No. of Periods: 45

Text Book

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016).

Reference Books

1. Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies
2. Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System
3. DR. Gavin Wood, "ETHEREUM: A Secure Decentralized Transaction Ledger,"Yellow paper.2014.
4. Nicola Atzei, Massimo Bartoletti, and Tiziana Cimoli, A survey of attacks on Ethereum smart contracts