B.E. MECHANICAL ENGINEERING

CURRICULUM

(2020 AND ONWARDS)

(REGULAR PROGRAMME)

Department of Mechanical Engineering
FACULTY OF ENGINEERING

Enable | Enlighten | Enrich
KARPAGAM
ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)

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Pollachi Main Road, Eachanari Post, Coimbatore – 641 021.INDIA

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Eachanari Post, Coimbatore-641021.Tamilnadu,India.

FACULTY OF ENGINEERING

B.E. (MECHANICAL ENGINEERING)

COURSE OF STUDY AND SCHEME OFEXAMINATION

(2020Batch Onwards)

SEMESTERI										
Course Code	Course title	Objectives & Outcomes		Instruction Hours / Week			Credits	Maximum Marks		
		PEO	PO	L	T	P		CIA	ESE	Total
								40	60	100
20BEME101	English	1	1,2,8,9	2	0	2	3	40	60	100
20BEME102	Mathematics-I	1	1,2,3,5,8,9	3	1	0	4	40	60	100
20BEME141	Engineering Physics	1	1,2,3,8,9,11	3	0	4	5	40	60	100
20BEME142	Engineering Chemistry - I	1	1,2,3,8,9,11	3	0	4	5	40	60	100
20BEME143	Python Programming	1,3	1,2,3,5,9	2	0	2	3	40	60	100
20BEME111	Engineering Graphics-I	1,2	1,2,3,5	1	0	4	3	40	60	100
Total				14	1	16	23	240	360	600

SEMESTERII										
Course Code	Course title	Objectives & Outcomes		Instruction Hours / Week			Credits	Maximum Marks		
		PEO	PO	L	T	P		CIA	ESE	Total
								40	60	100
20BEME201	Communicative English	1	1,2,8,9	2	0	2	3	40	60	100
20BEME202	Mathematics-II	1	1,2,3,5	3	1	0	4	40	60	100
20BEME203	Physics for Mechanical Engineers	1,3	1,2,3,8	3	0	0	3	40	60	100
20BEME241	Basic Electrical and Electronics Engineering	1,3	1,2,3,5	3	1	2	5	40	60	100
20BEME211	Workshop Practices	1,2	1,2,3,5,9	0	0	4	2	40	60	100
20BEME212	Engineering Graphics II	1,2	1,2,3,5	1	0	4	3	40	60	100
Total				12	2	12	20	240	360	600

SEMESTER III										
Course Code	Course title	Objectives & Outcomes		Instruction Hours / Week			Credits	Maximum Marks		
		PEO	PO	L	T	P		CIA	ESE	Total
								40	60	100
20BEME301	Mathematics III	I	1,3,5,6,7,8	3	1	0	4	40	60	100
20BEME302	Engineering Mechanics	I	1,3,5,6,7,8	3	1	0	4	40	60	100
20BEME303	Thermodynamics	I	1,2,3,4,10,11	3	1	0	4	40	60	100
20BEME341	Manufacturing Technology I	I	1,2,3,4,10	3	0	2	4	40	60	100
20BEME311	Machine Drawing	I	1,2,3,4,10	2	0	2	3	40	60	100
VALUE ADDED COURSE										
20BEME351	Constitution of India	-	-	1	0	0	0	100	0	100
Total				15	3	4	19	300	300	600

SEMESTER IV										
Course Code	Course title	Objectives & Outcomes		Instruction Hours / Week			Credits	Maximum Marks		
		PEO	PO	L	T	P		CIA	ESE	Total
								40	60	100
20BEME401	Environmental Studies	1	1,2,3,4,10	3	0	0	3	40	60	100
20BEME441	Manufacturing Technology II	1	1,2,3,6,8,9	3	0	2	4	40	60	100
20BEME442	Applied Thermodynamics	1	1,2,3,4,10	3	1	2	5	40	60	100
20BEME443	Strength of Materials	1	1,2,3,4,10	3	1	2	5	40	60	100
20BEME444	Fluid Mechanics & Fluid Machines	1	1,2,3,4,10	3	1	2	5	40	60	100
VALUE ADDED COURSE										
20BEME451	Essence of Indian Traditional Knowledge	-	-	1	0	0	0	100	0	100
			Total	16	3	8	22	300	300	600

SEMESTERV										
Course Code	Course title	Objectives & Outcomes		Instruction Hours / Week			Credits	Maximum Marks		
		PEO	PO	L	T	P		CIA	ESE	Total
								40	60	100
20BEME501	Design of Machine Elements	1	1,2,3,4,9	3	1	0	4	40	60	100
20BEME541	Engineering Materials and Metallurgy	1	1,2,3,4,10	3	0	2	4	40	60	100
20BEME542	Industrial Metrology	1	1,2,3,6,8,9	3	0	2	4	40	60	100
20BEME543	Heat and Mass Transfer	1	1,2,3,4,5	3	1	2	5	40	60	100
20BEME544	Theory of Machines	1	1,2,3,4,10	3	1	2	5	40	60	100
20BE_____	Open Elective I	-	-	3	0	0	3	40	60	100
VALUE ADDED COURSE										
20BEME551	Geometrical Dimensioning and Tolerance	-	-	1	1	0	0	100	0	100
			Total	19	4	8	25	340	360	700

SEMESTER VI										
Course Code	Course title	Objectives & Outcomes		Instruction Hours / Week			Credits	Maximum Marks		
		PEO	PO	L	T	P		CIA	ESE	Total
								40	60	100
20BEME601	Design of Transmission Systems	1	1,2,3,4,8,9,10	3	1	0	4	40	60	100
20BEME602	Instrumentation & Control systems	1	1,2,3,4,10	3	0	0	3	40	60	100
20BEME603	Power Plant Engineering	1	1,2,3,8,9	3	0	0	3	40	60	100
20BEME6E	Professional Elective-I	-	-	3	0	0	3	40	60	100
20BEME6E	Professional Elective-II	-	-	3	0	0	3	40	60	100
20BE_____	Open Elective II	-	-	3	0	0	3	40	60	100
20BEME611	Computer Aided Modeling and Simulation Laboratory	1	1,2,3,4,5,8,9	0	0	3	2	40	60	100
20BEME691	Mini project work	-	-	1	0	0	1	100	0	100
VALUE ADDED COURSE										
20BEME651	Motors and Pumps	-	-	1	0	1	0	100	0	100
			Total	20	1	4	22	480	420	900

SEMESTER VII										
Course Code	Course title	Objectives & Outcomes		Instruction Hours / Week			Credits	Maximum Marks		
		PEO	PO	L	T	P		CIA	ESE	Total
								40	60	100
20BEME741	Automation in Manufacturing	1	1,2,3,4,5,8,9	3	0	2	4	40	60	100
20BEME742	Computer Aided Engineering	1	1,2,3,4,5,8,9	3	1	2	5	40	60	100
20BEME7E	Professional Elective-III	-	-	3	0	0	3	40	60	100
20BEME7E	Professional Elective-IV	-	-	3	0	0	3	40	60	100
20BEME7E	Professional Elective-V	-	-	3	0	0	3	40	60	100
20BE_____	Open Elective III	-	-	3	0	0	3	40	60	100
20BEME791	Projectwork Phase – I	-	-	0	0	6	3	100	-	100
			Total	18	1	10	24	340	360	700

SEMESTER VIII										
Course Code	Course title	Objectives & Outcomes		Instruction Hours / Week			Credits	Maximum Marks		
		PEO	PO	L	T	P		CIA	ESE	Total
								40	60	100
20BEME8E	Professional Elective-VI	-	-	3	0	0	3	40	60	100
20BE_____	Open Elective IV	-	-	3	0	0	3	40	60	100
20BEME891	Project Work Phase – II	-	-	0	0	12	6	120	180	300
			Total	6	0	12	12	200	300	500

PROFESSIONAL ELECTIVE I

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks		
		L	T	P		CIA	ESE	Total
						40	60	100
20BEME6E01	Composite Materials	3	0	0	3	40	60	100
20BEME6E02	Renewable Energy Sources	3	0	0	3	40	60	100
20BEME6E03	Industrial Robotics	3	0	0	3	40	60	100
20BEME6E04	Hydraulics and Pneumatics Power Control	3	0	0	3	40	60	100

PROFESSIONAL ELECTIVE II

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks		
		L	T	P		CIA	ESE	Total
						40	60	100
20BEME6E05	Refrigeration and Air Conditioning	3	0	0	3	40	60	100
20BEME6E06	Advanced Manufacturing Processes	3	0	0	3	40	60	100
20BEME6E07	Vibration Analysis and Control	3	0	0	3	40	60	100
20BEME6E08	Hybrid Vehicle Technology	3	0	0	3	40	60	100

PROFESSIONAL ELECTIVE III

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks		
		L	T	P		CIA	ESE	Total
						40	60	100
20BEME7E01	Design for Manufacture and Assembly	3	0	0	3	40	60	100
20BEME7E02	Computational Fluid Dynamics	3	0	0	3	40	60	100
20BEME7E03	Energy Conservation Methods and Energy Audit	3	0	0	3	40	60	100
20BEME7E04	Additive Manufacturing	3	0	0	3	40	60	100

PROFESSIONAL ELECTIVE IV

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks		
		L	T	P		CIA	ESE	Total
						40	60	100
20BEME7E05	Gas Dynamics and Jet Propulsion	3	0	0	3	40	60	100
20BEME7E06	Design of Mechatronic Systems	3	0	0	3	40	60	100
20BEME7E07	Logistics and Supply Chain Management	3	0	0	3	40	60	100
20BEME7E08	Operation Research	3	0	0	3	40	60	100

PROFESSIONAL ELECTIVE V

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks		
		L	T	P		CIA	ESE	Total
						40	60	100
20BEME7E09	Design of Jigs, Fixtures and Press Tools	3	0	0	3	40	60	100
20BEME7E10	Advanced I.C. Engines	3	0	0	3	40	60	100
20BEME7E11	Non-Destructive Testing	3	0	0	3	40	60	100
20BEME7E12	Industrial Safety Engineering	3	0	0	3	40	60	100

PROFESSIONAL ELECTIVE VI

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks		
		L	T	P		CIA	ESE	Total
						40	60	100
20BEME8E01	Quality Control and Reliability Engineering	3	0	0	3	40	60	100
20BEME8E02	Cogeneration and Waste Heat Recovery Systems	3	0	0	3	40	60	100
20BEME8E03	Computer Aided Drafting and Cost Estimation	3	0	0	3	40	60	100
20BEME8E04	Battery Management System	3	0	0	3	40	60	100

COURSES OFFERED BY OTHER DEPARTMENTS								
Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks		
		L	T	P		CIA	ESE	Total
						40	60	100
20BESHOE**	Solid Waste Management	3	0	0	3	40	60	100
20BESHOE**	Green Chemistry	3	0	0	3	40	60	100
20BESHOE**	Applied Electrochemistry	3	0	0	3	40	60	100
20BEEEOE**	Electric Hybrid Vehicles	3	0	0	3	40	60	100
20BEEEOE**	Renewable Energy Resources	3	0	0	3	40	60	100
20BECEOE**	Housing, Plan and Management	3	0	0	3	40	60	100
20BECEOE**	Computer-Aided Civil Engineering Drawing	3	0	0	3	40	60	100
20BTCEOE**	Industrial Wastewater Treatment	3	0	0	3	40	60	100

COURSES OFFERED TO OTHER DEPARTMENTS								
Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks		
		L	T	P		CIA	ESE	Total
						40	60	100
20BEMEOE01	Computer Aided Design	3	0	0	3	40	60	100
20BEMEOE02	Industrial Safety and Environment	3	0	0	3	40	60	100

Skill Development

Employability Skill

Entrepreneurship Skill

Programme Educational Objectives (PEO's)

- **1:**Graduates will more conscious about their profession with social awareness and responsibility.
- **2:**Graduates will be engineering experts, who would help solve industry's technological problems.
- **3:**Graduates will be engineering professionals, consultants or entrepreneurs engaged in technology development.

Programme Outcomes (PO's)

- **1 - Engineering Knowledge:** Ability to apply knowledge of mathematics, science and engineering fundamentals for solving the complex engineering problems.

- **2 - Problem Analysis:**Identify, formulate, review and analyze the complex engineering problems, by conceptual and fundamental principles of mechanical engineering to reach value added sustainable conclusions.
- **3 - Designs / development of solution:** 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, cultural, societal and environmental consideration.
- **4 - Conduct investigations of complex Problems:** Ability to apply appropriate tools, technique and research knowledge to investigate complex engineering problems.
- **5 - Modern tool usage:** To understand and apply modern techniques and IT tools for the design and analysis of mechanical systems.
- **6 - The engineer and society:** Understand the impact of engineering solutions in a societal context and to be able to respond effectively to the needs for sustainable development.
- **7 - Environment and sustainability:** Understanding the mechanism of pollutant formation and its control techniques.
- **8 - Ethics:** Understanding of human and ethical responsibilities towards the profession and society.
- **9 - Individual and team work:** Function effectively as an individual, and as a member or a leader in diverse teams, and in multi-disciplinary situations.
- **10 - Communication:** Ability to communicate effectively with engineering community and instruct in the form of reports, presentation and documents.
- **11 - Project management and finance:** Ability to understand the economics and cost analysis in order to take economically sound decisions.
- **12 - Lifelong learning:** To recognize the need for, and have the ability to engage in independent and lifelong learning.

Programme Specific Outcomes (PSO's)

- **1:**students acquired theoretical and practical background of technical and managerial skill to make them employable graduate.
- **2:**students beamed fundamentally and rural – time (physical) problem solving skills by the use of advanced materials research lab and advanced welding laboratory.

Programme Educational Objectives	**Programme Objectives**											
	1	2	3	4	5	6	7	8	9	10	11	12
1			✓			✓	✓	✓	✓	✓		
2	✓	✓	✓	✓	✓					✓	✓	✓
3	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓

Total Marks: 5200

Total number of credits: 167

PEO: ProgrammeEducationalObjectives **PO: ProgrammeOutcomes**
L: LectureHour **T: TutorialHour** **CIA: ContinuousInternal Assessment**
P:PracticalHour **C: No.ofCredits** **ESE: End Semester Examinations**

Note:

1. The passing minimum for Mandatory course is 50 marks out of 100 marks. There will be two tests, of which one will be class test covering 50% of syllabus for 50 marks and other for 50marks.
2. Credits for mandatory courses are not counted for computation ofCGPA.
3. A student will be eligible to get Under Graduate degree with Honors or additional Minor Engineering, if he/she completes an additional 20 credits. These could be acquired through MOOCs.

SEMESTER I

20BECC101 **ENGLISH** **4 H – 3 C**

Instruction hours / week L :2 T : 0 P:2 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To enable students to attain fluency and accuracy to inculcate proficiency in professional communication to meet the growing demand in the field of Global communication.
2. To make the students to meet the growing demand in the field of Globalcommunication.
3. To help students acquire their ability to speak effectively in real life situations.
4. To inculcate the habit of reading and to develop their effective reading skills.
5. To ensure that students use dictionary to improve their active and passive vocabulary.
6. To enable students to improve their lexical, grammatical and communicative competence.

COURSE OUTCOMES

Students undergoing this course will be able to

1 Use English language for communication: verbal & non –verbal.
2 Enrich comprehension and acquisition of speaking & writing ability.
3 Gain confidence in using English language in real life situations.
4 Improve word power: lexical, grammatical and communication competence.
5 To guide the students to write business letters and other forms of technical writing.
6 To enable students to prepare for oral communication in formal contexts.

UNIT: I - **BASIC WRITING SKILLS**

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

UNIT: 1I - VOCABULARY BUILDING

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

UNIT: III - GRAMMAR AND USAGE

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

UNIT: IV - LISTENING AND READING SKILLS

Note taking- viewing model interviews – listening to informal conversations – improving listening / reading comprehension – reading model prose / poems – reading exercise

UNIT: V.-**WRITING PRACTICES**

Comprehension - Précis Writing - Essay Writing Listening Comprehension - Common Everyday Situations: Conversations and Dialogues - Communication at Workplace – Interviews - Formal Presentations

Note: Students shall have hands on training in improving listening skill in the language laboratory @ 2 periods per each unit.

SUGGESTED READINGS

1. Sangeeta Sharma , Meenakshi Raman, .(2015),Technical Communication: Principles And Practice, 2nd Edition, OUP, New Delhi.
2. Sanjay Kumar and PushpLata, (2011), Communication Skills, Oxford University Press.
3. Liz Hamp - Lyons and Ben Heasly, (2006), Study Writing, Cambridge University Press
4. F.T. Wood., (2007), Remedial English Grammar, Macmillan.
5. Michael Swan, (1995). Practical English Usage, OUP.

SEMESTER I

20BEME102 **MATHEMATICS - I** **4 H – 4 C**

Instruction hours / week L : 3 T : 1 P: 0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

The goal of this course is for the students

1. To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
2. To understand geometrical aspects of curvature and elegant application of differential calculus which are needed in engineeringapplications.
3. To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model Engineering problems.
4. To familiarize the student with functions of several variables this is the foundation for many branches of Engineering.
5. To introduce sequence and series this is central to many applications in Engineering.
6. To equip the students with standard concepts and tools at an intermediate to advanced level.

COURSE OUTCOMES

Upon completion of this course the students will be able

1. To solve the rank, Eigen values and eigenvectors, diagonalization of a matrix, Symmetric matrices and the students will be able to use matrix algebra techniques for practical applications.
2. To equip the students to have basic knowledge and understanding in one field of materials, differential calculus
3. To solve simple standard examples using the ideas of differential equations.
4. To apply various techniques to solve Partial Differential Equations
5. To develop the tool of power series for learning advanced Engineering Mathematics.
6. To apply the knowledge acquired to solve various Engineering problems.

UNIT I - MATRICES

Introduction - Characteristic equation – Eigenvalues and Eigenvectors of a real matrix – Properties – Cayley-Hamilton theorem (excluding proof) – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic forms – Reduction to canonical form through orthogonal reduction. Simple problems using Scilab.

UNIT II – DIFFERENTIAL CALCULUS

Overview of Derivatives - Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes- Evolutes as Envelope of normals

UNIT III - DIFFERENTIAL EQUATIONS

Linear Differential equations of second and higher order with constant coefficients – Homogeneous equation of Euler’s and Legendre’s type – Method of variation parameters.

UNIT IV – FUNCTIONS OF SEVERAL VARIABLES

Partial derivatives- Homogeneous functions and Euler’s theorem - Total derivative -Differentiation of implicit functions - Jacobians -Partial differentiation of implicit functions- Taylor’s series for functions of two variables- Errors and approximations - Maxima and minima of functions of two variables- Lagrange’s method of undetermined multipliers.

UNIT V - SEQUENCES AND SERIES

Sequences: Definition and examples – **Series:** Types and Convergence – Series of positive terms – Tests of convergence: Comparision test, Integral test and D’Alembert’s ratio test – Alternating series – Leibnitz’s test – Series of positive and negative terms – Absolute and conditional convergence.

SUGGESTED READINGS:

1. Grewal B.S., (2014), Higher Engineering Mathematics, 43rd Edition, Khanna Publishers, New Delhi.
2. Erwin Kreyszig, (2016), Advanced Engineering Mathematics, 10th Edition, John Wiley, India.
3. BaliN.P. and Manish Goyal, (2014), A text book of Engineering Mathematics, Laxmi Publications, New Delhi, India.
4. Veerarajan T**,** (2008), Engineering Mathematics for first year,Tata McGraw-Hill, New Delhi,.
5. Ramana B.V**,** (2010), Higher Engineering Mathematics, 11th Reprint, Tata McGraw Hill New Delhi.
6. Hemamalini. P.T**,** (2014), Engineering Mathematics**,** McGraw Hill Education (India) Private Limited, New Delhi.
7. ThomasG.B and. FinneyR.L**,** (2002), Calculus and Analytic geometry, 9th Edition,Pearson**,**.
8. Michale D. Greenberg, (2011), Advanced Engineering Mathematics, 2nd Edition, Books Pearson Education, First Indian reprint.
9. Peter V. O'Neil,(2012), Advanced Engineering Mathematics, 7th Edition, Cengage learning.
10. Gilbert Strang, (2009), Introduction to Linear Algebra, 4th Edition, Wellesley- Cambridge Press.

WEBSITES:

1. www.efunda.com
2. www.mathcentre.ac.uk
3. www.intmath.com/matrices-determinants
4. www. Intmath.com/calculus/calculus-intro.php

SEMESTER I

20BEME141 **ENGINEERING PHYSICS** **7 H – 5 C**

(Theory & Laboratory)

Instruction hours / week L : 3 T : 0 P:4 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

(i)THEORY

COURSE OBJECTIVES

The Goal of this course is for students to

1. Inculcate the basics of properties of matter, sound and its applications.
2. Basics of laser and optical fiber with appropriate applications.
3. Disseminate the fundamentals of thermal physics and their applications.
4. Introduce the concepts of quantum mechanics for diverse applications.
5. Impart the basic knowledge of crystal and its various crystal structures.
6. To make the students to understand the process of production and measurement.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Understand the elastic nature of materials.
2. Infer the characteristics of laser for various engineering applications.
3. Extend the knowledge on optical fiber for communication purposes.
4. Illustrate the thermal properties of materials through various methods.
5. Develop the idea of quantum mechanics through applications.
6. Identify the different atomic arrangements of crystals and its defects.

UNIT I – PROPERTIES OF MATTER AND SOUND Elasticity – basic definitions, stress - strain diagram -factors affecting elastic modulus and tensile strength–Poisson's ratio – Twisting couple - Torsion pendulum- bending of beams – bending moment – young's modulus – cantilever method, uniform and non-uniform bending – I-shaped girders.

Loudness, decibel, echo, reverberation, Sabine's formula, Ultrasonic – Production, Industrial and medical applications.

UNIT II – LIGHT, LASER AND FIBER OPTICS Light – interference – reflection, refraction – Air wedge - LASER- Principle – characteristics - emission and absorption process- Einstein's coefficients derivation. Types of LASER - Nd:YAG, CO_2, Semiconductor LASER- Applications of LASER in industry and medicine.

Fiber optics: Total internal reflection – modes of propagation of light in optical fibers – numerical aperture and acceptance angle – types of optical fibers (Material, refractive index and mode) – fiber optical communication system (block diagram) - Fiber optic sensors: pressure and displacement.

UNIT III – THERMAL PHYSICS

Introduction– thermal expansion of solids and liquids – expansion joints – bimetallic strips – Mode of heat transfer- heat conductions in solids – thermal conductivity – derivation, Phonons -Forbe's and Lee's disc method: theory and experiment – conduction through compound media (series and parallel) – thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters.

UNIT IV – QUANTUM PHYSICS

Merits of quantum theory, Demerits of classical theory – Black body radiation, Photo electric effect – Compton scattering: experimental description, dual nature of matter and radiation – de Broglie wavelength, uncertainty principle – Schrödinger's wave equation – time dependent and time independent equations – particle in one dimensional box- physical significance of wave function, Scanning Electron Microscope, Transmission Electron Microscope.

UNIT V – CRYSTAL PHYSICS

Crystalline materials – types - unit cell, primitive cell, intercepts, interfacial angle - crystal systems, Bravais lattices, Miller indices – determination of inter-planar distances - Coordination number and packing factor for SC, BCC, FCC, HCP structures-crystal imperfections: point defect, line defect, surface and volume defect. Crystal growth techniques:Czochralski and Bridgman method.

SUGGESTED READINGS

1. Bhattacharya D.K. & Poonam T., Engineering Physics, Oxford University Press,2015.
2. Gaur R.K. and Gupta S.L, Engineering Physics, DhanpatRai Publications, 2012.
3. Pandey .B.K. & Chaturvedi .S, Engineering Physics, Cengage Learning India, 2012.
4. Halliday.D., Resnick R. & Walker. J, Principles of Physics, Wiley, 2015.
5. Charles Kittel, Kittel's Introduction to Solid State Physics, Wiley India Edition, 2019.
6. P.M. Mathews, K.Venkatesan, A text book of Quantum Mechanics, 2/e, Mc Graw Hill Education, 2017.
7. Laser Fundamentals, William T Silfvast, Cambridge Univ Press. 2012.
8. Fiber Optics and Optoelectronics, R P Khare, Oxford, 2012.
9. Daniel V.Schroeder, An Introduction to Thermal Physics, Pearson, 2014.
10. D.S. Mathur, Elements of properties of matter, S.Chand, 2010.

JOURNALS

1. Nature Physics.
2. Journal of Applied Mechanics (ASME).
3. Ultrasonics and sonochemistry (Elsevier).
4. Journal of Light wave Technology (IEEE).
5. Optics and Laser Technology (Elsevier).
6. Applied Thermal Engineering (Elsevier).
7. Physical Review B (American Physical Society).

WEBLINKS

1. https://nptel.ac.in/courses/122/103/122103011/
2. https://nptel.ac.in/courses/113/104/113104081/
3. http://hyperphysics.phy-astr.gsu.edu/hbase/optmod/lascon.html

(ii) LABORATORY

COURSE OBJECTIVE:

- To learn the basic concepts in physics relevant to different branches of Engineering and Technology.

COURSE OUTCOME:

- To familiarize the properties of material and basic concepts in physics.

LIST OF EXPERIMENTS – PHYSICS (Any 10 Experiments)

1. Torsional pendulum – Determination of rigidity modulus of wire and moment of inertia of disc
2. Uniform bending (or) Non-uniform Bending– Determination of young's modulus.
3. Viscosity of liquids-Determination of co-efficient of viscosity of a liquid by Poiseuille's flow .
4. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids.
5. Laser- Determination of the wave length of the laser using grating, Acceptance angle of optical fiber.
6. Spectrometer- Determination of wavelength using grating.
7. Air wedge – Determination of thickness of a thin sheet/wire.
8. Lee's disc – Determination of thermal conductivity.
9. Determination of Band gap of a semiconductor.
10. Potentiometer – Determination of thermo emf of a thermo couple.
11. Characteristics of photo diode.
12. Particle size determination using LASER.

SEMESTER I

20BEME142 **ENGINEERING CHEMISTRY – I** **7 H – 5 C**

(Theory & Laboratory)

Instruction hours / week L : 3 T : 0 P: 4 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

(i) CONCEPTS IN CHEMISTRY FOR ENGINEERING

COURSE OBJECTIVE

The goal of this course is for students to

1. Study the basics of Periodic properties, Intermolecular forces
2. Understand the terminologies of electrochemistry and to study about energy storage devies
3. Understand the concept of corrosion and its prevention
4. Comprehend the basic water technology and its purification.
5. Comprehend the basic organic chemistry and to synthesis simple drug.
6. Study about spectroscopic technique.

COURSE OUTCOMES

Upon completion of the course the students will be able to

1. Rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.
2. Analyse the mechanism of different energy storage devices.
3. Rationalise different types of corrosion and its prevention.
4. List the various methods in the purification of water.
5. Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
6. Integrate the chemical principles in the projects undertaken in field of engineering and technology

UNIT I - PERIODIC PROPERTIES, INTERMOLECULAR FORCES

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers. Ionic, dipolar and van Der Waals interactions.

UNIT II – ELECTROCHEMISTRY AND STORAGE DEVICES

Thermodynamic functions. Free energy and emf. Cell potentials, the Nernst equation and applications. Types of electrodes Standard Hydrogen Electrode (SHE) & Calomel. Energy storage devices Primary and secondary cells leclanche cell, Lead Acid Battery, Nickel Cadmium Battery, Lithium Battery Charging and discarging reactions.

UNIT III – CORROSION AND ITS CONTROL

Chemical and Electrochemical corrosion - Galvanic corrosion - Differential aeration corrosion - Corrosion control - Sacrificial anode and Impressed current cathodic methods - Corrosion inhibitors - Protective coatings – Organic Coatings-Paints - Constituents and functions –Inorganic coatings- Metallic coatings - Electroplating (Au) and Electro less plating (Ni) - Surface conversion coating - Hot dipping

UNIT IV – WATER TECHNOLOGY

Sources-Characteristics – Specification for drinking water, BIS &WHO-Alkalinity – Types of alkalinity and determination – Hardness – Types and estimation by EDTA method - Domestic water treatment – Disinfection methods (Chlorination, Ozonation. UV treatment) – Boiler feed water – Requirements – Disadvantages of using hard water in boilers – Internal conditioning (Phosphate, Calgon and Carbonate conditioning methods) – External conditioning – Demineralization process – Desalination -

Reverse osmosis.

UNIT V - SPECTROSCOPIC TECHNIQUES AND APPLICATIONS

Spectroscopy (Principles and Instrumentation only). Electronic spectroscopy.Vibrational and rotational spectroscopy. Applications. Surface characterization techniques Scanning electron microscope (SEM) and Transmission electron microscopy (TEM). Fluorescence and its applications in medicine.

.

SUGGESTED READINGS

1. B. H. Mahan, (2010).University chemistry, Pearson Education,
2. M. J. Sienko and R. A. Plane, Chemistry: Principles and Applications.
3. C. N. Banwell, (2001)Fundamentals of Molecular Spectroscopy, McGraw-Hill,.
4. B. L. Tembe, Kamaluddin and M. S. Krishnan, Engineering Chemistry (NPTEL Web-book)
5. P. W. Atkins, (2009).Physical Chemistry, Oxford University Press,
6. K. P. C. Volhardt and N. E. Schore, (2014).5th Edition, Organic Chemistry: Structure and Function, W.H. Freeman,
7. P C Jain & Monica Jain, (2015).Engineering Chemistry, DhanpatRai Publishing Company,

(ii) CHEMISTRY LABORATORY

COURSE OBJECTIVES

The goal of this course is for students to

- To provide students with practical knowledge of quantitative analysis of materials by classical and instrumental methods for developing experimental skills in building technical competence.

COURSE OUTCOMES

Upon completion of the course the students will be able to

1. The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering. The students will learn to:
2. Estimate rate constants of reactions from concentration of reactants/products as a function of time
3. Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc

Choice of 10 experiments from the following:

1. Determination of surface tension and viscosity
2. Determination of Sodium Carbonate and Sodium Hydrogen Carbonate in a mixure using volumetric titration
3. Determination of Ca / Mg using complexometric titration
4. Thin layer chromatography
5. Determination of chloride content of water
6. Determination of the rate constant of a reaction
7. Conductometry - Determination of cell constant and conductance of solutions
8. pH Metry – Determination of Acid / Base
9. Potentiometry - determination of redox potentials and emfs
10. Saponification/acid value of an oil
11. Determination of the partition coefficient of a substance between two immiscible liquids
12. Adsorption of acetic acid by charcoal
13. Use of the capillary viscosimeters to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

SEMESTER I

20BEME143 **PYTHON PROGRAMMING** **4 H – 3 C**

(Theory & Laboratory)

Instruction hours / week L : 2 T : 0 P: 2 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

(i) THEORY

COURSE OBJECTIVES:

Students undergoing this course are exposed to:

1. Describe the core syntax and semantics of Python programming language.
2. Discover the need for working with the strings and functions.
3. Illustrate the process of structuring the data using lists, dictionaries, tuples and sets.
4. Indicate the use of regular expressions and built-in functions to navigate the file system.
5. Infer the Object-oriented Programming concepts in Python.
6. Students will solve problems, explore real-world software development challenges, andcreate practical and contemporary applications.

COURSE OUTCOMES:

Upon Completion of this course, the student will be able to:

1. Explain various operators used in python.
2. Apply the string handling functions to solve the given problem
3. Describe Object oriented concepts with python
4. Use image processing techniques in python programming to solve a given problem
5. Discuss the functions of networking in python
6. Solve a given analogy

UNIT I INTRODUCTION

Installing Python; basic syntax, interactive shell, editing, saving, and running a scriptvariable, assignments; immutable variables; numerical types; arithmetic operators and expressions; comments in the program; understanding error messages;

UNIT II CONDITIONAL STATEMENT & STRING HANDLING

Conditions, Boolean logic, logical operators; ranges; Control statements: if-else, loops (for, while); short-circuit (lazy) evaluation – Manipulating files and directories, os and sys modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab-separated). String manipulations: subscript operator, indexing, slicing a string; strings and number system: converting strings to numbers and vice versa. Binary, octal, hexadecimal numbers.

UNIT III OBJECT ORIENTED PROGRAMMING WITH PYTHON

Classes and OOP: classes, objects, attributes and methods; defining classes; design with classes, data modeling; persistent storage of objects – OOP, continued: inheritance, polymorphism, operator overloading; abstract classes; exception handling, try block

UNIT IV IMAGE PROCESSINGWITH PYTHON

Design with functions: hiding redundancy, complexity; arguments and return values; formal vs actual arguments, named arguments. Program structure and design. Recursive functionsSimple Graphics and Image Processing: “turtle” module; simple 2d drawing – colors, shapes; digital images, image file formats, image processing Simple image manipulations with ‘image’ module (convert to b/w, rayscale, blur, etc).

UNIT V NETWORKINGWITH PYTHON

Multithreading, Networks, and Client/Server Programming; introduction to HTML, interacting with remote HTML server, running html-based queries, downloading pages; CGI programming, programming a simple CGI form.

SUGGESTED READINGS :

1. Shroff ,“Learning Python: Powerful Object-Oriented Programming: 5th Edition, Fifth edition (24 July 2013)
2. Timothy A. Budd 'Exploring Python' – TATA McGRAW-HILL Edition - 2011
3. VamsiKurama, "Python Programming: A Modern Approach", Pearson Education, 2018.
4. “Python Essential Reference”. Addison-Wesley Professional; 4 edition (July 19, 2009) by David M.Baezly
5. “Python Cookbook” O’Reilly Media; 3rd edition (June 1, 2013) by David M. Baezly.
6. Guido Van Rossum, Fred . L. Drake 'Introduction to Python' – Network Theory Limited – March 2011
7. Alex Martelli 'Python in a Nutshell' - O'Reilly - 2nd Edition, 2006

WEBSITES:

1. https://www.codecademy.com/learn/python
2. www.learnpython.org/

(ii) LABORATORY

PYTHON PROGRAMMING

COURSE OBJECTIVES:

Students undergoing this course are exposed to:

1. To write, test, and debug simple Python programs.
2. To implement Python programs with conditionals and loops.
3. Use functions for structuring Python programs.
4. To infer the Object-oriented Programming concepts in Python.
5. Represent compound data using Python lists, tuples, and dictionaries.
6. Read and write data from/to files in Python.

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

1. Write, test, and debug simple Python programs.
2. Implement Python programs with conditionals and loops.
3. Develop Python programs step-wise by defining functions and calling them.
4. Infer the Object-oriented Programming concepts in Python.
5. Use Python lists, tuples, dictionaries for representing compound data.
6. Read and write data from/to files in Python.

LIST OF EXPERIMENTS:

1. Compute the GCD of two numbers.
2. Find the square root of a number (Newton’s method)
3. Exponentiation (power of a number)
4. Find the maximum of a list of numbers
5. Linear search and Binary search
6. Selection sort, Insertion sort
7. Merge sort
8. First n prime numbers
9. Multiply matrices
10. Programs that take command line arguments (word count)
11. Find the most frequent words in a text read from a file
12. Simulate elliptical orbits in Pygame
13. Simulate bouncing ball in Pygame

SEMESTER I

20BEME111 ENGINEERING GRAPHICS I 5 H – 3 C

Instruction hours / week L : 1 T : 0 P:4 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To make the students to design a system, component, or process to meet desired needs.
2. To prepare the students to design the components with realistic constraints.
3. To make the students to consider economic, environmental, ethical, health and safety when they design.
4. To make the students to design the components with considering manufacturability, andsustainability
5. To prepare the students to communicate effectively use the techniques, skills, and modern engineering tools.
6. To make the students to understand to use necessary for engineeringpractice.

COURSE OUTCOMES

On completion of this course, students will be able to

1. Introduction to engineering design and its place insociety
2. Exposure to the visual aspects of engineering design and engineering graphicsstandards
3. Exposure to engineeringcommunication effectively.
4. Exposure to 3D free hand sketching.
5. Acquired the knowledge of projections of points, lines and plane surfaces.
6. Understand the basic concept of projection of solids.

UNITI INTRODUCTION

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Bureau of Indian Standards (BIS), Layout of drawing sheets, sizes of drawing sheets, different types of lines used in drawing practice geometric constructions, principles of dimensioning– linear, angular, aligned system, unidirectional system, parallel dimensioning, chain dimensioning, location dimension and size dimension.Reducing Scale, Enlarging Scale, Plain Scale, Diagonal Scale and Vernier Scale. Conic sections including the Ellipse, Parabola and Hyperbola (eccentricity method only); Cycloid, Epicycloid, Hypocycloid and Involute.

UNITII FREE HANDSKETCHING

Representation of Three-Dimensional objects – General principles of orthographic projection – Need for importance of multiple views and their placement – First angle projection – layout views – Developing visualization skills through free hand sketching of multiple views from pictorial views of objects.

UNITIII INTRODUCTION TO COMPUTER GRAPHICS – 2D

Overview of Computer Graphics, listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars, Drawing Area, Dialog boxes and windows, Shortcut menus ,The Command Line (where applicable), Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids]; consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Annotations, layering & other functions.

UNITIV PROJECTION OF POINTS AND LINES

Projection of points and straight lines located in the first quadrant inclined to both planes– Determination of true lengths and true inclinations.

UNITV PROJECTION OF PLANESURFACES

Projection of polygonal surface and circular lamina inclined to both reference planes.

SUGGESTED READINGS

1. Venugopal K and Prabhu Raja V, (2015), Engineering Graphics, New Age InternationalPublishers.
2. C M Agrawal and Basant Agrawal, (2012), Engineering Graphics, Tata McGraw Hill, NewDelhi.
3. James D. Bethune, (2019), Engineering Graphics with AutoCAD ,Macromedia Press.
4. Narayana, K.L. & P Kannaiah, (2010), Text book on Engineering Drawing, ScitechPublishers.
5. Shah, M.B. & Rana B.C., (2010), Engineering Drawing and Computer Graphics, PearsonEducation.
6. Bhatt N.D., Panchal V.M. & Ingle P.R, (2014), Engineering Drawing, Charotar PublishingHouse.

SEMESTER II

20BEME201 **COMMUNICATIVE ENGLISH** **4H – 3 C**

Instruction hours / week L : 2 T : 0 P: 2 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

The goal of this course is for students to

1. To help students acquire their ability to speak effectively in real life situations.
2. To enable students to communicate in effective way without any barriers.
3. To inculcate the habit of listening and to develop their effective listening skills.
4. To ensure that students use different aids in order to attain effective communication.
5. To enable students to improve their group behavior and presentation skill.
6. To enable students to improve their lexical, grammatical and communicativecompetence.

COURSE OUTCOMES

Students undergoing this course will be able to

1 Enrich comprehension and acquisition of listening, speaking & writing ability.
2 Gain confidence in using English language and develop leadership qualities.
3 To guide the students to effectively manage the team as a team player.
4 To develop the students Interpersonal and Interview skills.
5 Use English language for communication: verbal & non –verbal
6 To enable students to prepare for oral communication in formal contexts.

Unit: I - COMMUNICATION SKILLS:

Communication Skills: Introduction, Definition, The Importance of Communication TheCommunication Process – Source, Message, Encoding, Channel, Decoding Receiver, Feedback, Context

Barriers to Communication: Physiological Barriers, Physical Barriers, Cultural Barriers, Language Barriers, Gender Barriers, Interpersonal Barriers, Psychological Barriers, Emotional Barriers

Perspectives in Communication: Introduction, Visual Perception, Language, Other factors affecting our perspective-Past Experiences, Prejudices, Feelings, Environment

Unit:1I - ELEMENTS OF COMMUNICATION Introduction, Face to Face Communication- Tone of Voice, Body Language (Non-verbal communication), Verbal Communication, Physical Communication.

Communication Styles: Introduction, The Communication Styles Matrix with example for each - Direct Communication Style, Spirited Communication Style, Systematic Communication Style, Considerate Communication Style.

Unit: III - BASIC LISTENING SKILLS

Introduction, Self-Awareness, Active Listening, Becoming anActive Listener, Listening in Difficult Situations.

Effective Written Communication: Introduction, When and When Not to Use Written Communication-Complexity of the Topic, Amount of Discussion's Required, Shades of Meaning, Formal Communication.

Writing Effectively: Subject Lines, Put the Main Point First, Know Your Audience Organization of the Message.

Unit: IV - INTERVIEW SKILLS AND GIVING PRESENTATIONS

Purpose of an interview, Do's and Don'ts of an interview- Dealing with Fears, planning your Presentation, Structuring YourPresentation, Delivering Your Presentation, Techniques of Delivery.

Unit: V.-WRITING PRACTICES

Group Discussion: Introduction, Communication skills in group discussion, Do's and Don'ts of group discussion

Note: Students shall have hands on training in improving Speaking skill in the language laboratory @ 2 periods per each unit.

SUGGESTED READINGS

1. SanjayKumar,Pushpalata, (2011),Communicationskills,1st EditionOxfordPress.
2. Konarnira, (2011), Communication Skills forprofessionals,2nd EditionNew arrivals.
3. John Adair, 4th Edition, (2009), . Effective communication, 1st EditionCengageLearning, India pvt.ltd
4. ButterField, (2011), Softskillforeveryone, Macmillan.
5. Stephen.P.Robbins, (2013).Communicationskills, OxfordPress

SEMESTER II

20BEME202 **MATHEMATICS - II** **4 H – 4 C**

Instruction hours / week L : 3 T : 1 P: 0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES:

The goal of this course is for the students

1. To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.
2. To calculate and establish identities connecting these quantities, to evaluate line, surface and volume integrals in simple coordinate systems and to use Gauss, Stokes and Greens theorems to simplify calculations of integrals and prove simple results.
3. To enable the students to apply the knowledge of Mathematics in various Engineering fields by making them to identify the functions in engineering problems as analytic function and their study as a function of a complex variables.
4. To develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence, to specify some difficult integration that appears in applications can be solved by complex integration in application areas such as fluid dynamics and flow of the electric current.
5. To equip the students to Understand the basic concepts of one- and two-dimensional random variables.
6. To use Laplace transforms efficiently for solving the problems that occur in various branches of engineering disciplines.

COURSE OUTCOMES:

Upon completion of this course the students will be able

1. To apply integration to compute multiple integrals, area, volume, integrals in polar and Cartesian coordinates, in addition to change of order and vector integration.
2. To acquaint the student with the concepts of vector calculus, needed for problems in all Engineering disciplines
3. To find the Analytic functions using the Cauchy Riemann equations and they will learn mapping properties of elementary functions and mapping properties of some special transcendental functions.
4. To understand relations between conformal mappings and quadratic differentials and how geometric structures are changing under conformal mappings.
5. To evaluate complex integrals using the Cauchy integral formula and the residue Theorem and to appreciate how complex methods can be used to prove some important theoretical results.
6. To evaluate Laplace transform and inverse transform of simple functions, properties, various related theorems and application to differential equations with constant coefficients

UNIT I - MULTIPLE INTEGRALS

Double integral – Cartesian coordinates – Polar coordinates – Area as double integrals -Change of order of integration – Triple integration in Cartesian co-ordinates

UNITII- VECTOR CALCULUS

Gradient, Divergence and Curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration – Green's theorem, Gauss divergence theorem and Stoke's theorems (Statement Only)- Surfaces : hemisphere and rectangular parallelopipeds.

UNITIII-ANALYTIC FUNCTIONS

Analytic functions - Cauchy-Riemann equations in Cartesian and polar forms – Sufficient condition for an analytic function (Statement Only) - Properties of analytic functions – Constructions of an analytic function - Conformal mapping: w = z+a, az, 1/z and bilinear transformation.

UNITIV-COMPLEX INTEGRATION

Complex Integration - Cauchy's integral theorem and integral formula (Statement Only) – Taylor series and Laurent series - Residues – Cauchy's residue theorem (Statement Only) - Applications of Residue theorem to evaluate real integrals around unit circle and semi circle (excluding poles on the real axis).

UNIT V - LAPLACE TRANSFORM

Transforms of elementary functions – Basic properties – Transforms of derivatives and integrals – Initial and final value theorems. Inverse Laplace transforms – Convolution theorem (statement only) – Solution of Ordinary Differential Equations with constant coefficients using Laplace transforms – Transform of periodic functions.

Total : 60

SUGGESTED READINGS:

1. Grewal, B.S., (2014), Higher Engineering Mathematics Khanna Publishers, New Delhi, 43rd Edition.
2. Kreyszig Erwin, (2016), Advanced Engineering Mathematics , John Wiley and Sons, 10th Edition, New Delhi.
3. Bali N. P and Manish Goyal, (2011), A Text book of Engineering Mathematics, Eighth Edition, Laxmi Publications Pvt Ltd.
4. Ramana B.V, (2008), Higher Engineering Mathematics, Tata McGraw Hill Publishing Company, New Delhi.
5. Kandasamy. P, Thilagavathy. K, Gunavathy. K.,(2008), Engineering Mathematics, S Chand & Co. Ltd, New Delhi.
6. Hemamalini. P.T**,** (2014), Engineering Mathematics**,** McGraw Hill Education (India) Private Limited, New Delhi.
7. Venkataraman, M. K., (2005), Engineering Mathematics, The National Publishing Company, Chennai.
8. Dass, H.K., and Er. Rajnish Verma,(2011), Higher Engineering Mathematics, S. Chand Private Ltd.
9. Glyn James,(2012), Advanced Modern Engineering Mathematics, 3rd Edition, Pearson Education,
10. Peter V. O'Neil,(2012), Advanced Engineering Mathematics, 7th Edition, Cengage learning.
11. Sastry.S.S,(2014), Engineering Mathematics''. Vol.I&II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi.
12. Wylie, R.C. and Barrett. L.C., (2012), Advanced Engineering Mathematics, Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi.
13. Narayanan. S, Manicavachagampillay.T.K and Ramaniah, (2002),Advanced Mathematics for Engineering Students, Viswanathan S.(Printers and Publishers) Pvt. Ltd. Chennai.

WEBSITES:

1. www.intmath.com
2. www.efunda.com
3. www.mathcentre.ac.uk
4. www.sosmath.com/diffeq/laplace/basic/basic.html

SEMESTER II

20BEME203 PHYSICS FOR MECHANICAL ENGINEERS 3 H – 3 C

Instruction hours / week L : 3 T : 0 P: 0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

The Goal of this course is for students to

1. Introduce the essential theorems, principles and its applications of Motion
2. Impart the basic knowledge about rigid body dynamics and friction.
3. Inculcate the concepts of viscosity and its measurement techniques.
4. To learn about the strengthening mechanisms for Non-ferrous alloys.
5. Disseminate the magnetic, dielectric and super conducting properties of materials and their applications.
6. Introduce the essential principles of materials science for mechanical and related engineering applications.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Have knowledge on the various types of motions and their applications.
2. Acquire knowledge on rigid body dynamics and friction.
3. Understand the concept of viscosity and various measurement techniques.
4. Gain knowledge on magnetic, dielectric and superconducting properties of materials.
5. Understand the basics of ceramics, composites and nanomaterials.
6. Get fundamental knowledge on engineering mechanics and composite materials.

UNIT I MOTION AND SYSTEM OF PARTICLES

Motion: Newton's Laws of Motion, Motion in a resistive medium; Drag force & Drag Coefficient, Drag force – derivation for velocity and position - terminal velocity.

System of particles: Centre of mass of rigid bodies – General expression; Newton's law for a system of particles; Linear momentum for a particle and a system of particles; Conservation of linear momentum; System with varying mass; Single stage Rocket, motion - Velocity & Acceleration with and without gravity; Elastic and inelastic collisions.

UNIT II DYNAMICS OF RIGID BODY AND FRICTION

Moment of Inertia - Kinetic energy and angular momentum of rotating body - centripetal and centrifugal force - Theorems of perpendicular and parallel axes - smooth surface - Compound pendulum - Centre of suspension and centre of oscillation - Centre of percussion - Minimum period of a compound pendulum - Kater's pendulum. Friction - Laws of friction - Resultant reaction - Angle and cone of friction - Equilibrium of a body on a rough plane inclined to the horizontal - The friction clutch.

UNIT III VISCOSITY

Newton's law of viscous flow - streamlined and turbulent motion - Reynold's number - Poiseuille's formula for the flow of a liquid through a horizontal capillary tube - Experimental determination of co-efficient of a liquid by Poiseuille's method - Ostwald's viscometer –Stokes' formula - Viscosity of gases - Meyer's formula - Rankine's method - Variation of viscosity with temperature and pressure - Lubrication. Equation of continuity of flow - Euler's equation for unidirectional flow - Bernoulli's theorem – Filter pump and Wings of aeroplane - Torricelli's theorem - Pitot tube.

UNIT IV MAGNETIC, DIELECTRIC AND SUPERCONDUCTING MATERIALS

Dia, Para, Ferromagnetic materials, Ferromagnetism – domain theory – types of energy – hysteresis – hard and soft magnetic materials – ferrites – dielectric materials – types of polarization –Lorentz field - Claussius – Mossotti Relation– frequency effects on polarization – dielectric breakdown – insulating materials – Ferroelectric materials – superconducting materials – properties - Applications.

UNIT V – NEW ENGINEERING MATERIALS

Ceramics - types and applications – composites: classification, role of matrix and reinforcement, processing of fiber reinforced plastics – metallic glasses: types , glass forming ability of alloys, melt spinning process, applications – shape memory alloys: phases, shape memory effect, pseudoelastic effect, NiTi alloy, applications – nanomaterials: preparation (bottom up and top down approaches), properties - applications – carbon nanotubes – applications.

SUGGESTED READINGS

1. Bhattacharya D.K. & Poonam T., Engineering Physics, Oxford University Press,(2015).
2. Halliday.D., Resnick R. & Walker. J, Principles of Physics, Wiley, (2015).
3. D.S. Mathur, Mechanics, S. Chand & Company Ltd., New Delhi –(1990).
4. K N SreenivasaRao, Classical Mechanics, Universities Press- Orient Longman (2003 ed)
5. Mechanics- Berkeley Physics Course Vol(1)- SI units CharlesKitteletal, McGrawHill Education (India) 2e (2011).

JOURNALS

1. Journal of Applied Mechanics (ASME)
2. Journal of Alloys and Compounds (ELSEVIER)
3. Ceramics International (ELSEVIER)
4. Magnetism and Magnetic Materials (ELSEVIER)
5. IEEE Transactions on Magnetics (IEEE)
6. Journal of Superconductor and Novel Magnetism (SPRINGER)

WEBLINKS

1. https://nptel.ac.in/courses/122104014/
2. https://nptel.ac.in/courses/118104008/
3. https://nptel.ac.in/courses/115101012/

SEMESTER II

20BEME241 **BASIC ELECTRICAL AND ELECTRONICS ENGINEERING (Theory & Laboratory)** **6 H – 5 C**

Instruction hours / week L : 3 T : 1 P: 2 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

THEORY

COURSE OBJECTIVES

1. To impart the basic knowledge about the Electric circuits.
2. To understand the concept of Electro Mechanical Energy Conversion and Transformers.
3. To understand the working of Semiconductor devices and Measuring Instruments.
4. To understand and analyze basic electric and magnetic circuits.
5. To study the working principles of electrical machines and power converters.
6. To impart the basic knowledge of Digital Circuits.

COURSE OUTCOMES

At the end of this course, students will be able to

1. Attributing the electric circuits with DC and AC excitation by applying various circuit laws.
2. Attributing the magnetic circuits and transformer.
3. Reproduce the two port networks.
4. Evaluate the various digital circuits in real time applications.
5. Analysis various semiconductor devices in real time applications.
6. Reproduce the Measuring Instruments.

UNIT I - DC CIRCUITS

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation.Superposition, Thevenin and Norton Theorems.

UNIT II - AC CIRCUITS

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

UNIT III - ELECTRICAL MACHINES AND TRANSFORMER

Construction and working of a three-phase and Single-phase induction motor. Construction, working and speed control of DC motor. Magnetic materials, BH characteristics, Construction and working principle of ideal and practical transformer.

UNIT IV- SEMICONDUCTOR DEVICES AND DIGITAL ELECTRONICS

Bipolar Junction Transistor – Characteristics. Introduction to operational Amplifier –Model– Applications.Number systems – binary codes - logic gates - Boolean algebra, laws & theorems

UNIT V- MEASURING INSTRUMENTS AND ELECTRICAL INSTALLATION

Principle, construction, and operation of moving coil and moving iron meters-Measurement of Power.Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, RCCB, MCCB. Earthing. Types of Batteries and its application in Electric Vehicle, Important Characteristics for Batteries. Elementary calculations for energy consumption and battery back up

SUGGESTED READINGS

1. S.K.Bhattacharya, “Basic Electrical Engineering”, Pearson, 2019.
2. E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.
3. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
4. A.Sudhaka and Shyammohan S Palli,(2013), Circuits and Networks, McGraw Hill.
5. R.Muthusubramanian and S.Salivahanan,(2014),Basic Electrical and Electronics Engineering, McGraw Hill.

WEBSITES:

1. www. nptel.ac.in.
2. encyclopedia-magnetica.com/doku.php/coenergy.
3. https://en.wikibooks.org/wiki/electronics/measuring instruments.

SEMESTER II

20BEME211 WORKSHOPPRACTICES 4 H – 2 C

Instruction hours / week L : 0 T : 0 P:4 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To prepare the students to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, andsustainability
2. To prepare the students to communicate effectively and to use the techniques, skills, and modern engineering tools necessary for engineeringpractice
3. To provide practical knowledge on preparing holes with higher finish by Drilling / Tapping / Reaming.
4. To facilitate the understanding of surface and cylindrical grinding operations for surface finish.
5. To introduce single and multi-point cutting tools.
6. To impart knowledge on the operations in Capstan and Turret Lathe.

COURSE OUTCOMES

Upon completion of this course, the students will gain

1. Knowledge of the different manufacturing processes which are commonly employed in the industry.
2. To fabricate components using differentmaterials.
3. Students will be able to fabricate components with their ownhands.
4. Acquire knowledge on the working principles of machines.
5. Practical knowledge of the dimensional accuracies and dimensionaltolerances possible with different manufacturingprocesses.
6. By assembling different components, they will be able to produce small devices of theirinterest.

(i) LECTURES &VIDEOS:

Detailed contents

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturingmethods
2. CNC machining, Additivemanufacturing
3. Fitting operations & powertools
4. Electrical &Electronics
5. Carpentry
6. Plastic molding, glasscutting
7. Metalcasting
8. Welding

(ii) WORKSHOPPRACTICE:

1. Machineshop
2. Fittingshop
3. Carpentry
4. Electrical &Electronics
5. Weldingshop
6. Casting
7. PlumbingExercises

SUGGESTEDREADINGS

1. Gowri S, Jeyapoovan, T.,Engineering Practices Lab Manual, 5th edition, Vikas Publishing House Pvt. Ltd, Chennai. 2017.
2. Bawa, H.S, Workshop Practice, 2nd edition, Tata McGraw – Hill Publishing Company Limited, New Delhi, 2009.
3. Choudhry S K, Elements of workshop technology, Vol 2, 13th edition, Indian book distributing company, Kolkatta,2010.
4. D K Singh, Manufacturing Technology, 2nd edition, Pearson Education,2008.
5. Kalpakjian S., Steven S. Schmid, Manufacturing Engineering and Technology, 4thedition,Pearson Education India Edition,2001.
6. Roy A. Lindberg, Processes and Materials of Manufacture, 4th edition, Prentice Hall India,1997.
7. Rao P.N., Manufacturing Technology, Vol. I and Vol. II, 4th edition, Tata McGrawHill House,2018.

SEMESTER II

20BEME212 ENGINEERING GRAPHICS-II 4 H – 2.5 C

Instruction hours / week L : 1 T : 0 P:3 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To prepare the students to make section of solids like Prism, Cylinder, and Pyramid.
2. To prepare true shape of section.
3. To gain the knowledge on lateral surfaces.
4. To acquire the knowledge about development of surfaces like Prisms, pyramids, cylinders and cones.
5. To gain the knowledge on 2D drawing using CAD software.
6. To acquire the knowledge on basics of 3D modeling packages.

COURSE OUTCOMES

On completion of this course, students will be able to

1. The students to draw section of solids like Prism, Cylinder, and Pyramid.
2. Students can prepare true shape of section.
3. Students gain the knowledge on lateral surfaces.
4. Students acquire the knowledge about development of surfaces like Prisms, pyramids, cylinders and cones.
5. Students gain the knowledge on 2D drawing using CAD software.
6. Students acquire the knowledge on basics of 3D modeling packages.

UNITI PROJECTION OFSOLIDS

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method.

UNITII SECTION OF SOLIDS

Sectioning of Prism, Cylinder, Pyramid, and Conein simple vertical position by cutting planes inclined to one reference plane and perpendicular to the other – Obtaining true shape of section.

UNITIII DEVELOPMENT OFSURFACES

Development of lateral surfaces of simple and truncated solids – Prisms, pyramids, cylinders and cones – Development of lateral surfaces of solids with cylindrical cutouts, perpendicular to the axis.

UNITIV COMPUTER GRAPHICS –3D

Introduction to3D modeling packages. Drafting practices - modeling of simple engineering components, sections and extraction of 2D drawings.

UNITV ISOMETRIC PROJECTIONS

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple solids, truncated prisms, pyramids, cylinders and cones; Conversion of Isometric Views to Orthographic Views and Vice-versa

SUGGESTED READINGS:

1. Venugopal K and Prabhu Raja V, (2015), Engineering Graphics, New Age InternationalPublishers.
2. C M Agrawal and Basant Agrawal, (2012), Engineering Graphics, Tata McGraw Hill, NewDelhi.
3. James D. Bethune, (2019), Engineering Graphics with AutoCAD,Macromedia Press.
4. Narayana, K.L. & P Kannaiah, (2010), A Text book on Engineering Drawing, ScitechPublishers.
5. Bureau of Indian Standards, (2003), Engineering Drawing Practices for Schools and Colleges SP 46, BIS, New Delhi.
6. Shah, M.B. & Rana B.C., (2010), Engineering Drawing and Computer Graphics, PearsonEducation.
7. Bhatt N.D., Panchal V.M. & Ingle P.R, (2014), Engineering Drawing, Charotar PublishingHouse.

SEMESTER – III

20BEME301 **MATHEMATICSIII** **4 H – 4 C**

Instruction hours / week L: 3 T: 1 P:0 **Marks:** Internal: **40** External: **60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES:

The goal of this course is for the students

1. To introduce the basic concepts of PDE for solving standard partial differential equations
2. To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
3. To provide an overview of probability and statistics to engineers
4. To introduce the basic concepts of two-dimensional random variables
5. To acquaint the knowledge of testing of hypothesis for small samples.
6. To acquaint the knowledge of testing of hypothesis for large samples this plays an important role in real life problems.

COURSE OUTCOMES:

Upon Completion of this course the students will be able

1. To solve field problems in engineering involving PDEs.
2. To Appreciate the physical significance of Fourier series techniques in solving one- and two-dimensional heat flow problems and one-dimensional wave equations.
3. To apply the basic concepts of probability and have knowledge of standard distribution which can describe real life phenomenon.
4. To apply one- and two-dimensional random variables to solveEngineering applications.
5. To formulate and solve problems involving random variables and apply statistical methods for analyzing experimental data
6. To apply the concept of testing of hypothesis for small and large samples in real life problems.

UNIT I - PARTIAL DIFFERENTIAL EQUATIONS

Definition of Partial Differential Equations, First order partial differential equations, solutions of first order linear PDEs; Solution to homogenous and non-homogenous linear partial differential equations of second order by complimentary function and particular integral method.

UNIT II - APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS

Second-order linear equations and their classification, Initial and boundary conditions, D'Alembert's solution of the wave equation; Duhamel's principle for one dimensional wave equation. Heat diffusion and vibration problems, Separation of variables method to simple problems in Cartesian coordinates. The Laplacian in plane, cylindrical and spherical polar coordinates, solutions with Bessel functions and Legendre functions. One dimensional diffusion equation and its solution by separation of variable.

UNIT III-PROBABILITY AND RANDOM VARIABLES

Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality. Continuous random varibales and their properties, distribution functions and densities, normal, exponential and gamma densities

UNIT IV - TWO -DIMENSIONAL RANDOM VARIABLES

Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule. Basic Statistics, Measures of Central tendency: Moments, skewness and Kurtosis -Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation. Curve fitting by the method of least squares-fitting of straight lines, second degree parabolas and more general curves.

UNIT V - TESTINGOF HYPOTHESIS

Test of significance: Large sample test for single proportion, difference of proportions, Tests for single mean, difference of means, and difference of standard deviations. Test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.

SUGGESTED READINGS:

1. Grewal B.S., ―Higher Engineering Mathematics‖, Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi
4. Publications, Reprint, 2010.
5. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).
6. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
7. Johnson, R.A., Miller, I and Freund J., "Miller and Freund‘s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
8. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.
9. Devore. J.L., "Probability and Statistics for Engineering and the Sciences‖, Cengage Learning, New Delhi, 8th Edition, 2014.
10. Papoulis, A. and UnniKrishnapillai, S., "Probability, Random Variables and Stochastic Processes", McGraw Hill Education India, 4th Edition, New Delhi, 2010.
11. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.
12. Spiegel. M.R., Schiller. J. and Srinivasan, R.A., "Schaum‘s Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.
13. Walpole. R.E., Myers. R.H., Myers.S.L. and Ye.K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th Edition, 2007.
14. Johnson, R.A., Miller, I and Freund J., "Miller and Freund‘s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

WEBSITES:

1. www.cut-theknot.org/probability.shtml
2. www.mathcentre.ac.uk
3. www.mathworld. Wolfram.com
4. www.sosmath.com

SEMESTER – III

20BEME302 **ENGINEERINGMECHANICS** **4 H – 4 C**

Instruction hours / week L : 3 T : 1 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVE

The goal of this course is for students

1. To develop capacity to predict the effect of force and motion.
2. To understand the importance of free body diagram for complex machine structure.
3. To perform force analysis using law of mechanics.
4. To introduce the concepts of static equilibrium condition for particles and rigid bodies
5. To understand the concepts of kinematics of particles and friction.
6. To make the students conversant to solve the problems using equation of motions.

COURSE OUTCOMES

At the end of the course the students will be able to

1. Understand the concepts of force, laws of mechanics and unit systems.
2. Develop free body diagrams for a mechanical system and to apply equilibrium conditions for effective design.
3. Determine the centroid and second order moment fora plane figure.
4. Analyze statically determinate planarframes.
5. Analyze the motion and calculate trajectorycharacteristics.
6. Understand the concepts of kinetics of particles and friction.

UNITI STATICS OFPARTICLES

Forces – system of forces – concurrent forces in plane and space– resultant – problems involving the equilibrium of a particle–free body diagram–equilibrium of particle in space.

UNITII STATICS OF RIGID BODIES IN TWODIMENSIONS

Rigid bodies–moment of force about an axis– Varignon's theorem – moment and couple - equivalent system of coplanar forces– Rigid body in equilibrium–problems involving equilibrium of rigid body–types of supports– reactions of beams – trusses and frames

UNITIII CENTROID, CENTRE OF GRAVITY AND MOMENT OFINERTIA

Centroid – plane and composite areas, Parallel axis theorem and Perpendicular axis theorem - determination of moment of inertia of plane figures, polar moment of inertia – radius of gyration – mass moment of inertia of simple solids.

UNITIV KINEMATICS OFPARTICLES

Introduction – plane, rectilinear motion – time dependent motion – rectangular coordinates – projectile motion.

IMPULSE AND MOMENTUM: Concept of conservation of momentum – Impulse–Momentum principle– Impact – Direct central impact – Oblique central impact – Impact of elastic bodies.

UNIT V KINETICS OF PARTICLES AND FRICTION

KINETICS OF PARTICLES: Equations of motion–rectilinear motion–Newton's II law – D'Alembert's principle – Energy – potential energy–kinetic energy–conservation of energy–work done by a force – work energy method.

Laws of friction – coefficient of friction– Angle of repose - problems involving dry friction – wedge and ladder friction.

SUGGESTED READINGS

1. Ferdinand P. Beer, J.R Russell Johnston, David F. Mazurek, S. Brian and Dr.SanjeevSanghi, Vector Mechanics for Engineers–Statics and Dynamics, 12th Edition, Tata Mc–Graw Hill Publishing Co. Ltd., New Delhi,2019
2. Bansal R K, Engineering Mechanics, 4th edition, Laxmi Publications Pvt. Ltd., New Delhi,2016
3. Young D H and Timashenko S, Engineering Mechanics, 5th Edition, Tata McGraw–Hill, New Delhi,2015
4. N H Dubey, Engineering Mechanics: Statics and Dynamics, 1st Edition, Tata McGraw–Hill, New Delhi,2017.

SEMESTER – III

20BEME303 **THERMODYNAMICS** **4 H – 4 C**

Instruction hours / week L : 3 T : 1 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVE

The goal of this course is for students

1. To understand theModel of physical systems into relevant thermodynamic system and apply energy balance equation for closed and open system.
2. To provide knowledge on entropy change in thermodynamic processes.
3. To Study and acquire knowledge on various thermodynamic properties of pure substances in real time problems.
4. To establish the basic thermodynamic relations and properties of ideal and real gases for physical systems.
5. To facilitate the understanding of properties of air using psychometric chart.
6. To acquaint the student with the conceptsand applications of the thermodynamics to the various real-life systems.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Understand the first law and able to differentiate closed and open system, also able to apply first law to both types ofsystems
2. Define the physical description of second law and its application to heat engine, refrigerator and heat pump.
3. Also understand the concepts of entropy and able to find out the entropy generated in a thermodynamic system
4. Understand the properties of pure substance and ideal gasconcepts
5. Describe the importance of availability concept and able to apply the thermodynamic relations in applications.
6. Understand the psychrometric properties and various processes to create human comfort at various physicalconditions.

UNIT I BASIC CONCEPTS AND FIRSTLAW

Basic concepts - Classical and Statistical approaches - Thermodynamic systems - closed, open, isolated. Property – State - Process-adiabatic - Quasi-static process – Cycle - Point and Path function – Energy - Work transfer - Concept of temperature and heat- Zeroth law of thermodynamics - Concept of ideal gases - First law of thermodynamics –PMM1, internal energy, specific heat capacities, enthalpy, and its application to closed system and open system-steady flow energyequation.

UNITII SECOND LAW ANDENTROPY

Physical description of the second law - Kelvin-Planck and Clausius statements –Equivalence - Reversible processes and cycles- Carnot cycle – Corollaries - Absolute temperature scale – Clausius Theorem, inequality - Entropy- Principle, transfer, generation, balance - Third law of thermodynamics

UNIT III THERMODYNAMIC AVAILABILITY ANDRELATIONS

Basics-Dead state, quality of energy, degradation of energy - Reversible processes – Maximum work - Exergy – Closed system - Steady flow system – Irreversibility - Exergy Balance - Second law efficiency – Exact differentials - Tds Relations - Maxwell's Relation – Clausius – Clapeyron Equation - Joule-Thompson Coefficient.

UNITIV PROPERTIES OF PURE SUBSTANCE AND GASMIXTURES

Pure substance - Phase change process - Property diagrams - PVT surface - Steam – types, dryness fraction - Avogadro's law - Ideal Gas - Equations of state-Vander Waal's equation - Real Gas - Compressibility and its chart - Mixtures of Gases – Properties.

UNITV PSYCHROMETRY

Psychrometry - Psychrometric charts - Property calculations of air vapour mixtures- Psychrometric Process-Adiabatic mixing - Evaporative cooling.

(Permitted to use standard thermodynamic table, Mollier diagram, and Psychometric chart in the examination)

SUGGESTED READINGS

1. Nag P K, Engineering Thermodynamics, 6th Edition, Tata McGraw-Hill, New Delhi,2017
2. Yunus A. Cengel and Michael A. Boles, Thermodynamics-An Engineering Approach, 8th Edition, Tata McGraw-Hill, New Delhi,2015
3. C P Arora, Thermodynamics, 12th Reprint, McGraw-Hill, NewDelhi,2007
4. Kothandaraman C P and Domkundwar S, A Course in Thermal Engineering, DhanpatRai& Company (P) Limited, New Delhi,2010.

SEMESTER – III **5 H – 4 C**

20BEME344 **MANUFACTURING TECHNOLOGYI**

(Theory & Laboratory)

Instruction hours / week L :3 T : 0 P:2 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

(i) THEORY

COURSE OBJECTIVE

1. To familiarize the students to apply suitable molding and casting methods for producing components.
2. To develop anunderstanding of types of metal joining processes.
3. To explain types of deformation processes.
4. To understand the concept of sheet metal operations and metal forming processes.
5. To provide an overview of various plastic component manufacturing processes for various applications.
6. To Study and acquire knowledge of process variables to manufacture defect free products.

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Apply suitable molding and casting methods for producingcomponents.
2. Know the methods of inspecting thecastings
3. Decide the type of metal joiningprocesses.
4. Work with various metal formingprocesses
5. Work with various sheet metaloperations.
6. Select the type of deformationprocesses.

UNITI **CASTING PROCESSES**

Sand Casting: Sand Mould – Pattern making: Pattern Materials, Pattern types and Pattern allowances – Moulding Sand properties and testing – Cores –Types and applications. Melting Furnaces: Cupola, Electric and Induction Furnaces. Special Casting Processes: Shell - Investment – Die casting - Centrifugal Casting – Stir casting. Casting Defects and Inspection of Casting: Destructive and Non-Destructive Testing (NDT) Methods.

UNITII **JOINING PROCESSES**

Basics of Welding – Classification of welding methods. Gas welding - Types – Flame characteristics. Arc Welding: Manual Metal Arc Welding – MIG and TIG Welding – Submerged arc welding –Operating principle and applications of: Resistance Welding - Plasma Arc welding– Electron Beam welding - Soldering and Brazing- WeldDefects.

UNITIII **METAL FORMINGPROCESSES**

Hot working and cold working of metals – Forging processes – Open and Closed Die Forging – Forging operations. Rolling: Types of Rolling Mills -Applications – Defects in rolled parts. Extrusion – Forward and Backward Extrusion, Applications. Drawing: Wire drawing – Tube Drawing-Applications.

UNITIV **SHEET METALOPERATIONS**

Sheet metal characteristics – Operations: Shearing, Bending and Drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes-Working principle and applications – Hydro forming – Metal spinning – Explosive forming: Confined and Unconfined system-Magnetic pulse forming.

UNITV **POWDER METALLURGYPROCESS**

Introduction to Powder Metallurgy process – Preparation of powders – types and functions of binders – blending - green compaction – sintering process and its effect on the product. Applications.

SUGGESTED READINGS

1. SeropeKalpajian, Steven R.Schmid, Manufacturing Engineering and Technology, 4th edition, Pearson Education, Inc., New Delhi,2014
2. D. K. Singh, Manufacturing Technology, 2nd edition, Pearson Education, Inc., New Delhi,2008
3. P.N. Rao, Manufacturing Technology: Vol I, 4th edition, Tata McGraw–Hill Publishing Limited, New Delhi,2013
4. P.C. Sharma, A text book of production technology, 4thEdition, S. Chand and Company, New Delhi,2014
5. Phillip F. Ostwald, Jairo Munoz, Manufacturing Processes and Systems, 9thedition, John Wiley and Sons, 2005.

(ii) LABORATORY

COURSE OBJECTIVES:

- To teach the process-level dependence of manufacturing systems throughtolerances
- To expose the students to a variety of manufacturing processes including their typical use andcapabilities.
- To teach the important effects that manufacturing processes may have on the material properties of the processed part with a focus on the most commonprocesses.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the idea for selecting materials forpatterns.

2. Types and allowances of patterns used in casting and analyze the components ofmoulds.

3. Design core, core print and gating system in metal castingprocesses

4. Understand the application of arc and gas welding inindustries.

5. Understand the principle behind the sheet metal formingprocess

6. Understand the working of the powder metallurgyprocess

LIST OF EXCERCISES

METAL CASTING:

- Pattern Design and making – for one castingdrawing.
- Sand properties testing – Exercise -for strengths, andpermeability
- Moulding Melting andCasting

WELDING:

- Exercises in ARCWelding
- Exercises in GASWelding

SHEET METAL FORMING

- Develop a flat blank layout from an assembly print, transfer the layout to the sheet metal, cut and form to the desiredshape

POWDER METALLURGY

- Form parts from metallic powders, record and plot pressing data, perform destructives tests on sintered powder metalparts.

SEMESTER – III

20BEME311 **MACHINEDRAWING** **4 H – 3 C**

Instruction hours / week L :2 T : 0 P:2 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

The goal of this course is for students

1. To explain the surfaces for sheet metal working applications.
2. To Understand the representation of details in machine drawing.
3. To introduce tolerances and fits of machine elements.
4. To equip them with skills to construct an assembly drawing using part drawings of machine components.
5. To equip them with skills to construct an assembly drawing of machine components using 2D drafting.
6. To equip them with skills to develop employability.

COURSEOUTCOMES

Learners should be ableto

1. Express the importance of machine drawing andGD&T.
2. Interpret drawings of machinecomponents.
3. Create assembled machinedrawings.
4. Make part drawings from an assemblydrawing.
5. Interpret the details of complex parts in cross sectionviews.
6. Sketch production drawing from assemblydrawing.

INTRODUCTION

Introduction to machine drawing. Importance of sectional views. Computer-aided drafting. Introduction to Geometric dimensioning and Tolerancing –Terms and definitions – Common symbols and Terminology – Fundamental Rules (Drawing)– Feature definition.

CONVENTIONS

Code of practice for engineering drawing-conventional representation of details- drilled and tapped holes, countersunk and counter bored holes, internal and external threads, undercuts, grooves, chamfers, fillet radii and keyways. Conventions to represent standard components-bolts, nuts, washers, screws, cotters, pins, circlips, bearings, gears, springs andflanges.

FITS AND TOLERANCES

Introduction to Limits, fits and tolerances-need, types, representation of tolerances on drawing, calculation of minimum and maximum clearances and allowances. Geometric tolerance-uses, types of form and position tolerances, symbols, method of indicating geometric tolerances on part drawings. Surface finish symbols-methods of indicating the surface roughness.

ASSEMBLY DRAWING PRACTICE

Making free hand sketches of typical subassemblies-flange coupling, stuffing box, journal bearings, rolling element bearings, keyed joints, cotter joints.

ASSEMBLY DRAWING PRACTICE USING CAD SOFTWARE

Assembly drawing - sectioning and bill of materials.Drawings of assemblies: Lathe Tail stock, Machine vice, Pedestal bearing and Plummer block.

SUGGESTED READINGS

1. Gopalakrishna K R, Machine Drawing, Subhas Stores, Bangalore,2017.
2. Ajeet Singh, Machine Drawing: Includes AutoCAD, Tata McGraw Hill, New Delhi,2012
3. Bhatt N. D and Panchal V.M, Machine Drawing, Charotar Publishing House, Chennai,2016.
4. ASME Y 14.5M-1994, Dimensioning and Tolerancing, ASME, New York,1995.

SEMESTER III - VALUE ADDED COURSE

20BEME351 **CONSTITUTIONOFINDIA** **1 H – 0 C**

Instruction hours / week L : 1 T : 0 P:0 **Marks:** Internal **: 100** External **: ---** Total**:100**

COURSE OBJECTIVES

1. To know about Indianconstitution.
2. To know about central government functionalities inIndia.
3. To know about state government functionalities inTN.
4. To know the relations between central and state government.
5. To know about Right of Women and Children.
6. To know about Indiansociety.

COURSE OUTCOMES

Upon completion of the course, students will be able to:

1. Understand the functions of the Indiangovernment.
2. Understand the functions of the stategovernment.
3. Understand the relations between central and state government.
4. Understand and abide the rules of the Indianconstitution.
5. Understand and appreciate different culture among thepeople.
6. Understand the Rights of Women, Children and other Weaker Sections.

UNITI INTRODUCTION

HistoricalBackground–ConstituentAssemblyofIndia–PhilosophicalfoundationsoftheIndian Constitution –Preamble–FundamentalRights–DirectivePrinciplesofStatePolicy–Fundamental Duties–Citizenship– Constitutional Remedies for citizens.

UNITII STRUCTURE AND FUNCTION OF CENTRALGOVERNMENT

Union Government – Structures of the Union Government and Functions - all India services – President – Vice President– Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

UNITIII STRUCTURE AND FUNCTION OF STATEGOVERNMENT

State Government – Structure and Functions – State recruiting agents – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts.

UNITIV CONSTITUTIONFUNCTIONS

Indian Federal System – Center – State Relations – President's Rule – Constitutional Amendments – Constitutional Functionaries - Assessment of working of the Parliamentary System in India.

UNITV INDIANSOCIETY

Society: Nature, Meaning and definition; Indian Social Structure; Caste, Religion, Language in India; Constitutional Remedies for citizens – Political Parties and Pressure Groups; Right of Women, Children and Scheduled Castes and Scheduled Tribes and other Weaker Sections.

SUGGESTED READINGS

1. Durga Das Basu, Introduction to the Constitution of India, Prentice Hall of India, NewDelhi
2. R.C.Agarwal, (1997).Indian Political System ,S.Chand and Company, NewDelhi,
3. Maciver and Page, Society: An Introduction Analysis, Mac Milan India Ltd, NewDelhi
4. K.L.Sharma(1997)., Social Stratification in India: Issues and Themes , Jawaharlal Nehru University, New Delhi,
5. Sharma, Brij Kishore,(2011)., Introduction to the Constitution of India, Prentice Hall of India, NewDelhi,
6. U.R.Gahai, (1998).Indian Political System, New Academic Publishing House, NewDelhi,.
7. R.N. Sharma, (1987).Indian Social Problems, Media Promoters and Publishers Pvt. Ltd, NewDelhi,

SEMESTER – IV

20BEME401 ENVIRONMENTALSTUDIES 3 H – 3 C

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

COURSE OBJECTIVES

The goal of this course is for students

1. To create the awareness about environmental problems amongpeople.
2. To develop an attitude of concern for theenvironment.
3. To motivate public to participate in environment protection andimprovement.
4. To demonstrate proficiency in quantitative methods, qualitative analysis, and critical thinking.
5. To develop writing and oral communication needed to conduct high-level work as interdisciplinary scholars and / orpractitioners.
6. To Learn about the systems concepts and methodologies to analyze and understand interactions.

COURSE OUTCOME

1. Master core concepts and methods from ecological and physical sciences and their application in environmental problemsolving.
2. Master core concepts and methods from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies andinstitutions.
3. Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
4. Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to globalscales.
5. Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.
6. Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnectedworld.

UNITI INTRODUCTION - ENVIRONMENTAL STUDIES &ECOSYSTEMS

Environment Definition, Scope and importance; Ecosystem, Structure and functions of ecosystem. Energy flow, Food chains and food webs, Ecological succession. Classification of ecosystem. Forest ecosystem, Grassland Ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

UNITII NATURAL RESOURCES - RENEWABLE AND NON-RENEWABLE RESOURCES

Natural resources - Renewable and Non – Renewable resources. Land resources and land use change, Land degradation, soil erosion and desertification. Forest resources - Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water resources - Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water. Use of alternate energy sources, growing energy needs, case studies. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

UNITIII BIODIVERSITY AND ITSCONSERVATION

Levels of biological diversity - genetic, species and ecosystem diversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value. Bio-geographical classification of India. Biodiversity patterns (global, National and local levels). Hot-spots of biodiversity. India as a mega-diversity nation. Endangered and endemic species of India. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

UNITIV ENVIRONMENTAL POLLUTION

Definition, causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution. Nuclear hazards and human health risks. Solid waste management and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Casestudies.

UNIT V SOCIAL ISSUES AND THE ENVIRONMENT

Concept of sustainability and sustainable development. Water conservation - Rainwater harvesting, watershed management. Climate change, global warming, ozone layer depletion, acid rain and its impacts on human communities and agriculture. Environment Laws (Environment Protection Act, Air Act, Water Act, Wildlife Protection Act, Forest Conservation Act). International agreements (Montreal and Kyoto protocols). Resettlement and rehabilitation of project affected persons. Disaster management (floods, earthquake, cyclones and landslides). Environmental Movements (Chipko, Silent valley, Bishnois of Rajasthan). Environmental ethics: Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi). Human population growth: Impacts on environment, human health and welfare.

SUGGESTED READINGS

1. Anonymous. 2004. A text book for Environmental Studies, University Grants Commission andBharat Vidypeeth Institute of Environmental Education Research, NewDelhi.
2. AnubhaKaushik., and Kaushik, C.P. 2004. Perspectives in Environmental Studies. New Age International Pvt. Ltd. Publications, NewDelhi.
3. Arvind Kumar. 2004. A Textbook of Environmental Science. APH Publishing Corporation, NewDelhi.
4. Daniel, B. Botkin., and Edward, A. Keller. 1995. Environmental Science John Wiley and Sons, Inc., New York.
5. Mishra, D.D. 2010. Fundamental Concepts in Environmental Studies. S.Chand& Company Pvt. Ltd., New Delhi.
6. Odum, E.P., Odum, H.T. and Andrews, J. 1971. Fundamentals of Ecology. Philadelphia:Saunders.
7. Rajagopalan, R. 2016. Environmental Studies: From Crisis to Cure, Oxford UniversityPress.
8. Sing, J.S., Sing. S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand & Publishing Company, NewDelhi.
9. Singh, M.P., Singh, B.S., and Soma, S. Dey. 2004. Conservation of Biodiversity and Natural Resources. Daya Publishing House, NewDelhi.
10. Tripathy. S.N., and Sunakar Panda. (2004). Fundamentals of Environmental Studies (2nd ed.). Vrianda Publications Private Ltd, NewDelhi.
11. Verma, P.S., and Agarwal V.K. 2001. Environmental Biology (Principles of Ecology). S. Chand and Company Ltd, NewDelhi.
12. Uberoi, N.K. 2005. Environmental Studies. Excel Books Publications, NewDelhi.

SEMESTER – IV

20BEME442 MANUFACTURINGTECHNOLOGY II 5 H – 4 C

(Theory & Laboratory)

Instruction hours / week L :3 T : 0 P:2 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

(i) THEORY

COURSE OBJECTIVE

1. To explain the mechanics of metal cutting, cutting tool materials, tool wear and cutting fluids.
2. To understand the concept of constructional features of different types of lathe and their operations.
3. To provide knowledge onconstruction & working of shaping, milling &drilling machines and gear cutting & finishing process.
4. To expose students tovarious types of grinding machines and broaching machines.
5. To explain the construction features of different types of CNC machine and manual part programming for a given component.
6. To perform part programming for CNC machines.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Calculate the cutting force during machining and other parameters related to metalcutting
2. Know the working of various conventional machinetools
3. Prepare manual part programming for simple components for a CNCmachine
4. Select the various abrasive processes for different machiningconditions.
5. Differentiate and select the various surface finishing methodsused
6. Explain the working of the electrical and electro chemical machiningprocesses.

UNIT I THEORY OF METALCUTTING

Mechanics of chip formation, cutting forces during machining, Types of Chips, cutting tools– Single point and multipoint cutting tools: Tool angles and Nomenclature of cutting tools. Orthogonal and Oblique cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish - cutting fluids: Types, characteristics, functions. Machinability: Definition and Factors influencing machinability.

UNITII CONVENTIONAL MACHINETOOLS

Lathes: Working principle, constructional details, specification, operations – Taper turning -Thread cutting methods - Special attachments - Capstan and Turret Lathes – Automats. Construction, working principle and types of operations of: Shaper, Planer, Slotting machine -, Drilling Machine - Milling Machine

UNIT III CNC MACHINING

Numerical Control (NC) machine tools – Computer Numerical Control (CNC) Machines: Types, Constructional details, special features - Machining Centre - Part programming fundamentals CNC Manual part programming – micromachining – wafer machining.

UNITIV ABRASIVEPROCESSES

Abrasive Processes: Grinding: Principle of grinding, grinding machine parts, types, grinding wheel – specifications and selection, types of grinding process– cylindrical grinding, surface grinding, centerless grinding - Typical applications – concepts of surface integrity- Broaching machines: Broach construction – push, pull, surface and continuous broaching machines. Surface finishing methods: Lapping, Honing and Super finishing. Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining - Working Principle and Construction - Applications.

UNITV ELECTRICAL AND ELECTRO-CHEMICAL ENERGY BASEDPROCESSES

Electric Discharge Machining (EDM)- Working Principle- EDM equipment's parts - electrode / Tool –Dielectric – Flushing – Wire cut EDM – Applications. Chemical machining and Electro-Chemical machining (CHM and ECM) - Etchants – Maskant - techniques of applying maskants - Applications. Principles of ECM- equipment's-Surface Roughness and material removal rate. Electrochemical Grinding and Electrochemical Honing - Applications.

SUGGESTED READINGS

1. P.N. Rao, Manufacturing Technology: Vol I, 4th edition, Tata McGraw–Hill Publishing Limited, New Delhi,2013
2. P.C. Sharma, A text book of production technology, 4thEdition, S. Chand and Company, New Delhi,2014
3. Phillip F. Ostwald, Jairo Munoz, Manufacturing Processes and Systems, 9thedition, John Wiley and Sons, 2005.
4. S K Choudhury, Elements of Workshop Technology Vol– II, 13th edition, Media Promotors Pvt Ltd., Mumbai, 2010
5. Hindustan Machine Tools, Production Technology, 1st edition, Tata McGraw–Hill,2001
6. Steve F. Krar, Arthur R. Gill and Peter Smid, Technology of Machine Tools, 7th edition, Tata McGraw– Hill,2013
7. Milton C. Shaw, Metal Cutting Principles, 2nd edition, Oxford University Press,2004

(ii) LABORATORY

COURSE OBJECTIVE

1. To Study and acquire knowledge on various basic machining operations in special purpose machines and its applications in real life manufacture of components in theindustry

COURSE OUTCOME

Upon completion of this course, the students will be able to
1. Perform shapingoperation
2. Perform milling & slottingoperation
3. Perform drilling, tapping and reamingoperation
4. Perform grindingoperations
5. Work with tool grindingmachine
6. Work in a capstan and turretlathe

LIST OF EXERCISES

1. Exercises inshaping.
2. Exercises inMilling.
3. Exercises inslotting.
4. Exercises in Drilling / Tapping /Reaming.
5. Exercises in Surface grinding and cylindrical grindingprocess.
6. Exercises in Tool grinding – single point and multi pointtools.
7. Exercises in Capstan and TurretLathe.

SEMESTER – IV

20BEME443 **APPLIEDTHERMODYNAMICS** **6 H – 5 C**

(Theory & Laboratory)

Instruction hours / week L : 3 T : 1 P:2 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

(i) THEORY

COURSE OBJECTIVES

The goal of this course is for students

1. To incorporate the concepts and laws in thermodynamic analysis of cyclicprocesses.
2. To impart the mechanisms of combustion offuels.
3. To apply the thermodynamic concepts in steam turbines andnozzles.
4. To learn about the performance ofcompressors.
5. To understand the concept of cogeneration and waste heat recovery in engineeringapplications.
6. To introduce concepts of refrigeration and air conditioning in engineeringapplications

COURSE OUTCOMES

Learners should be able to

1. Calculate the efficiency of various gas powercycles.
2. Calculate the performance characteristics ofengines.
3. Analyze combustion mechanism in ICengines.
4. Evaluate the characteristic of steam turbines andnozzles.
5. Evaluate the performance characteristics ofcompressors.
6. Identify and utilize the concepts of refrigeration and air conditioning in engineeringapplications

UNIT I STEAM POWER CYCLES AND STEAM NOZZLES

Introduction to steam power cycle – Rankine cycle, Reheated Rankine cycle, Regenerated Rankine cycle. Formation of Steam – PVT behaviour of pure substance - steam nozzles – flow through steam nozzles, effect of friction, critical pressure ratio, super saturated flow.

UNITII ICENGINE

Introduction to IC engines – classifications of IC engine - valve timing diagram and port timing diagram – fuel supply system – CRDI, MPFI – octane, cetane number - calculation of engine performance, heat balance sheet, retardation – Morse test.

UNITIII GAS POWER CYCLES

Otto, Diesel, Dual, Brayton cycles – actual and theoretical PV and TS diagram – Calculation of mean effective pressure and air standard efficiency

UNITIV REFRIGERATION AND AIRCONDITIONING

Fundamentals of refrigeration – COP – Vapour compression refrigeration system – cycle, p–h chart, Vapour absorption system – comparison, properties of refrigerants. Fundamentals of air conditioning system, cycle, controls, air handling and distribution, simple cooling and heat load estimation

UNITV AIR COMPRESSORS

Classifications of compressors – Reciprocating air compressor – Rotary compressor – vane type, centrifugal and axial, flow performancecharacteristics, effect of clearance volume, free air delivery and displacement, intercooler, after cooler.

(Permitted to use standard thermodynamic table, Mollier diagram, Psychometric chart and Refrigeration property table in the examination)

SUGGESTED READINGS

1. Rajput R.K, Thermal Engineering, 10th Edition, Laxmi Publications, New Delhi,2018
2. Arora C.P, Refrigeration and Air conditioning, 3rd edition, Tata McGraw–Hill, New Delhi,2008
3. Kothandaraman C.P, and Domkundwar A.V, A course in Thermal Engineering, 5thEdition, DhanpatRai and Sons, Delhi,2006
4. Ganesan V, Internal Combustion Engines, 4thedition, Tata McGraw–Hill, New Delhi,2012
5. Yunus A Cengel, Thermodynamics' An Engineering Approach, 8thedition, Tata McGraw Hill, New Delhi, 2015

(ii) LABORATORY

COURSEOBJECTIVE

The goal of this course is for students

1. Ability to conduct experiment on IC engine to study the characteristic and performance of IC design/ steamturbines.

COURSE OUTCOME

Upon completion of this course, the students will be able to

1. conduct experiment on IC engine to study the characteristic and performance of ICEngine
2. conduct experiment to find the thermo physical properties of givenfluid.

LIST OF EXPERIMENTS

I C ENGINES AND FUELS

1. Valve Timing and Port TimingDiagrams.
2. Performance Test on 4–stroke CIEngine.
3. Heat Balance Test on 4–stroke CIEngine.
4. Load test on 4–stroke CIEngine.
5. Retardation Test to find Frictional Power of a CIEngine.
6. Determination of Viscosity – Red WoodViscometer.
7. Determination of Flash Point and FirePoint.
8. Performance test on single/two stage reciprocating aircompressor.
9. Determination of COP of a refrigerationsystem
10. Experiments on air–conditioningsystem

SEMESTER – IV **6 H – 5 C**

20BEME444 **STRENGTH OFMATERIALS**

(Theory & Laboratory)

Instruction hours / week L : 3 T : 1 P:2 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

(i) THEORY

COURSE OBJECTIVES

The goal of this course is for students

1. To understand the concepts of stress and strain on deformation of solids.
2. To introduce the Concepts of safe working stresses and loads carrying capacity of beams.
3. To enrich the understanding of deflection in beams and columns in engineering applications.
4. To understand the importance of the effect of torsion on shafts and springs.
5. To provide knowledge on principal stresses and analyze thin cylinders and shells subjected to pressure forces.
6. To provide knowledge on components subjected to various loadings with the help of various theories of failures.

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Determine stress and strain on deformation ofsolids.
2. Draw the shear force and bending moment diagram for various types ofbeams.
3. Compute safe working stresses and load carrying capacity ofbeams.
4. Estimate the deflection in beams and columns in engineeringapplications.
5. Determine principal stresses and analyse thin cylinders and shells subjected to pressureforces.
6. Analyse the effect of torsion on shafts andsprings.

UNIT I STRESS, STRAIN AND DEFORMATION OFSOLIDS

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 – Strain energy and unit strain energy – Strain energy in uniaxialloads.

UNITII BEAMS – LOADS ANDSTRESSES

Types of beams: Supports and Loads – Shear force and Bending Moment in beams – Cantilever, Simply supported and Overhanging beams – Relationship between load, shear force and bending moment – Stresses in beams – Theory of simple bending – Stress variation along the length and in the beam section – Effect of shape of beam section on stress induced – Shear stresses in beams – Shear flow.

UNIT III BEAMDEFLECTION

Elastic curve of Neutral axis of the beam under normal loads – Evaluation of beam deflection and slope: Macaulay Method – Columns – End conditions – Equivalent length of a column – Euler equation – Slenderness ratio – Rankine's formula forcolumns

UNITIV TORSION

Analysis of torsion of circular bars – Torsional Shear stress – Bars of solid and hollow circular section – Stepped shaft –Torsional rigidity – Compound shafts – Fixed and simply supported shafts – Application to close–coiled helical springs – Maximum shear stress in spring section including Wahl Factor – Deflection of helical coil springs under axial loads – Design of helical coil springs – stresses in helical coil springs under torsion loads

UNITV SHELLS AND PRINCIPAL STRESSES

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

SUGGESTED READINGS

1. Dr. R. K. Bansal, A TEXTBOOK OF STRENGTH OF MATERIALS, 6th edition, Lakshmi Publications ltd, Chennai, 2019.
2. U C Jindal, Strength of Materials, 2nd edition, Pearson Education, 2018.
3. S S Rattan, Strength of materials, 3rd edition, Tata McGraw-Hill Publishing Co, 2016
4. Ferdinand Beer and E. Johnston and John DeWolf and David Mazurek, Mechanics of Materials, 8th edition, Tata McGraw-Hill Publishing Co, 2019
5. R S Khurmi& N. Khurmi, A Textbook of Strength of Materials (Mechanics of Solids), 26th Edition, S. Chand Publications, 2019.

(ii) LABORATORY

COURSEOBJECTIVE

The goal of this course is for students

1. To perform different destructivetesting
2. To learn the characteristicmaterials.
3. To understand the stress and strain relationship.
4. To determine the shear force for various materials.
5. To determine the impact load for various materials.
6. To determine the hardness for various materials

COURSE OUTCOMES

1. Ability to perform different destructivetesting
2. Ability to characteristicmaterials.
3. Understand the stress and strain relationship.
4. Determine the shear force for various materials.
5. Determine the impact load for various materials.
6. Determine the hardness for various materials

LIST OF EXPERIMENTS

1. Tensile test on metals–stress straincharacteristics
2. Cupping test on metal sheets–load deformation characteristics, cupping load, cuppingnumber.
3. Hardness test on metals–Brinell and Rockwell Hardnesstests.
4. Impact test on metals–Charpy, Izod impacttests.
5. Shear test on metals–direct shear strength, single shear, doubleshear.
6. Tests on helical springs–compression, tension springs–load deformation characteristics, stiffness, shearstress, modulus of rigidity,energy.
7. Torsion test on beams–torque and angle of twist characteristics, shear stress, modulus of rigidity,energy.

SEMESTER – IV **6 H – 5 C**

20BEME445 FLUID MECHANICS & FLUIDMACHINES

(Theory & Laboratory)

Instruction hours / week L : 3 T : 1 P:2 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

(i) THEORY

COURSE OBJECTIVES

The goal of this course is for students

1. To enrich the understanding offluid properties
2. To make the students conversant with types of flow and calculate Major and minor loses in pipes.
3. To acquaint the student with the concepts of Buckingham's π theorem.
4. To explainthe working of different pumps
5. To explainthe working of different turbines.
6. To equip students with skills to produce analytical solutions to various simpleproblems.

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Determine fluid properties to solve engineeringproblems.
2. Understand the flow characteristics of fluids and its mathematicalrelations.
3. Identify fluid behaviors and perform dimensional analysis for fluidflow.
4. Characterize the fluid flow in a fixedboundary.
5. Draw velocity vector diagram for hydraulicmachines.
6. Investigate performances of hydraulicmachines.

UNITI FLUID PROPERTIES AND FLOWCHARACTERISTICS

Fluid properties: Mass density, weight density, specific gravity, viscosity, compressibility, surface tension and capillarity. Buoyancy and floatation– metacentre and metacentric height.

Flowcharacteristics: concepts of system andcontrol volume, applicationof control volume to continuity equation, energy equation, momentum equation and moment ofmomentum equation.

UNITII FLOW THROUGH CIRCULAR PIPES

Hydraulic and energy gradient – Types of fluid flow – Types of flow line – Laminarflow through circular conduits – Boundary layer concepts – types of boundary layer thickness – Darcy Weisbach equation –friction factor – Moody diagram – commercial pipes – minor losses – Flow through pipes in series and parallel.

UNITIII DIMENSIONALANALYSIS

Dimension and units, dimensional homogeneity, applications of Buckingham's π theorem, study about Renold's number and significant for different fluids.

UNITIV HYDRAULICTURBINES

Classification of turbines – heads and efficiencies – velocity triangles. Axial, radial and mixed flow turbines. Pelton wheel, Francis turbine and Kaplan turbines- working principles - work done by water on the runner – draft tube. Specific speed - unit quantities – performance curves for turbines – governing of turbines.

UNITV HYDRAULICPUMPS

Classification of pumps – centrifugal pump–working principle–head, discharge, efficiencies and losses – performance curves – specific speed. Reciprocating pump–components and working–slip–indicator diagram – air vessel – Jet pump – Mono block pump – Submersible pump.

SUGGESTED READINGS

1. Victor L Streeter, E. Benjamin Wylie and K.W. Bedford, Fluid Mechanics, 9e, McGraw–Hill, New Delhi, 2010
2. Prof. Kumar K.L, Engineering Fluid Mechanics, 1st Edition, S. Chand publishers,2016
3. Bansal. R.K, A Text book of Fluid Mechanics and Hydraulics Machines, 10th edition, Laxmipublications (P) Ltd, New Delhi, 2018
4. White. F.M, Fluid Mechanics, 8thedition, Tata McGraw–Hill, New Delhi,2016
5. Fox and McDonald, Fluid Mechanics, 8thediton, John Wiley,2015

(ii) LABORATORY

COURSE OBJECTIVE

The goal of this course is for students

1. To supplement the theoretical knowledge gained in Fluid Mechanics and Machinery with practical testing
2. To understand the concepts of coefficient of discharge for Orifice meter and Venturi meter.
3. To explain the Calibration of Rotameter.
4. To understand the importance of friction factor for flow through pipes.
5. To impart knowledge on the performance of various pumps.
6. To impart knowledge on the performance of turbines.

COURSE OUTCOMES

1. Ability to use the measurement equipment's for flow measurement
2. Ability to do performance trust on different fluid machinery.
3. Estimate the friction factor for flow through pipes.
4. Asses the performance of centrifugal pump and submergible pump.
5. Asses the performance of reciprocating pump and gear pump.
6. Asses the performance of turbines.

LIST OF EXPERIMENTS

1. Determination of the Coefficient of discharge of given Orificemeter.
2. Determination of the Coefficient of discharge of givenVenturimeter.
3. Calculation of the rate of flow using Rotameter.
4. Determination of friction factor for a given set ofpipes.
5. Conducting experiments and drawing the characteristic curves of centrifugalpump
6. Conducting experiments and drawing the characteristic curves of submersiblepump
7. Conducting experiments and drawing the characteristic curves of reciprocatingpump.
8. Conducting experiments and drawing the characteristic curves of Mono block pump.
9. Conducting experiments and drawing the characteristic curves of Peltonwheel.
10. Conducting experiments and drawing the characteristics curves of Francisturbine.

20BEME451 ESSENCE OF INDIANTRADITIONALKNOWLEDGE 1 H – 0 C

Instruction hours / week L : 1 T : 0 P:0 **Marks:** Internal **:100** External **: ---**Total**:100**

COURSE OBJECTIVE

1. To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledgesystem.
2. To know the need and importance of protecting traditionalknowledge.
3. To know the various government acts and rules for protection ofTK.
4. To know the various enactments related to the protection of traditionalknowledge.
5. To understand the concepts of Intellectual property to protect the traditionalknowledge.
6. To know the traditional knowledge in different sectors like engineering, medicineetc.

COURSE OUTCOMES

Upon completion of the course, the students are expected to:

1. Understand the concept of Traditional knowledge and itsimportance
2. Know the need and importance of protecting traditionalknowledge.
3. Know the various government acts and rules for protection ofTK
4. Know the various enactments related to the protection of traditionalknowledge.
5. Understand the concepts of Intellectual property to protect the traditionalknowledge.
6. Know the traditional knowledge in different sectors like engineering, medicineetc.

UNITI INTRODUCTION

Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge

UNITII PROTECTION OFTK

Protection of traditional knowledge: the need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

UNITIII GOVERNMENTACTS

A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFRAct);

B: The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indicators act 2003.

UNITIV INTELLECTUAL PROPERTY RIGHTS

Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

UNITV TK IN DIFFERENT SECTORS

Traditional knowledge in different sectors: Traditional knowledge and engineering, Traditional medicine system, TK in air conditioning, TK in biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

SUGGESTED READINGS

1. Traditional Knowledge System in India, by Amit Jha,2009.
2. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin KumarSingh, PratibhaPrakashan2012.
3. Traditional Knowledge System in India by Amit Jha Atlantic publishers,2002
4. "Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2

SEMESTER – V

20BEME501 DESIGN OFMACHINEELEMENTS 4 H – 4 C

Instruction hours / week L : 3 T : 1 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

The goal of this course is for students

1. To understand the various types of stresses induced in different machine members.
2. To Study and acquire knowledge on design shaft and couplings for effective transmission of power.
3. To study the features of welded joints and fasteners required for various industrial applications.
4. To give exposure to design springs and flywheels for various engineering applications.
5. To understand the importance design bearings and levers for engineering applications.
6. To make the students conversant to implement design procedure for designing a machine.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Design components subjected to steady and variable stresses by considering stress concentration and able to apply various theories offailure
2. Design solid and hollow shafts based on strength, rigidity and critical speed, also able to design flange coupling and bush pin typecoupling
3. Design bolted joints and welded joints subjected to axial and eccentricloading.
4. Design helical spring, leaf spring subjected to steady and variable loading, also be able to design rim type flywheel.
5. Design of ball bearings of rolling contact type and journalbearing;
6. Design of levers of type I, II andIII.

UNITI STEADY STRESSES AND VARIABLE STRESSES IN MACHINEMEMBERS

Introduction to the design process – factors influencing machine design, selection of materials based on mechanical properties – Factor of safety. Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principal stresses for various load combinations, eccentric loading – Design of curved beams – crane hook and 'C' frame – theories of failure – stress concentration – design for variable loading – Soderberg, Goodman and Gerber relations.

UNITII DESIGN OF SHAFTS AND COUPLINGS

Design of solid and hollow shafts based on strength, rigidity and critical speed – Design of keys and key ways – Design of rigid and flexible couplings – Introduction to gear and shock absorbing couplings – design of knuckle joints.

UNITIII DESIGN OF FASTENERS AND WELDEDJOINTS

Threaded fasteners – Design of bolted joints including eccentric loading – Design of welded joints for pressure vessels and structures – theory of bonded joints.

UNITIV DESIGN OF SPRINGS ANDFLYWHEEL

Design of helical, leaf, disc and torsional springs under constant loads and varying loads – Concentric torsion springs – Belleville springs – Design of flywheels involving stresses in rim and arm.

UNITV DESIGN OF BEARINGSANDLEVERS

Selection of bearings – sliding contact and rolling contact types – Cubic mean load – Selection of journal bearings – McKees equation – Lubrication in journal bearings – calculation of bearing dimensions – Design of Levers.

***(Permitted to use PSG design data book in the examination*)**

SUGGESTED READINGS

1. Juvinall R.C and Marshek K.M, Machine Component Design, 5th Edition, John Wiley and Sons, New Delhi, 2016
2. Bhandari V.B, Design of Machine Elements, 4e, Tata McGraw–Hill Book Co, New Delhi, 2016
3. R S Khurmi& J. K. Gupta, A Textbook of Machine Design, 34th edition, S. Chand Publishing, 2019
4. Spotts M.F, Design of Machine Elements, 8th edition,Pearson Education, New Delhi, 2019
5. Design Data: Data Book of Engineers by PSG College-KalaikathirAchchagam– Coimbatore
6. V B Bhandari, Machine Design Data Book, 2nd Edition, Tata McGraw Hill Publishing Co, 2019.

SEMESTER – V

20BEME541 ENGINEERING MATERIALS AND METALLURGY 5 H – 4 C

(Theory &Laboratory)

Instruction hours / week L : 3 T : 0 P:2 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

(i) THEORY

COURSE OBJECTIVES

1. To impart knowledge on metallurgical aspects ofmetals.
2. To understand heat treatment processes on different grades ofsteel.
3. To familiarize on selection of ferrous and non-ferrous materials for variousapplications.
4. To impart knowledge on non-metallicmaterials
5. To learn about the strengthening mechanisms for Non-ferrousalloys.
6. To comprehend the significance of Non-Destructive Testing (NDT)methods.

COURSEOUTCOMES

Learners should be ableto

1. Identify the metallurgical aspects ofmetals.
2. Identify suitable heat treatment processes for variousapplications.
3. Select appropriate ferrous and non-ferrous materials for variousapplications.
4. Identify and select suitable non-metallicmaterials.
5. Identify suitable strengthening mechanisms for Non-ferrousalloys.
6. Work with non-destructive testingmethods.

UNITI CONSTITUTION OF ALLOYS AND PHASEDIAGRAMS

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, peritectic, eutectoid and peritectoid reactions, Iron – Iron carbide equilibrium diagram -Classification of steel and cast Iron, microstructure, properties and applications.

UNITII HEATTREATMENT

Definition – Full annealing, stress relief, recrystallisation and spheroidizing –normalising, hardening and tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on TTT diagram, CCT - Hardenability, Jominy end quench test – Austempering, martempering – case hardening - carburising, nitriding, cyaniding, carbonitriding – Flame and Induction hardening, Microstructure study and specimen preparation.

UNITIII FERROUS AND NON FERROUSMETALS

Effect of alloying elements on steel (Mn, Si, Cr, Mo, V, Ti& W) - stainless and tool steels – HSLA - maraging steels – Gray, White malleable, Spheroidal Graphite irons - Copper and Copper alloys – Brass, Bronze and Cupronickel – Aluminum and Al-Cu – precipitation, strengthening treatment – Bearing alloys.

UNITIV NON-METALLIC MATERIALS

Polymers – types of polymer, commodity and engineering polymers – Properties and Applications of thermoplastics (PP, PVC, ABS, and PMMA) and thermosetting plastics (PF, UF, MF) –Engineering Ceramics.

UNITV TESTING OF MECHANICAL PROPERTIES ANDINSPECTION

Mechanism of plastic deformation, slip and twinning – Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), Impact test - Izod and Charpy, Fatigue and creep test, S-N curve.

Non Destructive Testing: Non Destructive Testing basic principles and testing method of Radiographic testing, Ultrasonic testing, Magnetic particle test and Liquid penetrant test, Eddy current testing.

SUGGESTED READINGS

1. Kenneth G.Budinski and Michael K.Budinski, Engineering Materials: Properties and Selection, 9th Edition, Prentice-Hall of India Private Limited, New Delhi,2010
2. William D. Callister&David G. Rethwisch, Fundamentals of Materials Science and Engineering: An Integrated Approach, 5thedition, International Student Version, John Wiley & Sons, Inc.,2016.

3. Raghavan. V, Materials Science and Engineering, 6thedition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005
4. James F. Shackelford, Madanapalli K. Muralidhara, Introduction to Materials Science for Engineers, 6th edition, Pearson Education, India,2014

(ii) LABORATORY

COURSE OBJECTIVES:
1. To impart knowledge on metallurgical aspects ofmetals.
2. To understand heat treatment processes on different grades ofsteel.
3. To familiarize on selection of ferrous and non-ferrous materials for variousapplications.

COURSEOUTCOMES:
Learners should be ableto
1. Identify the metallurgical aspects ofmetals.
2. Identify suitable heat treatment processes for variousapplications.
3. Select appropriate ferrous and non-ferrous materials for variousapplications.
4. Identify and select suitable non-metallicmaterials.
5. Perform corrosiontest

LIST OF EXPERIMENTS
1. Study and use of metallurgical microscope (TermPaper).
2. Metallographic specimen preparation, mechanical polishing, mounting, andetching.
3. Microstructure of annealed pure metals-iron, copper, lead, zinc aluminium and use of specificetchants.
4. Macro etching and sulphurprinting.
5. Electropolishing.
6. Comparative study of microstructure of annealed steel (Hypo eutectoid, Eutectoid, Hyper eutectoid) and variation ofhardness.
7. Microstructure of Cast Iron (Gray, White,Nodular).
8. Microstructure of eutectic alloys Al-Si, Pb-Sn, andPb-Sb.
9. Microstructure of wrought and annealed single-phase alpha brass &Aluminium.
10. Recovery, Recrystallisation and Grain growth of cold workedcopper.
11. Galvanostatic polarization & determination of corrosion rate by Tafel'sExtrapolation
12. Potentiostatic Polarization, passivity & Passivity breakdownstudy

SEMESTER – V

20BEME542 **INDUSTRIALMETROLOGY** **5 H – 4 C**

(Theory & Laboratory)

Instruction hours / week L : 3 T : 0 P:2 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

(i) THEORY

COURSE OBJECTIVES

The goal of this course is for students

1. To provide knowledge on various Metrological equipments available to measure the dimension of the components.
2. To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.
3. To enrich the understanding of principles of measuring instruments and gauges
4. To give exposure to inspection of spur gear and thread elements.
5. To equip them with skills to linear measurements using various measuringinstruments
6. To give exposure toprocedures involved in erectingmachineries.

COURSE OUTCOMES

Upon completion of this course, the students will able to

1. Understand the basics of measurements and qualitystandards.
2. Perform linear measurements using various measuringinstruments
3. Perform the geometrical measurements of variouscomponents
4. Measure the various dimensions of a screwthread
5. Measure the dimensions of the simple spurgear.
6. Know the procedures involved in erectingmachineries.

UNITI BASICS OF MEASUREMENT, DEVICES AND QUALITYSTANDARDS

Definition of metrology, economics of measurement, measurement as a comparative process, dimensional properties, terminology and accuracy of measurement, measuring errors, Abbe's Principle, Principle of interferometry- flatness testing, optical interferometer, laser interferometer. Holography and speckle metrology. General cares and rules in measurement, International standardization, SI units and quantities, BIS-NPL standards – advantages, ISO 9000 quality standards, QS 9000 standards, Environment standards, metrology room measuring standardsroom.

UNITII LINEARMEASUREMENTS

Material length standards –line and end measurement – calibration of end bars, datum and reference surfaces, surface plates, gauges – feeler gauges, micrometers, dial test indicator, slip gauges, care of gauge blocks, Comparators- mechanical, electrical, optical and pneumatic, optical projector.

UNITIII GEOMETRICALMEASUREMENT

Angular measurement – plain Vernier and optical protractors, sine bar, optical instruments, flatness, parallelism and roundness measurement, need for limit gauge, design of plug gauge, Taylor's principle, three basic types of limit gauges, surface texture, reasons for controlling surface texture, parameters used , specification of surface texture, drawing and symbols, Tomilson surface meter.CMM.

UNITIV METROLOGY OF MACHINE ELEMENTS

Types of screw threads, terminology, proportions of ISO metric thread, measurement of major, minor and effective diameters. Gear terminology and standard proportions, spur gear measurement, checking of composite errors, base pitch measurement, clean roomenvironment.

UNITV MACHINE INSTALLATION ANDTESTING

Equipment erection, commissioning, testing procedure for lathe, milling, continuous process line. First aid, safety precautions in installation of equipment, protocol for repair and testing, inspection check list.

TEXT BOOKS

1. Jain R.K, Engineering Metrology, 21st edition, Khanna Publishers, Delhi, 2018reprint
2. Alan S. Morris, The Essence of Measurement, 1st edition, Prentice Hall of India, New Delhi,1996
3. N.V. Raghavendra and L. Krishnamurthy, Engineering Metrology and Measurements, 1st edition, Oxford University press of India,2013
4. R.K. Jain, Mechanical and Industrial Measurements, 12th edition, Khanna Publishers,1995.
5. J P Holman, Experimental Methods for Engineers, 1st edition, Tata McGraw Hill Education,2007
6. Beckwith T.G and N. Lewis Buck N, Mechanical Measurements, 6thedition,Addison Wesley, New york, 2006.

(ii) LABORATORY

COURSEOBJECTIVE

The goal of this course is for students
To gain practical and hands on experience in measuring the mechanical components using various measuring instruments anddevices.

COURSEOUTCOME

Upon completion of this course, the students will able to use the different measuring instruments to measure different measurements of given mechanical components.

METROLOGY

1. Calibration of Vernier / Micrometre / Dialgauge
2. Checking dimensions of part using slipgauges
3. Measurement of gear tooth dimensions – addendum, dedendum, pitch circle diameter and tooth thickness
4. Measurement of taper angle using sine bar / tool makersmicroscope
5. Measurement of straightness andflatness
6. Measurement of thread parameters
7. Checking the limits of dimensional tolerances using comparators (Mechanical / Pneumatic /Electrical)
8. Surface finishmeasurement

SEMESTER – V

20BEME543 **HEAT AND MASSTRANSFER** **6 H – 5 C**

(Theory & Laboratory)

Instruction hours / week L : 3 T : 1 P:2 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

(i) THEORY

COURSE OBJECTIVES

The goal of this course is for students

1. To understand the basic concepts of heat transfer.
2. To comprehend the fundamentals of convective heat transfer.
3. To learn about different types of heat exchangers and its analysis.
4. To recognize the importance of radiation heat transfer.
5. To study about the basic concepts of mass transfer.
6. To make the students conversant to solve complex problems where heat and mass transfer takes place.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Formulate and analyze heattransfer problems involving any of the three modes of heattransfer.
2. Obtain exact solutions for the temperature variation usinganalytical methods where possible or employ approximate methods orempirical.
3. Describe the process involved in phase change heat transfer like condensation,evaporation.
4. Design devices such as heat exchangers and also estimate theinsulation needed to reduce heat losses where necessary.
5. Understand the concepts of radiation and radiationshields
6. Identify the analogy between heat and mass transfer and concepts of masstransfer.

UNITI CONDUCTION

Basic Concepts – Mechanism of Heat Transfer – Conduction, Convection and Radiation – General Differential equation of Heat Conduction – Fourier Law of Conduction – Cartesian and Cylindrical Coordinates – One Dimensional Steady State Heat Conduction – Conduction through Plane Wall, Cylinders and Spherical systems – Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Use of HeislersChart.

UNITII CONVECTION

Basic Concepts – Convective Heat Transfer Coefficients – Boundary Layer Concept – Types of Convection – Forced Convection –External Flow – Flow over Plates, Cylinders and Spheres – Internal Flow – Laminar and Turbulent Flow – Combined Laminar and Turbulent – Flow over Bank of tubes – Free Convection –Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders andSpheres.

UNITIII PHASE CHANGE HEAT TRANSFER AND HEATEXCHANGERS

Nusselts theory of condensation–pool boiling, flow boiling, correlations in boiling and condensation. Types of Heat Exchangers – LMTD Method of heat Exchanger Analysis – Effectiveness – NTU method of Heat Exchanger Analysis – Overall Heat Transfer Coefficient – Fouling Factors.

UNITIV RADIATION

Basic Concepts, Laws of Radiation – Stefan Boltzman Law, Kirchoff Law –Black Body Radiation –Grey body radiation - Shape Factor Algebra – Electrical Analogy – Radiation Shields –Introduction to Gas Radiation.

UNITV MASS TRANSFER

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations

(Permitted to use standard Heat and Mass Transfer Table in the examination)

SUGGESTED READINGS

1. Sachdeva R.C, Fundamentals of Engineering Heat and Mass Transfer, 4th edition, New Age International, New Delhi,2017
2. Frank P. Incropera and David P. DeWitt, Fundamentals of Heat and Mass Transfer, 7th edition, John Wiley and Sons, New Delhi,2011
3. Jack P. Holman, Heat Transfer, 10th edition, McGraw–Hill Book Co, New Delhi,2017
4. Kothandaraman C.P, Fundamentals of Heat and Mass Transfer, 4th Edition, New Age International, New Delhi,2015

(ii) LABORATORY

COURSE OBJECTIVE

The goal of this course is for students

1. To study the heat transfer phenomena and predict the relevant coefficient using experiments.

COURSE OUTCOME

1. Students will be able to conduct experiment and determine the heat transfer properties of respective materials.

HEAT TRANSFER

1. Heat transfer through a compositewall
2. Thermal conductivity measurement by guarded platemethod
3. Natural convection heat transfer from a verticalcylinder
4. Heat transfer from pin–fin (natural and forced convectionmodes)
5. Effectiveness of Parallel/counter flow heat exchanger
6. Determination of Stefan–Boltzmannconstant
7. Determination of emissivity of a greysurface

SEMESTER – V

20BEME544 **THEORY OF MACHINES** **6 H – 5 C**

(Theory & Laboratory)

Instruction hours / week L : 3 T : 1 P:2 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

(i) THEORY

COURSE OBJECTIVE

The goal of this course is for students

1. To understand the concepts of degrees of freedom and todifferentiate the characteristics between mechanism, machine and structure.
2. To analysis the relative motion between machine elements of a mechanism.
3. To understand the basic concepts of gear terminologies and gear trains.
4. To understand the undesirable effects of unbalance forces inamechanism.
5. To expose students to vibration phenomenon and its types along with the vibrationterminologies.
6. To understand the effect of Dynamics due to undesirablevibrations.

COURSE OUTCOMES

Upon completionof this course, Students will be able to

1. Develop a 2D sketch for a planner mechanism and to analyze the degrees of freedom for the same.
2. Perform velocity and accelerationanalysis for the simple mechanisms.
3. Specify the gear terminology and to select appropriate gear trains for engineeringapplications.
4. Perform force analysis of reciprocating engine and balancing of rotating & reciprocatingmasses.
5. Describe the vibration phenomenon and its types along with the vibrationterminologies.
6. Analyze the systems subjected tovibration

UNITI MECHANISMS

Machine Structure – Kinematic link, pair and chain – Grueblers criteria – Constrained motion – Degrees of freedom - Slider crank and crank rocker mechanisms – Inversions – Applications.

UNITII KINEMATIC ANALYSIS AND FRICTION

Displacement, velocity and acceleration – analysis in simple mechanisms – Graphical Method –velocity and acceleration polygons. Surface contacts–Sliding and Rolling friction – Friction drives –Friction clutches.

UNITIII GEARING ANDCAMS

Gear profile and geometry – Nomenclature of spur and helical gears – Gear trains: Simple, compound gear trains and epicylic gear trains - Determination of speed and torque- Cams – Types of cams – Design of profiles – Knife edged, flat faced and roller ended followers with and without offsets for various types of follower motions.

UNITIV FORCE ANALYSIS ANDBALANCING

Dynamic force analysis- Inertia force and Inertia torque – D'Alemberts principle – Dynamic Analysis in Reciprocating Engines - Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder Engine – Balancing Multi–cylinder Engines

UNITV VIBRATION

Free vibration – Equations of motion – natural frequency – Types of Damping – Damped vibration, critical speeds of simple shaft. Response to periodic forcing – Harmonic Forcing – Forcing caused by unbalance – Support motion – Force transmissibility and amplitude transmissibility – Vibration isolation.Torsional systems; Natural frequency of free torsional vibrations, Natural frequency of two and three rotor systems.

SUGGESTED READINGS

1. Rattan S.S, Theory of Machines, 5th edition, Tata McGraw–Hill Publishing Company Ltd., New Delhi, 2019
2. Shigley J.E, Uicker J.J, Theory of Machines and Mechanisms, 4th edition, Oxford University Press, New York, 2010.
3. Rao J.S., Dukkipati R.V, Mechanism and Machine Theory, 2nd edition, New Age International publishers, 2014
4. Charles E. Wilson, Kinematics and Dynamics of Machinery, 3rd edition, Pearson Education Ltd,2008
5. R. S. Khurmi, J. K. Gupta, Theory of Machines, 14rd edition, S Chand & Co Ltd,2005.

(ii) LABORATORY

COURSEOBJECTIVES

The goal of this course is for students

1. To supplement the principles learnt in kinematics and Dynamics ofMachinery.

COURSE OUTCOME

Upon completion of this course students will be able to

1. Determine the various parameters of governors, Cam &Gyroscopes
2. Determine the critical speed of a givenshaft
3. Perform balancing of rotating and reciprocatingparts
4. Determine the natural frequency of a givensystem
5. Determine the mass moment of inertia of a givencomponent
6. Determine the damping coefficient of a single degree freedomsystem

LIST OF EXPERIMENTS

1. Governors – Determination of sensitivity, effort, etc. for Watt, Porter, Proell, and spring-controlled Governors
2. Cam – Determination of jump speed and profile of thecam.
3. Motorized Gyroscope–Verification of laws –Determination of gyroscopiccouple.
4. Whirling of shaft–Determination of critical speed of shaft with concentratedloads.
5. Balancing of rotating and reciprocatingmasses.
6. Determination of moment of inertia by oscillation method for connecting rod andflywheel.
7. Vibrating system – spring mass system – Determination of damping co–efficient of single degree of freedomsystem
8. Determination of torsional frequencies for compound pendulum and flywheel system withlumped moment of inertia.
9. Transverse vibration –free– Beam. Determination of natural frequency and deflection ofbeam.

20BE_____ **OPEN ELECTIVE– I** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3 Hours

Students will select the open elective course from the set of open electives offered by various departments which are listed in the table of curriculum.

SEMESTER - V

20BEME551 GEOMETRICAL DIMENSIONINGANDTOLERANCE 1 H – 0 C

Instruction hours / week L : 1 T : 0 P:0 **Marks:** Internal **:100**External **: ---**Total**:100**

COURSE OBJECTIVES

1. To understand the concepts of geometrical dimensioning andTolerancing
2. To study the physical importance of them in industrial point ofview
3. To know the various types of Tolerancing, its measurement anddesign.
4. To translate geometric callouts into plain English with one meaning.
5. To explain the major rules found in ASME Y14.5-2009
6. To understand the hierarchy of geometric tolerancing.

COURSE OUTCOMES

1. Ability to learn and apply geometric dimensioning and tolerance standards to communicate designintent
2. Ability to Learn how the knowledge of certain processes can affect part design anddocumentation
3. Gain added insight on working in a team designenvironment.
4. Translate geometric callouts into plain English with one meaning.
5. Explain the major rules found in ASME Y14.5-2009
6. Understand the hierarchy of geometric tolerancing.

INTRODUCTION

Introduction to Geometric dimensioning and Tolerancing – working of geometric system – Terms and definitions – Common symbols and Terminology – Fundamental Rules (Drawing)– Feature definition – With Size and Without Size – Material Condition (Maximum, Least, Regard of Material Condition)– Limit Tolerancing – Dimension Origin –Limits of Size, Rule 1 or Envelope Principle – Go– No Go Gauges.

FORM AND ORIENTATION TOLERANCE

Design considerations – Flatness and Circularity measurement concepts – Orientation tolerance specification and application design.

POSITION AND RUNOUT TOLERANCE

Profile of surface and line tolerance design and application – Location tolerance, Position, applied and material condition consideration – Coaxial controls and design – Concentricity, Symmetry – Measurement and application – Design considerations – Position, Composite tolerance concept, design and Measurement – Runout, Total Runout tolerances – Measurement and considerations.

SUGGESTED READINGS

1. Siddeshwar and Kanniah, Machine Drawing, Tata McGraw Hill,2001
2. Gopalakrishna, K.R, Machine Drawing, , Subhas Stores,2002
3. Wade. O, Tolerance Control in design and manufacturing, Industrial Press,1972
4. STANDARDS - IS :10714,10715,10716,10717,11669,10719,813,919,2709,8000 pt 1 to 10721,11158 and AWS/ISO

SEMESTER – VI

20BEME601 DESIGN OFTRANSMISSIONSYSTEMS 4 H – 4 C

Instruction hours / week L : 3 T : 1 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

The goal of this course is for students

1. To Study and acquire knowledge on design the power transmission components like belts, pulleys, ropes, chains and sprockets.
2. To Study and acquire knowledge on design spurs and parallel axis helical gears.
3. To give exposure to dimensions for bevel and worm gears.
4. To provide an overview ofdesign procedures of gear boxes for industrial applications.
5. To provide an overview ofclutches and brakes for engineering applications.
6. To make the student acquire sound knowledgeofmechanical system.

COURSE OUTCOMES

Upon completion of this course, the students will able to

1. Design V –belts, Flatbelts,
2. Design Wire ropes and chaindrive.
3. Design spur gear and helicalgear
4. Design bevel and wormgear
5. Design multispeed gearbox
6. Design clutches andbrakes

UNITI DESIGN OF TRANSMISSION SYSTEMS FOR FLEXIBLEELEMENTS

Design of V belts and pulleys – Selection of Flat belts and pulleys – Wire ropes and pulleys – Selection of Transmission chains and Sprockets – Design of sprockets.

UNITII DESIGN OF SPUR AND HELICALGEARS

Gear Terminology – Speed ratios and number of teeth–Force analysis – Tooth stresses – Dynamic effects – Fatigue strength – Factor of safety – Gear materials – Module and Face width–power rating calculations based on strength and wear considerations – Parallel axis Helical Gears & cross helical gears - Terminology– Pressure angle in the normal and transverse plane– Equivalent number of teeth–forces and stresses – Estimating the size of the helical & cross helicalgears.

UNITIII DESIGN OF BEVEL AND WORMGEARS

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits– terminology – Thermal capacity, materials–forces and stresses, efficiency, estimating the size of the worm gear pair.

UNITIV DESIGN OF GEARBOXES

Geometric progression – Standard step ratio – Ray diagram, kinematics layout –Design of sliding mesh gear box –Constant mesh gear box. – Design of multi speed gear box.

UNITV DESIGNOFCLUTCHESANDBRAKES

Design of plate clutches –axial clutches–cone clutches–internal expanding rim clutches–internal and external shoe brakes.

(Permitted to use PSG design data book in the examination)

SUGGESTED READINGS

1. Juvinall R.C and Marshek K.M, Machine Component Design, 5th Edition, John Wiley and Sons, New Delhi, 2016
2. Bhandari V.B, Design of Machine Elements, 4e, Tata McGraw–Hill Book Co, New Delhi, 2016
3. R S Khurmi& J. K. Gupta, A Textbook of Machine Design, 34th edition, S. Chand Publishing, 2019
4. Spotts M.F, Design of Machine Elements, 8th edition,Pearson Education, New Delhi, 2019
5. Design Data: Data Book of Engineers by PSG College-KalaikathirAchchagam– Coimbatore
6. V B Bhandari, Machine Design Data Book, 2nd Edition, Tata McGraw Hill Publishing Co, 2019.

SEMESTER – VI

20BEME602 INSTRUMENTATION & CONTROL SYSTEMS 3 H – 3 C

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To provide a basic knowledge about measurement systems and theircomponents
2. To learn about various measurements like displacement, temperature, pressure, level, flow,speed
3. To learn about control systems and itsprinciples.
4. To learn how to measure the quantities like strain, humidity andforce
5. To learn how to measure the quantities like torque andpower
6. To classify the various control methods and its application.

COURSE OUTCOME

Upon completion of this course, the Students will be able to

1. Understand the measurement systems, their accuracy &range.
2. Measure the quantities like displacement, temperature,pressure
3. Measure thequantities like level, flow andspeed
4. Measure thequantities like strain, humidity andforce
5. Measure the quantities like torque andpower
6. Classify the various control methods and its application and do system models and perform response analysis

UNITI INTRODUCTION

Basic principles of measurement - Measurement systems, generalized configuration and functional descriptions of measuring instruments - examples. Dynamic performance characteristics - sources of error, Classification and elimination of error.

UNITII MEASUREMENTS I

Measurement of Displacement: Theory and construction of various transducers to measure displacement - Piezo electric, Inductive, capacitance, resistance, ionization and Photo electric transducers, Calibration procedures. Measurement of Temperature: Classification-Ranges-Various Principles of measurement -Expansion, Electrical Resistance- Thermistor - Thermocouple- Pyrometers-Temperature Indicators. Measurement of Pressure: Units - classification - different principles used. Manometers, Piston, Bourdon pressure gauges, Bellows - Diaphragm gauges. Low pressure measurement - Thermal conductivity gauges -ionization pressure gauges, McLeod pressure gauge.

UNITIII MEASUREMENTS II

Measurement of Level: Direct method - Indirect methods - capacitative, ultrasonic, magnetic, cryogenic fuel level indicators - Bubbler level indicators. Flow Measurement: Rotameter, magnetic, Ultrasonic, Turbine flow meter, Hot - wire anemometer, Laser Doppler Anemometer (LDA). Measurement of Speed: Mechanical Tachometers - Electrical tachometers - Stroboscope, Non- contact type of tachometer. Measurement of Acceleration and Vibration: Different simple instruments - Principles of Seismic instruments - Vibro meter and accelerator meter using thisprinciple.

UNITIV MEASUREMENTS III

Stress Strain Measurements: Various types of stress and strain measurements - electrical strain gauge - gauge factor — method of usage of resistance strain gauge for bending compressive and tensile strains - usage for measuring torque, Strain gauge Rosettes. Measurement of Humidity: Moisture content of gases, sling psychrometer, Absorption psychrometer, Dew point meter. Measurement of Force, Torque and Power: Elastic force meters, load cells, Torsion meters,Dynamometers.

UNITV CONTROLSYSTEMS

Elements of Control Systems: Introduction, Importance - Classification - Open and closed systems Servomechanisms - Examples with block diagrams - Temperature, speed and position control systems. Control method - P, PI, PID, when to choose what, tuning of controllers. System models, transfer function and system response, frequency response; Nyquist diagrams and their use.

SUGGESTED READINGS

1. W. Bolton, Instrumentation and control systems ,2nd edition, Newnes,2015
2. Chennakesava R Alavala, Principles of Industrial Instrumentation and Control Systems, 1st edition, Cengage Learning, 2009.
3. R.K. Jain, Mechanical and Industrial Measurements, 12th edition, Khanna Publishers,1995.
4. Instrumentation Technology Magazine Editors, Instrumentation & control systems engineering handbook, Tab Books, 1978, 2007(Digital).
5. J P Holman, Experimental Methods for Engineers, 1st edition, Tata McGraw Hill Education,2007

SEMESTER – VI

20BEME603 **POWER PLANT ENGINEERING** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

The goal of this course is for students

1. To give exposure toaccessories and layout required for a steam power plant depending upon the requirements.
2. To study performance of steam power plant.
3. To make the student acquire sound knowledgeofworking of nuclear and hydel power plant.
4. To study the features ofgas turbine power plant.
5. To make the student acquire sound knowledgeofeconomics of the power plant.
6. To make the student acquire sound knowledgeon renewable energy technologies and availability.

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Select the accessories and layout required for a steam power plant depending upon therequirements.
2. Explain the working principles of various types ofboilers
3. Compute performance improvement in gas turbine powerplant.
4. Explain the working of nuclear and MHD powerplant.
5. Apply appropriate type of renewable energy technologies for generating electricity depending upon the application and availability.
6. Identify the type of pollution control method required for powerplant.

UNITI STEAM POWER PLANT

Introduction to Power Plants – Steam Boilers– High Pressure and Super Critical Boilers – Fluidized Bed Boilers – Industrial Standards for boiler. Comparison and Selection of boiler, Fuel and Ash Handling, Combustion Equipment for burning coal, Mechanical Stokers, Pulveriser, Electrostatic Precipitator, Cooling Towers.

UNITII SOLAR AND WIND POWERPLANT

Introduction to solar power plant - types of solar power plant - selection of site and shadow analysis - selection of PV module tilt angle - site survey and plant assessment - type of solar radiation - types of solar inverter - selection of string /central / off grid inverter - sizing of solar inverter for roof top and grid.

Introduction to windpower plant - overview of wind turbine components - design aspects of wind turbine types of wind turbine blade, non-crimp fabric in blade, drive train concepts of wind turbine - wind turbine gear box - wind turbine generator.

UNITIII NUCLEAR AND HYDEL POWERPLANTS

Nuclear Energy – Fission, Fusion Reaction, Types of Reactors, pressurized water reactor, Boiling Water Reactor, Waste Disposal and safety.

Hydel Power Plant – Essential Elements, Selection of Turbines, Governing of Turbines– Micro Hydel developments.

UNITIV DIESEL AND GAS TURBINE POWERPLANT

Types of Diesel Plants, Components, Selection of Engine Type, Applications Gas Turbine Power Plant – Fuels – Gas Turbine Material – Open and Closed Cycles – Reheating – Regeneration and Intercooling – Combined Cycle.

UNITV OTHER POWER PLANTS AND ECONOMICS OF POWERPLANTS

Geo thermal –OTEC – Tidel – Pumped storage Safety aspects and Cost of Electric Energy – Fixed and operating Costs – Energy Rates – Types of Tariffs – Economics of load sharing, comparison of economics of various power plants.

SUGGESTED READINGS

1. Arora S.C and Domkundwar S, A course in Power Plant Engineering, 8th edition, Dhanpatrai Publishers, New Delhi, 2016
2. Nag P.K, Power plant Engineering, 4th edition, Tata McGraw Hill, New Delhi, 2017
3. Rajput R.K, Power Plant Engineering, 4th edition, Laxmi Publications, Chennai, 2016
4. Md. Rabiul Islam, FazRahman, and Wei Xu, Advances in Solar Photovoltaic Power Plants, 1st edition, Springer. 2018.

SEMESTER – VI

20BEME6E__ **PROFESSIONAL ELECTIVE - I** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

20BEME6E__ **PROFESSIONAL ELECTIVE - II** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

20BE_____ **OPEN ELECTIVE - II** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

SEMESTER - VI

20BEME611 **COMPUTER AIDED MODELING ANDSIMULATIONLABORATORY** **3 H – 2 C**

Instruction hours / week L :0 T : 0 P:3 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVE

The goal of this course is for students

1. To gain practical experience in handling 2D drafting and 3D modeling softwaresystems.
2. To impart training on SOLID WORKS for modelling
3. To provide knowledge on assembly ofcomponents
4. To facilitate the understanding of manufacturing drawings from the modelscreated
5. To understand the importance of MAT Lab for simulating different systems
6. To acquaint the student with the conceptsof mat lab for performing various mathematical operations.

COURSE OUTCOME

Upon completion of this course, the students can able to

1. use computer and CAD software's for modeling of mechanicalcomponents
2. use various options in SolidWorks for modeling of givencomponents
3. create assembly ofcomponents
4. prepare manufacturing drawings from the modelscreated
5. Use MAT Lab for simulating different systems like hydraulic and pneumaticcircuits
6. Use mat lab for performing various mathematicaloperations

COMPUTER AIDED DESIGN

1. 3D modeling of various machine elements using various options like protrusion, cut, sweep, draft, loft, blend,rib.
2. Assembly – creating assembly from parts – assemblyconstraints
3. Conversion of 3D solid model to 2D drawing – different views, sections, isometric view and dimensioning.
4. Introduction to SurfaceModeling.
5. Introduction to File Import, Export – DXF, IGES, STL,STEP

Note: Any one of the 3D MODELING software's like SOLIDWORKS, CREO, CATIA, NX Software, AutoCADetc.

COMPUTER AIDED SIMULATION

1. Simulation of Air conditioning system with condenser temperature and evaporator temperatures as input to get COP usingSoftware
2. Simulation of Hydraulic / Pneumatic cylinder usingSoftware
3. Simulation of cam and follower mechanism usingSoftware
4. MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and twovariables
5. Use of MATLAB to solve simple problems invibration

SEMESTER - VI

20BEME691 **MINI PROJECT WORK** **1 H – 1 C**

Instruction hours / week L : 1 T : 0 P:0 **Marks:** Internal **: 100** External **:0** Total**:100**

COURSE OBJECTIVE

1. To expose students to problem definitions
2. To understand the Fabricate device/system/component (s) for problem solving.
3. To equip them subject knowledge to solve real world problems.
4. To acquaint the student to newer techniques to improve the performance of a device/system.
5. To develop the skill to prepare the project reports
6. To develop the skill to prepare power point presentation and to face reviews and viva voce examination.

COURSE OUTCOMES

1. Formulate problem definitions
2. Fabricate device/system/component (s) for problem solving.
3. Apply subject knowledge to solve real world problems.
4. Implement newer techniques to improve the performance of a device/system.
5. Develop the skill to prepare the project reports
6. Develop the skill to prepare power point presentation and to face reviews and viva voce examination.

COURSE DESCRIPTION

The students may be grouped into maximum of 4 students and work under a project supervisor. The device/ system/component(s) to be fabricated may be decided in consultation with the supervisor and if possible, with an industry. A project report to be submitted by the groupand the fabricated model, which will be reviewed and evaluated for internal assessment bya Committee constituted by the Head of theDepartment.

20BEME651 **MOTORS AND PUMPS** **1 H – 0 C**

Instruction hours / week L : 1 T : 0 P:0 **Marks:** Internal **: 100**External**:0 ---**Total**:100**

COURSE OBJECTIVES

1. To understand the working principles ofpumps
2. To understand the working principles andmotors
3. To develop the system curve
4. To calculate the Net Positive Suction Head
5. To calculate the pump Total Head versus Rate of Flow characteristic
6. To match pumps to variable, parallel and series pumping systems

COURSE OUTCOMES

1. Understand the working principles ofpumps.
2. Understand the working principles andmotors.
3. Develop the system curve.
4. Calculate the Net Positive Suction Head.
5. Calculate the pump Total Head versus Rate of Flow characteristic.
6. Match pumps to variable, parallel and series pumping systems.

UNITI SINGLE PHASE INDUCTIONMOTOR

Constructional details of single-phase induction motor – Principle of operation – Types – Losses and Efficiency – Performance analysis – Starting methods of single–phase induction motors. – Design aspects of motors for usage in submersible pumps– Motors Rating and selectioncriteria.

UNITII THREE PHASE INDUCTIONMOTOR

Constructional details – Types of rotors – Principle of operation – Need for starters – Types of starters – DOL, Stator resistance and reactance, rotor resistance, autotransformer and star–delta starters – Speed control – Change of voltage, torque, number of poles and slip – Losses and Efficiency – Performance analysis – Design aspects of motors for usage in submersible pumps – Motors Rating and selection criteria.

UNITIII PUMPS

Pumps: Definition and Terminologies – classifications – Applications, Cavitation in pump – rotary pumps: working principles of gear and vane pumps, Trouble shooting.

SUGGESTED READINGS

1. Bansal. R.K, A Text book of Fluid Mechanics and Hydraulics Machines, 10th edition, Laxmipublications (P) Ltd, New Delhi, 2018
2. Kothari, D. P., and Nagrath, I. J, Electric Machines, Tata McGraw Hill Publishing Company Ltd., New Delhi,2014
3. Bimbhra, P. S, Electrical Machinery, Khanna Publishers, New Delhi,2003.

SEMESTER - VII

20BEME741 **AUTOMATIONINMANUFACTURING** **5 H – 4 C**

(Theory & Laboratory)

Instruction hours / week L: 3 T: 0 P:2 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

(i) THEORY

COURSE OBJECTIVES

1. To understand the importance of automation in the of field machine tool basedmanufacturing
2. To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics andCNC
3. To understand the basics of product design and the role of manufacturingautomation
4. To provide an overview of importance of group technology andFMS
5. To provide knowledge on various inspection technologies to enhance the quality of thesystem
6. To enrich the understanding of various manufacturing supportsystems

COURSE OUTCOMES

Upon completion of this course, the students will

1. Understand the basics and need for automation inmanufacturing
2. Describe the essential requirement of the computers indesign
3. Explain the importance of group technology andFMS
4. Understand the essentiality of qualitycontrol.
5. Apply various inspection technologies to enhance the quality of thesystem.
6. Explain various manufacturing supportsystems.

UNITI MANUFACTURINGOPERATIONS

Production System Facilities, Manufacturing Support systems, Automation in Production systems, Automation principles & Strategies - Manufacturing Operations, Product/Production Relationship, Production concepts and Mathematical Models & Costs of Manufacturing Operations

UNITII AUTOMATED MANUFACTURINGSYSTEMS

Basic Elements of an Automated System, Advanced Automation Functions & Levels of Automation, Continuous versus Discrete control, Computer Process control, Forms of Computer Process Control. Components of Manufacturing systems, Classification of Manufacturing Systems, overview of Classification Scheme, Single Station Manned Workstations and Single Station Automated Cells.

UNITIII GROUP TECHNOLOGY & FLEXIBLE MANUFACTURINGSYSTEMS

Part Families, Parts Classification and coding, Production Flow Analysis, Cellular Manufacturing, Flexible Manufacturing Systems: What is an FMS, FMS Components, FMS Applications & Benefits, and FMS Planning & Implementation Issues.

UNITIV QUALITY CONTROL SYSTEMS AND INSPECTIONTECHNOLOGIES

Traditional and Modern Quality Control Methods, Taguchi Methods in Quality Engineering, Introduction to SQC Tools. Automated Inspection, Coordinate Measuring Machines Construction, operation & Programming, Software, Application & Benefits, Flexible Inspection System, Inspection Probes on Machine Tools, Machine Vision, and Optical Inspection Techniques & Non-contact Non-optical Inspection Technologies.

UNITV MANUFACTURING SUPPORTSYSTEM

Process Planning, Computer Aided Process Planning, Concurrent Engineering & Design for Manufacturing, Advanced Manufacturing Planning, Just-in Time Production System, Basic concepts of lean and Agile manufacturing.

SUGGESTED READINGS:

1. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing,4thEdition, Pearson EducationLtd,2016
2. SeropeKalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 4th edition,PearsonEducation,2010.
3. YoramKoren, Computer control of manufacturing system, 1st edition,Tata McGraw-HillEducation,2017
4. Ibrahim Zeid, CAD/CAM: Theory & Practice, 2ndedition, Tata McGraw-HillEducation,2009

(ii) LABORATORY

COURSE OBJECTIVES

1. To study the features of CNC MachineTool.
2. To expose students to modern control systems (Fanuc, Siemensetc.,)
3. To know the application of various CNC machines like CNC lathe, CNC Vertical Machiningcentre.
4. To create part programming involving differentmotions.
5. To understand the working of standard cannedcycles.
6. To generate NC code usingsoftware's

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Create manual part programming for various components using G and Mcodes
2. Expose students to modern control systems (Fanuc, Siemensetc.,)
3. Know the application of various CNC machines like CNC lathe, CNC Vertical Machiningcentre
4. Create part programming involving differentmotions.
5. Understand the working of standard cannedcycles.
6. Generate NC code usingsoftware's

LIST OF EXPERIMENTS

1. MANUAL PART PROGRAMMING (Using G and M Codes) in CNCMachine.
2. Part programming for Linear, Circular interpolation, and Contourmotions.
3. Part programming using standard canned cycles for Thread cutting, Drilling, Peck drilling, andBoring.
4. NC code generation using software's like Edge CAM, CREO,etc.
5. CNC Controllers like FANUC, Siemens, and Hiedenhainetc.

SEMESTER – VII

20BEME742 COMPUTERAIDEDENGINEERING 6 H – 5 C

(Theory & Laboratory)

Instruction hours / week L : 3 T : 1 P:2 **Marks: Internal : 40 External : 60 Total:100**

End Semester Exam :3Hours

(i) THEORY

COURSE OBJECTIVES

The goal of this course is for students

1. To get the knowledge on CAD/CAMsystems.
2. To introduce the students to various techniques in CAD and help them to gain proficiency in developing mathematical models and CNCprogrammes.
3. To understand the concept of finite element method for displacement and nodalforces.
4. To gain knowledge of numerical calculations and computer tools forvalidation.
5. To study the convergence of output results and validate through theoreticalapproach.
6. To introduce the concepts of coding behind working of finite element concepts

COURSE OUTCOMES

Upon completion of this course, the students will

1. Understand geometric transformation techniques inCAD.
2. Develop mathematical models to represent curves and surfaces and model engineering components using solid modelingtechniques.
3. Develop CNC programs to manufacture industrialcomponents.
4. Apply core mechanical concept to provide preliminary results of nodal force and displacement usingFEM.
5. Explain the coding behind working of finite element concept for validation of static structural and thermal analysis.
6. Interpret the results of finite element analysis and make an assessment results in terms of modeling Discretization.

UNIT I INTRODUCTION TO CAD/CAM AND GEOMETRIC MODELING

Introduction to CAD/CAM: Introduction to CAD/CAM/CIM, CAD/CAM input devices, CAD/CAM output devices, CAD/CAM Software. Transformations of geometry - Geometric Modeling of Curves - Geometric Modeling of Surfaces. Geometric Modeling of Solids, CSG approach of solid modeling. Data Exchange Formats andApplications

UNIT II CAM AND CNC

Computer Aided Manufacturing (CAM): Introduction to Computer Numerical Control (CNC), Structure of NC machine tools, Designation of axes, Drives & actuation systems, Feedback devices, CNC tooling, Automatic tool changers & Work holding devices. CNC Programming: Part programming fundamentals, Manual Part Programming, APT Programming, Geometric & motion commands, Post processor commands.

UNIT III INTRODUCTION TO FEM

Historicalbackground–Matrixapproach–Applicationtothecontinuum–Discretization–Matrixalgebra–
Governing equations for continuum – Classical Techniques in FEM – Weighted residual method – Ritzmethod

UNIT IV ONE AND TWO DIMENSIONAL PROBLEMS

One Dimensional problems: Finite element modeling – Coordinates and shape functions– Potential energy approach – Galerkin approach – Assembly of stiffness matrix and load vector – Finite element equations – Quadratic shape functions – Applications to plane trusses. Two Dimensional problems: Poisson equation – Laplace equation – Triangular elements – Element stiffness matrix – Force vector – Galerkin approach – Stress calculation – Temperature effects.

UNIT V AXISYMMETRIC AND ISOPARAMETRIC CONTINUUM

Axisymmetric formulation – Element stiffness matrix and force vector – Galerkin approach – Body forces and temperature effects – Stress calculations – Boundary conditions – Applications. Isoparametric formulation: The four node quadrilateral – Shape functions – Element stiffness matrix and force vector – Numerical integration – Stiffness integration – Stress calculations – Four node quadrilateralelement.

SUGGESTED READINGS:

1. Ibrahim Zeid , CAD/CAM : Theory & Practice, 2nd edition, Tata McGraw-HillEducation,2009
2. Rao S.S, The Finite Element Method in Engineering, 4th Edition, Butter worth Heinemann imprint, USA, 2011
3. Daryl L. Logan, A First course in the Finite Element Method, 5th Edition, Cengage Learning, Stamford, USA,2011
4. Tirupathi R. Chandrupatla, Ashok D. Belegundu, Introduction to Finite Elements in Engineering: International Edition, 4th Edition, Pearson Education Limited,2014
5. David V Hutton, Fundamentals of Finite Element Analysis, 1st Edition, Tata McGraw–Hill Education, 2005

(ii) LABORATORY

COURSEOBJECTIVES

The goal of this course is for students

1. To perform simple structural analysis and thermal analysis using simulation software's.
2. To perform structural analysis of bars andtrusses.
3. To perform structural analysis of beams andframes.
4. To perform 2D analysis of plate andshells
5. To perform modal analysis of simplesystems
6. To perform thermal analysis of simplesystems

COURSE OUTCOMES

Upon completion of this course, the Students will be able to

1. Perform structural analysis of bars andtrusses
2. Perform structural analysis of beams andframes
3. Perform 2d analysis of plate andshells
4. Perform modal analysis of simplesystems
5. Perform thermal analysis of simplesystems
6. Perform fluid and failure analysis of simplesystems

LIST OF EXPERIMENTS
(Simple Analysis using ANSYS Tool)

1. Structural Analysis (Static)
   1d and 2d analysisof
   - Bar andtruss,
   - Beams &frames,
   - Plate and shellstructures
2. Structural vibration analysis(Dynamic)
   - Modalanalysis
   - Frequency responseanalysis
   - Transient responseanalysis
3. Thermal analysis – simpleproblems
4. Fluid Analysis – simple problems
5. Failure analysis – simpleproblems

SEMESTER – VII

20BEME7E__ **PROFESSIONAL ELECTIVE–III** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**
End Semester Exam :3Hours

20BEME7E__ **PROFESSIONAL ELECTIVE–IV** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**
End Semester Exam :3Hours

20BEME7E__ **PROFESSIONAL ELECTIVE–V** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**
End Semester Exam :3Hours

20BE_____ **OPEN ELECTIVE– III** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**
End Semester Exam :3Hours

SEMESTER – VII

20BEME791 **PROJECT WORKPHASE -I** **6 H – 3 C**

Instruction hours / week L : 0 T : 0 P:6 **Marks:** Internal **:100** External **: --**Total**:100**

COURSE OBJECTIVES

1. To expose students to problem definitions
2. To understand the Fabricate device/system/component (s) for problem solving.
3. To equip them subject knowledge to solve real world problems.
4. To acquaint the student to newer techniques to improve the performance of a device/system.
5. To develop the skill to prepare the project reports
6. To develop the skill to prepare power point presentation and to face reviews and viva voce examination.

COURSE OUTCOMES

1. Formulate problem definitions
2. Fabricate device/system/component (s) for problem solving.
3. Apply subject knowledge to solve real world problems.
4. Implement newer techniques to improve the performance of a device/system.
5. Develop the skill to prepare the project reports
6. Develop the skill to prepare power point presentation and to face reviews and viva voce examination.

COURSE DESCRIPTION

The students in a group consisting of maximum of 4 students works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. The project work carried out in this semester may be a standalone project or part of the work of project work –V carried out in the eighth semester.

SEMESTER – VIII

20BEME8__ PROFESSIONAL ELECTIVE–VI 3 H – 3 C

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

20BE_____ OPEN ELECTIVE-IV 3 H – 3 C

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

20BEME891 PROJECTWORK PHASE - II 12 H – 6 C

Instruction hours / week L : 0 T : 0 P:12 **Marks:** Internal **: 120**External **:180**Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVE

1. To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voceexamination.
2. To expose students to problem definitions.
3. To understand the Fabricate device/system/component (s) for problem solving.
4. To equip them subject knowledge to solve real world problems.
5. To acquaint the student to newer techniques to improve the performance of a device/system.
6. To develop the skill to prepare the project reports

COURSE OUTCOMES

1. Formulate problem definitions
2. Fabricate device/system/component (s) for problem solving.
3. Apply subject knowledge to solve real world problems.
4. Implement newer techniques to improve the performance of a device/system.
5. Develop the skill to prepare the project reports
6. Develop the skill to prepare power point presentation and to face reviews and viva voce examination.

COURSE DESCRIPTION

The students in a group consisting of maximum of 4 student's works on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of theDepartment.

PROFESSIONAL ELECTIVE I

20BEME6E01 **COMPOSITE MATERIALS** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P: 0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To understand the fundamentals of composite material strength and its mechanicalbehavior
2. Understanding the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of thefiber.
3. Thermo-mechanical behavior and study of residual stresses in Laminates duringprocessing.
4. Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronicchips.
5. To introduce the concepts of carbon-carbon composite for different industrialapplication
6. To impart knowledge on various advances incomposites.

COURSE OUTCOMES

Learners should be able to

1. Select the various types of composite matrix required for anapplication.
2. Choose appropriate manufacturing process for polymer matrix composite.
3. Opt appropriate manufacturing process for metal matrixcomposite.
4. Use the concepts of ceramic composites and its productiontechniques.
5. Identify the type of carbon-carbon composite for different industrialapplication.
6. Explain the various advances incomposites

UNITI INTRODUCTION TO COMPOSITES

Fundamentals of composites - need for composites – Enhancement of properties - classification of composites – Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Reinforcement – Particle reinforced composites, Fibre reinforced composites. Applications of various types ofcomposites.

UNITII POLYMER MATRIXCOMPOSITES

Polymer matrix resins – Thermosetting resins, thermoplastic resins – Reinforcement fibres – Rovings – Woven fabrics – Non woven random mats – various types of fibres. PMC processes - Hand lay up processes – Spray up processes – Compression moulding – Reinforced reaction injection moulding - Resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fibre reinforced plastics (FRP), Glass fibre reinforced plastics(GRP).

UNITIII METAL MATRIXCOMPOSITES

Characteristics of MMC, Various types of Metal matrix composites Alloys - MMC, Advantages of MMC, Limitations of MMC, Metal Matrix, Reinforcements – particles – fibres. Effect of reinforcement - Volume fraction – Rule of mixtures. Processing of MMC – Powder metallurgy process - diffusion bonding – stir casting – squeezecasting.

UNITIV CERAMIC MATRIXCOMPOSITES

Engineering ceramic materials – properties – advantages – limitations – Monolithic ceramics - Need for CMC – Ceramic matrix - Various types of Ceramic Matrix composites- oxide ceramics – non oxide ceramics – aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering - Hot pressing – Cold isostatic pressing (CIPing) – Hot isostatic pressing(HIPing).

UNITV RECENT ADVANCEMENT IN COMPOSITES

Carbon /carbon composites – Advantages of carbon matrix – limitations of carbon matrix Carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol gel technique. Composites for aerospace applications. smart nanocomposite, bioactive composite.

SUGGESTED READINGS

1. Mathews F.L and Rawlings R.D, Composite Materials: Engineering and Science, 1st edition,Wood head publishing Ltd, England,1999
2. Chawla K.K, Composite materials: Science and Engineering, 4th edition,Springer Science & Business Media, 2019
3. Clyne T.W and Withers P.J, An Introduction to Metal Matrix Composites,1st edition,Cambridge University Press, New York,1995
4. Strong A.B, Fundamentals of Composite Manufacturing, 2nd edition,Society of Manufacturing Engineering, 2008
5. Sharma S.C, Composite materials, 1st edition, Narosa Publications, New Delhi,2000.

20BEME6E02 **RENEWABLE ENERGY SOURCES** **3 H – 3C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

The goal of this course is for students

1. To understand the different energy resources and theirimpacts.
2. To provide knowledge on energy production from solarplants.
3. To impart knowledge on wind mills, tide and geo thermal energyconservations.
4. To provide basic knowledge on production of biomassenergy.
5. To understand the economic analysis of an OTEC powerplant.
6. To understand the basic principles fuel cell, Geo thermal power plants.

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Determine the impacts of harnessing different renewableenergy.
2. Analyze and design solar cells so as to improve itsperformance.
3. Explain energy generation techniques in wind mills, tide and geo thermal powerplant.
4. Understand the technique of harvesting energy from bio mass and biowastes
5. Perform economic analysis for OTEC powerplants.
6. Get basic knowledge on fuel cells, solar cells, thermionic generatorsetc.

UNITI ENERGY AND ENVIRONMENT

Primary energy sources – world energy resources–Indian energy scenario–energy cycle of the earth – environmental aspects of energy utilization, CO_2 emissions and Global warming–renewable energy resources and their importance.Economics of Renewable Energy Systems.

UNITII SOLARENERGY

Principles of solar energy collection – solar radiation – measurements – instruments – data and estimation– types of collectors – characteristics and design principles of different type of collectors – performance of collectors – testing of collectors. Solar thermal applications – water heaters and air heaters – performance and applications – simple calculations – solar cooling – solar drying – solar ponds – solar tower concept – solar furnace.

UNITIII WIND, TIDAL AND GEO THERMALENERGY

Energy from the wind – general theory of windmills – design aspects of horizontal axis windmills – applications, performance and site selection of windmills. Energy from tides and waves – working principles of tidal plants and ocean thermal energy conversion plants – power from geothermal energy – principle of working of geothermal power plants.

UNITIV BIOENERGY

Energy from bio mass and bio gas plants – pyrolysis, gasification, combustion and fermentation –various types – design principles of biogas plants – applications.Utilization of industrial and municipal wastes – energy from the agricultural wastes.

UNITV OTHER RENEWABLE ENERGYSOURCES

Direct energy conversion (Description, principle of working and basic design aspects only) – Magneto hydrodynamic systems (MHD) – thermoelectric generators – thermionic generators – fuel cells – solar cells – types, Emf generated, power output, losses and efficiency and applications. Hydrogen conversion and storage systems

SUGGESTED READINGS

1. R K Bansal, A Non-Conventional Energy sources, 1st edition, Vikas Publishing house, New Delhi,2014
2. John A. Duffie, William A. Beckman, Solar Engineering of Thermal Processes, 4thEdition, John Wiley & Sons, Inc ,2013
3. S. P. Sukhatme and J K Nayak, Solar Energy: Principles of Thermal Collection and Storage, 3rd edition, Tata McGraw Hill, New Delhi,2008
4. Ashok V Desai, Non–conventional Energy, 1st edition, New Age International (P) Ltd.,2011.

WEB REFERENCES

1. https://nptel.ac.in/courses/121106014/
2. https://www.studentenergy.org/topics/renewable-energy

20BEME6E03 **INDUSTRIALROBOTICS** **3 H – 3C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

The goal of this course is for students

1. To understand the anatomy, basic concepts and applications ofrobot.
2. To learn the drives and end effectors used inrobot.
3. To study the various types of sensors used inrobot.
4. To familiarize robot kinematics and robotprogramming
5. To provide knowledge on simple offline robot program
6. To impart knowledge on economic analysis ofrobots.

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Identify the various types ofrobots.
2. Select appropriate drive systems and end effectors for industrialapplication.
3. Decide the types of sensors required according to the applications ofrobot.
4. To identify the different types of machine visiontechnologies
5. Develop simple offline robot program for differentapplications.
6. Calculate the economic analysis ofrobots.

UNIT I FUNDAMENTALS OFROBOT

Robot – Definition – Robot Anatomy – Co–ordinate Systems, Work Envelope, types and classification – Specifications – Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and Their Functions – Need for Robots – Different Applications

UNITII ROBOT DRIVE SYSTEMS AND END EFFECTORS

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of all these Drives

End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations

UNIT III SENSORS AND MACHINEVISION

Requirements of a sensor, Principles and Applications of the following types of sensors – Position sensors (Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, Pneumatic Position Sensors), Range Sensors (Triangulation Principle, Structured, Lighting Approach, Time of Flight Range Finders, Laser Range Meters), Proximity Sensors (Inductive, Hall Effect, Capacitive, Ultrasonic and Optical Proximity Sensors), Touch Sensors, (Binary Sensors, Analog Sensors), Wrist Sensors, Compliance Sensors, Slip Sensors

Camera, Frame Grabber, Sensing and Digitizing Image Data – Signal Conversion, Image Storage, Lighting Techniques. Image Processing and Analysis – Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms. Applications – Inspection, Identification, Visual Serving and Navigation.

UNITIV ROBOT KINEMATICS AND ROBOTPROGRAMMING

Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional), Four Degrees of Freedom (In 3 Dimensional) – Deviations and Problems.

Teach Pendant Programming, Lead through programming, Robot programming Languages – VAL Programming – Motion Commands, Sensor Commands, End effecter commands, and Simple programs

UNITV IMPLEMENTATION AND ROBOT ECONOMICS

RGV, AGV; Implementation of Robots in Industries – Various Steps; Safety Considerations for Robot Operations; Economic Analysis of Robots – Pay back Method, EUAC Method, Rate of Return Method, Process application of Robots and Collaborative robots.

SUGGESTED READINGS

1. NicholasO,MitchellW,MikellGroover,RogerNNagelandAshishDutta,IndustrialRobotics– Technology Programming and Applications, 2nd edition, McGraw–Hill, New Delhi, 2012
2. Fu.K.S., Gonzalz.R.C. and Lee C.S.G, Robotics Control, Sensing, Vision and Intelligence, 1st edition, McGraw–Hill Book Co., New Delhi,2008
3. YoramKoren, Robotics for Engineers, 1st edition, McGraw–Hill Book Co., New Delhi,2007
4. Janakiraman. P.A, Robotics and Image Processing: An Introduction, 1st edition, Tata McGraw–Hill, New Delhi,1995.

20BEME6E04 HYDRAULICS AND PNEUMATICSPOWERCONTROL 3 H – 3 C

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVE

The goal of this course is for students

1. To recognize symbols and fundamentals in fluid power generation anddistribution.
2. To identify power source for hydraulicsystems.
3. To select appropriate components used in various hydraulicsystems.
4. To design hydraulic circuits for givenapplications
5. To distinguish the components used in pneumaticcircuits.
6. To create the logic circuits for controlling electro-hydraulic/ pneumaticsystems.

COURSE OUTCOMES

At the end of the course, the students will be able to

1. Recognize symbols and fundamentals in fluid power generation anddistribution.
2. Identify power source for hydraulicsystems.
3. Select appropriate components used in various hydraulicsystems.
4. Design hydraulic circuits for givenapplications
5. Distinguish the components used in pneumaticcircuits.
6. Create the logic circuits for controlling electro-hydraulic/ pneumaticsystems.

UNITI FLUID POWER SYSTEMS ANDFUNDAMENTALS

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids and air – selection of hydraulic fluids – components of fluid power system – Fluid power symbols. Applications of Pascals Law– Losses in pipe, valves andfittings – comparison between hydraulic and pneumatics.

UNITII HYDRAULIC POWER SOURCES AND ACTUATORS

Sources of Hydraulic Power: Pumping theory – Pump classification – Gear pump, Vane Pump, piston pump, Pressure boosting pumps, construction and working of pumps – pump performance – Variable displacement pumps. Fluid Power Actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, Double acting special cylinders like tanden, Rodless, Telescopic, Cushioning mechanism, Construction of double acting cylinder, Rotary actuators – Fluid motors, Gear, Vane and Piston motors, Rotary distributor.

UNITIII HYDRAULICCONTROL VALVES AND COMPONENTS

Construction of Control Components : Direction control valve – 3/2 way valve – 4/2 way valve – Shuttlevalve – check valve – pressure control valve – pressure reducing valve, sequence valve, Flow control valve – Fixed and adjustable, electrical control solenoid valves, Relays, ladder diagram. Accumulators and Intensifiers: Types of accumulators – Accumulators circuits, sizing of accumulators, intensifier – Applications ofIntensifier – Intensifier circuit.

UNITIV PNEUMATIC SYSTEMS ANDCOMPONENTS

Pneumatic Components: Compressors – Filter, Regulator and Lubricator UNIT Air control valves, Quick exhaust valves, pneumatic actuators. Fluid Power Circuit Design, Speed control circuits, synchronizing circuit, Pneumo hydraulic circuit, Sequential circuit design for simple applications using cascade method.

UNITV DESIGN OF PNEUMATICCIRCUITS

Servo systems – Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Fluidics – Introduction to fluidic devices, simple circuits, Introduction to Electro Hydraulic Pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Fluid power circuits; failure and troubleshooting.

SUGGESTED READINGS

1. Anthony Esposito, Fluid Power with Applications, 1st edition, Pearson Education, New Delhi,2013
2. Majumdar S. R, Oil Hydraulic Systems: Principles and Maintenance, 1st edition, Tata McGraw–Hill, New Delhi,2000.
3. IlangoSivaraman, Introduction To Hydraulics And Pneumatics, 3rdedition,, PHI Learning Pvt. Ltd, New Delhi,2017.
4. Michael J, Prinches and AshbyJ.G, Power Hydraulics, 1st edition, Prentice Hall of India, New Delhi, 2007 (digital)

PROFESSIONAL ELECTIVE II

20BEME6E05 REFRIGERATION ANDAIRCONDITIONING 3 H – 3 C

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

The goal of this course is for students

1. To understand the underlying principles of operations in different Refrigeration & Air conditioning systems andcomponents.
2. To provide knowledge on design aspects of Refrigeration & Air conditioningsystems
3. To introduce the concepts on use of unconventional refrigerant system for industrialapplication
4. To expose students to properties of air using psychrometricchart
5. To provide knowledge on cooling load for a givensystem
6. To know the application of air conditioning system for industrial and domestic purpose

COURSE OUTCOMES

Learners should be able to

1. Calculate COP of various refrigerationcycles.
2. Choose appropriate refrigerants for variousapplications.
3. Identify the use of unconventional refrigerant system for industrialapplication.
4. Calculate the properties of air using psychrometricchart.
5. Calculate cooling load for a givensystem
6. Select the appropriate air conditioning system for industrial and domesticapplications.

UNIT I REFRIGERATIONCYCLE

Review of thermodynamic principles of refrigeration. Concept of refrigeration system. Vapour compression refrigeration cycle – use of P–H charts – multistage and multiple evaporator systems – cascade system – COP comparison. Vapor absorption refrigeration system. Ammonia water and Lithium Bromide water systems. Steam jet refrigeration system

UNIT II REFRIGERANTS, SYSTEM COMPONENTS ANDBALANCING

Compressors – reciprocating and rotary (elementary treatment.) – Condensers – evaporators – cooling towers. Refrigerants – properties – selection of refrigerants, Alternate Refrigerants, Refrigeration plant controls – testing and charging of refrigeration units. Balancing of system components. Applications to refrigeration systems – ice plant – food storage plants – milk –chilling plants – refrigerated cargo ships.

UNITIII PSYCHROMETRY

Psychrometric processes– use of psychrometric charts – – Grand and Room Sensible Heat Factors – bypass factor – requirements of comfort air conditioning – comfort charts – factors governing optimum effective temperature, recommended design conditions and ventilation standards

UNITIV COOLING LOADCALCULATIONS

Types of load – design of space cooling load – heat transmission through building. Solar radiation –infiltration –internalheatsources(sensibleandlatent)–outsideairandfreshairload–estimationoftotalload–
Domestic, commercial and industrial systems – central air conditioning systems.

UNIT V AIRCONDITIONING

Air conditioning equipments – air cleaning and air filters – humidifiers – dehumidifiers – air washers – condenser – cooling tower and spray ponds – elementary treatment of duct design – air distribution system. Thermal insulation of air conditioning systems. – Applications: car, industry, stores, and public buildings

SUGGESTED READINGS

1. Manohar Prasad, Refrigeration and Air Conditioning, 3rd edition, New Age International Ltd, New Delhi, 2015.
2. Arora. C.P, Refrigeration and Air Conditioning, 3rd edition, Tata McGraw–Hill, New Delhi,2008
3. Roy.JDossat, Principles of Refrigeration, 4th edition, Prentice Hall of India PVT Ltd., New Delhi,1998
4. Jordon and Prister, Refrigeration and Air Conditioning, 2nd edition, Prentice Hall of India PVT Ltd.,New Delhi,1982
5. StoeckerN.W and Jerold W.Jones, Refrigeration and Air Conditioning, 2nd edition, McGraw Hill, New Delhi,2007

20BEME6E06 ADVANCEDMANUFACTURINGPROCESSES 3 H – 3 C

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVE

The goal of this course is for students

1. To enhance specified concepts and skills regarding various processes including powder metallurgy and foundry techniques.
2. To learn about wide range of welding process, which are currently used in the manufacturing industry.
3. To acquire knowledge to understand the working concept of sheet metal and forming process.
4. To learn about various machining process parameters, influence on performance and applications.
5. To learn the concepts of rapid product development, apply acquired knowledge to meet global challenges in changing design in time compressed mode.
6. To provide knowledge on optimum parametric for advanced manufacturing process.

COURSE OUTCOME

Upon the completion of this course, the students will be able to

1. Understand the concepts and processing parameters of powder metallurgyprocess.
2. Different kinds of metal joiningprocesses.
3. Explain various sheet metal makingprocesses
4. Summarize various hot working and cold working methods ofmetals
5. Describe the constructional and operational features of modern machiningprocess
6. Understand the importance of rapid prototyping in the productdevelopment

UNITI POWDER METALLURGY AND FOUNDRY TECHNIQUES

Introduction to powder metallurgy process – preparation of powders – types and functions of binders – green compaction – sintering process and its effect on the product. High pressure moulding, Squeeze casting, Vacuum castings

UNITII ADVANCED WELDINGPROCESSES

Percussion Welding– Electro Slag Welding, Plasma Arc Welding – Thermit Welding – Electron Beam Welding – Friction and Inertia Welding – Friction Stir Welding – Under Water WeldingProcess.

UNITIII SHEET METAL AND FORMINGPROCESS

Sheet metal process –Laser welding and Cutting, Working principle and application of special forming process – Hydro Forming– Rubber Pad Forming– Explosive Forming – Magnetic Pulse Forming– Peen Forming – Super Plastic Forming – Deep Drawing Process.

UNITIV ADVANCED MACHININGPROCESS

Modern machining process: Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, Electro chemical Machining, Electro chemical Grinding, Electro Discharge Machining, wire cut EDM, Electron Beam Machining, plasma arc machining, Laser Beam Machining. Ultrasonic Machining, High speed machining process – deep hole drilling process

UNITV RAPIDPROTOTYPING

Introduction to Rapid Prototyping – Need for RPT– Stereo–lithography – Selective Laser Sintering, Fused Deposition Modeling, Laminated Object Manufacturing, Solid Ground Curing, Ballistic Particle Manufacturing

SUGGESTED READINGS

1. O. P. Khanna, A Textbook of Welding Technology, 1st edition, DhanpatRai Publications Pvt Ltd,2012
2. P.N. Rao, Manufacturing technology Volume I, 4th edition, Tata McGraw Hill Education,2013
3. Singh, M.K, Unconventional Manufacturing Process, 1st edition, New age international,2019.
4. Vijay.K Jain, Advanced Machining Processes, 1st edition, Allied Publishers Pvt. Ltd,2010

WEB REFERENCES

1. https://nptel.ac.in/courses/112107078/

20BEME6E07 **VIBRATION ANALYSISANDCONTROL** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVE

The goal of this course is for students

1. To understand the Fundamentals of Vibration and its practicalapplications
2. To understand the working principle and operations of various vibrations Measuringinstruments.
3. To understand the various Vibration controlstrategies.
4. To understand the various Vibration controlstrategies
5. To equip them with skills to solve mathematically a multi-degree freedom system & continuoussystem
6. To give exposure to the various experimental methods used for vibrationanalysis

COURSE OUTCOMES

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

1. Define the terms involved in vibrationsystem.
2. Describe the importance of vibrationisolation
3. Explain the working nature of two degree of freedomsystems
4. Solve mathematically a multi-degree freedom system & continuoussystem
5. List the various techniques used in vibrationcontrol
6. Explain the various experimental methods used for vibrationanalysis.

UNITI SINGLE DEGREE FREEDOM SYSTEM

Introduction -Sources of Vibration-Mathematical Models- Displacement, velocity and Acceleration- Review Of Single Degree Freedom Systems -Vibration isolation Vibrometers and accelerometers -.Response To Arbitrary and non- harmonic Excitations – Transient Vibration –Impulse loads-Critical Speed of Shaft-Rotor systems.

UNITII TWO DEGREE FREEDOM SYSTEM

Introduction-Free Vibration of Undamped And Damped- Forced Vibration With Harmonic Excitation System –Coordinate Couplings And Principal Coordinates.

UNITIII MULTI-DEGREE FREEDOM SYSTEM AND CONTINUOUSSYSTEM

Multi Degree Freedom System –Influence Coefficients and stiffness coefficients- Flexibility Matrix and Stiffness Matrix – Eigen Values and Eigen Vectors-Matrix Iteration Method –Approximate Methods: Dunkerley, Rayleigh's, and Holzer Method -Geared Systems-Eigen Values and Eigen vectors for large system of equations using sub space, Lanczos method - Continuous System: Vibration of String, Shafts and Beams.

UNITIV VIBRATIONCONTROL

Specification of Vibration Limits –Vibration severity standards- Vibration as condition Monitoring tool-Vibration Isolation methods- -Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber- Damped Vibration absorbers-Static and Dynamic Balancing-Balancing machines-Field balancing – Vibration Control by Design Modification- - Active VibrationControl.

UNITV EXPERIMENTAL METHODS IN VIBRATIONANALYSIS

Vibration Analysis Overview - Experimental Methods in Vibration Analysis.-Vibration Measuring Instruments - Selection of Sensors- Accelerometer Mountings. -Vibration Exciters-Mechanical, Hydraulic, Electromagnetic And Electrodynamics –Frequency Measuring Instruments-. System Identification from Frequency Response - Testing for resonance and mode shapes.

SUGGESTED READINGS

1. Rao, S.S, Mechanical Vibrations, 5th edition, Prentice Hall ,2017
2. William Tyrrell Thomson, Marie Dillon Dahleh, Theory of Vibration with Applications, 5thedition,Prentice Hall,1998
3. Ramamurti. V, Mechanical Vibration Practice with Basic Theory, 1st edition, Narosa publishing house, New Delhi,2000
4. S. Graham Kelly, Mechanical Vibrations: Theory and Applications, SI Edition, Cengage learning,2012.

20BEME6E08 **HYBRIDVEHICLETECHNOLOGY** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

The goal of this course is for students

1. This course introduces the fundamental concepts, principles, analysis and design of hybrid, electric and fuel cellvehicles.
2. To understand working of different configurations of electric vehicles, and its components, hybrid vehicle configuration and performanceanalysis.
3. To impart knowledge on various energy source
4. To provide knowledge on concepts of electric propulsionsystems
5. To expose students to various drive trains for hybrid electricvehicles
6. To facilitate the understanding of the concepts of electronic converters

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Understand the concepts of electric and hybrid electricvehicles
2. Describe about the various energy source available for the hybrid electricvehicles.
3. Explain the concepts of electric propulsionsystems
4. Design series drive train for hybrid electricvehicles
5. Design parallel drive train for hybrid electricvehicles
6. Understand the concepts of electronic converters for battery charging of electric hybridvehicles.

UNITI ELECTRIC AND HYBRID ELECTRICVEHICLES

Configuration of Electric Vehicles and its advantages, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains

UNITII ENERGY STORAGE FOR EV ANDHEV

Energy storage requirements, Battery parameters, Types of Batteries, Modeling of Battery, Properties of Battery, Battery Efficiency, Battery pack design. Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modeling of PEMFC, Super Capacitors.

UNITIII ELECTRIC PROPULSION

EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives

UNITIV DESIGN OF ELECTRIC AND HYBRID ELECTRICVEHICLES

Series Hybrid Electric Drive Train Design: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of PPS Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design, energy storage design

UNITV POWER ELECTRONIC CONVERTER FOR BATTERYCHARGING

Charging methods for battery, Termination methods, charging from grid, The Z-converter, Isolated bidirectional DC-DC converter, Design of Z-converter for battery charging, Highfrequency transformer based isolated charger topology, Transformer less topology.

SUGGESTED READINGS

1. M. Ehsani, Y. Gao, S. Gay and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, 3rd edition, CRC Press2018
2. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition, CRC Press2011
3. Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles , 1st edition, Springer,2013
4. Ron Hodkinson and John Fenton, Light Weight Electric/Hybrid Vehicle Design, 1st edition, Butterworth Heinemann, 2001
5. Chan.C.Cand.Chau.K.T, Modern Electric Vehicle Technology, 1st edition, OXFORD University Press 2001
6. Chris Mi, M. AbulMasrur, David WenzhongGao, Hybrid Electric Vehicles Principles and Applications with Practical Perspectives, 2nd edition, Wiley Publication2017.

PROFESSIONAL ELECTIVE III

20BEME7E01 DESIGN FOR MANUFACTUREAND ASSEMBLY 3 H – 3 C

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

The goal of this course is for students

1. To study the various factors influencing the manufacturability of components and the use of tolerances in manufacturing.
2. To understand the importance of the DFM approach and guidelines.
3. To enrich the understanding of the selective assembly and Datum systems.
4. To introduce the concepts of demonstrate true Position tolerancing theory.
5. To develop an understanding of the standard techniques and redesigning cast members using weldments and plastic component manufacturing.
6. To equip them with skills on Tolerance Charting Technique.

COURSE OUTCOMES

Upon completion of this course, the students will be able to,

1. Understand the importance of DFMA in industrialscenerio
2. Implement the tolerancesanalysis.
3. Identify different types of tolerance allocationmethods.
4. Practice the geometric dimensioning and toleranceconcepts.
5. Prepare tolerancechart.
6. Implement DFM concepts in practice.

UNIT I DFM APPROACH, SELECTION AND SUBSTITUTION OF MATERIALSIN INDUSTRY

DFM approach, DFM guidelines, standardisation, group technology, value engineering, comparison of materials on cost basis, design for assembly, DFA index, Poka – Yoke principle; 6σ concept; Tolerance Analysis: Process capability, process capability metrics, Cp, Cpk, cost aspects, feature tolerances, geometric tolerances, surface finish, review of relationship between attainable tolerance grades and different machining process, cumulative effect of tolerances, sure fit law, normal law and truncated normallaw.

UNIT II SELECTIVEASSEMBLY

Interchangeable and selective assembly, deciding the number of groups, Model–I: group tolerances of mating parts equal; Model–II: total and group tolerances of shaft, control of axial play.

Datum Systems: Grouped datum systems–different types, two and three mutually perpendicular grouped datum planes, grouped datum system with spigot and recess, pin and hole, and tongue–slot pair, computation of translational and rotational accuracy.

UNIT III TRUE POSITION TOLERANCINGTHEORY

Comparison between co–ordinate and convention method of feature location tolerancing and true position tolerancing, zero true position tolerance, virtual size concept, floating and fixed fasteners, projected tolerance zone, functional gauges, paper layout gauging, compound assembly,examples.

UNIT IV FORM DESIGN OF CASTINGS ANDWELDMENTS

Redesign of castings based on parting line considerations, minimising core requirements, redesigning cast members using weldments, use of welding symbols – design considerations for plastic component manufacturing.

UNIT V TOLERANCECHARTING

Tolerance Charting Technique: Operation sequence for typical shaft type of components, preparation of process drawings for different operations, tolerance worksheets and centrality analysis, examples, design features to facilitate machining. Datum features – functional and manufacturing, component design–machining considerations, redesign for manufacture,examples.

TOTAL

SUGGESTED READINGS

1. Harry Peck, Designing for Manufacture, 1st edition, Pitman Publications, London,1973
2. Gerhard Pahl, Wolfgang Beitz, Engineering Design – A Systematic Approach, 3rd Edition, Springer Science & Business Media,2007.
3. Spotts M F, Dimensioning and Tolerance for Quantity Production, 1st edition, Prentice Hall Inc., New Jersey, USA, 2008(Digital)
4. Oliver R Wade, Tolerance Control in Design and Manufacturing, 1st edition, Industrial press Inc., New York, 2008
5. James G Bralla, Hand Book of Product Design for Manufacturing, 1st edition, McGraw Hill Publications, New Delhi, 2000(Digital)
6. Clyde M. Creveling, Tolerance Design – A Hand Book for Developing Optimal Specifications, 1st edition, Prentice Hall,2012

20BEME7E02 **COMPUTATIONALFLUIDDYNAMICS** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

The goal of this course is for students

1. To introduce Governing Equations of viscous fluidflows.
2. To introduce numerical modeling and its role in the field of fluid flow and heattransfer.
3. To enable the students to understand the various discretization methods, solution procedures and turbulencemodeling.
4. To create confidence to solve complex problems in the field of fluid flow and heat transfer.
5. To understand basic properties of computational methods – accuracy, stability, consistency.
6. To understand the importance continuity and momentum equations for different types of fluidflow

COURSE OUTCOMES

Upon completion of this course, the students can able

1. Identify, solve engineering problems by computational fluiddynamics.
2. Understand the importance of governing equations involved inCFD
3. Formulate and solve problems in the field of fluid flow and heattransfer.
4. Solve the heat conduction problems using finite differencemethod.
5. Analyze and provide solutions for convection and diffusionproblems.
6. Develop continuity and momentum equations for different types of fluidflow.

UNITI GOVERNING EQUATIONS AND BOUNDARYCONDITIONS

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 – Turbulence –Kinetic –Energy Equations – mathematical behavior of PDEs on CFD: Elliptic, Parabolic and Hyperbolicequations.

UNITII DISCRETIZATION AND SOLUTIONMETHODOLOGIES

Methods of Deriving the Discretization Equations – Taylor Series formulation – Finite difference method – Control volume Formulation – Spectral method.

Solution methodologies: Direct and iterative methods, Thomas algorithm, Relaxation method, Alternating Direction Implicit method.

UNITIII FEM TECHNIQUES

FEM techniques in CFD,strong and weak Boundry,Value problem,Weighted residual formulation,gelerkin foundation,variational formulation, implementation of FEM.

UNITIV HEATCONDUCTION,CONVECTION ANDDIFFUSION

Finite difference and finite volume formulation of steady/transient one–dimensional conduction equation, Source term linearization, Incorporating boundary conditions, Finite volume formulations for two and three dimensional conduction problems.Finite volume formulation of steady one–dimensional convection and Diffusion problems, Central, upwind, hybrid and power–law schemes – Discretization equations for two dimensional convection and diffusion.

UNITV CALCULATION OF FLOWFIELD

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–ε) models.

SUGGESTED READINGS

1. Versteeg H.K and Malalasekera.W, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd edition, Pearson education,2008
2. Muralidhar K and Sundarajan T, Computational Fluid Flow and HeatTransfer,2nd edition, Narosapublication, 2014
3. Fletcher C.A.J., Computational Technique for Fluid Dynamics, Vol I & Vol II., springer-vorlag. berlin-2012.

20BEME7E03 ENERGY CONSERVATION METHODS ANDENERGY AUDIT **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

The goal of this course is for students

1. To understand and analyze the energy data ofindustries
2. To carryout energy accounting andbalancing of industrial boilers.
3. To conduct energy audit and suggest methodologies for energysavings of furnaces.
4. To learn energy conservation opportunities of electrical components.
5. To utilize the available resources in optimalways.
6. To make the students conversant with concepts of industrialfurnaces

COURSE OUTCOMES:

At the end of the course, student will be able to

1. Understand the Environmental aspects of energyutilization
2. Perform combustionanalysis
3. Explain the concepts of industrialboiler
4. understand how to work with the steam generated from the boilers in the industrial point ofview
5. Explain the concepts of industrialfurnaces
6. Perform Energyaudit

UNITI ENERGYSCENARIO

Present status, rate of growth, energy utilization (sector wise), concept of energy conservation, energy economics.

COMBUSTION: Fuel analysis, combustion calculations, air requirements, theoretical and excess air requirements, excess air control, flue gas analysis and measurement, types of draught, draught calculations, chimney size calculations. F.D and I.D fan draught requirements and power requirements, furnace pressure requirements.

UNITII INDUSTRIALBOILERS

Types and characteristics of industrial boilers, heat balance in boilers, efficiency trials in boilers, energy conservation opportunities in boilers operation and maintenance, water treatment requirements, soot blowing requirements, super heaters and superheat controls, waste heat recovery systems.

STEAM: Distribution requirements of steam and steamlines, efficient utilization of steam, steam trapping and air venting, flash steam recovery, condensate recovery, thermal insulation for systems including HVAC, steam balance calculations.

UNITIII INDUSTRIALFURNACES

Furnace types and characteristics, heat balance in furnaces, furnace efficiency calculations, energy conservation opportunities in furnaces, refractories types and properties, waste heat recovery system, insulating refractories, ceramic fibers, heat loss reduction calculations, wall and stored heat lossreduction.

UNITIV ENERGY CONSERVETION OF ELECTRICAL COMPONENTS

Working principle of pump, fan and compressor – classification - performance analysis - energy conservation opportunities.

UNITV ENERGY AUDIT AND APPLICATIONS

Types, methodology, questionnaire development, specific energy consumption (unitwise/section wise), identification of energy conservation measures/ technologies, economic and cost benefit analysis, case studies, Energy rating for thermal equipment, Energy saving measurement – Star status –National awards.

SUGGESTED READINGS

1. Turner, W. C., Doty, andTruner, W. C, Energy Management Hand book, 9th edition, Fairmont Press / CRC press, 2018.
2. De. B. K., Energy Management audit & Conservation, 2nd edition, Vrinda Publication,2014
3. W. Trinks, M. H. Mawhinney, Industrial Furnaces, 6th edition, John Wiley Publications, London,2006
4. PrabirBasu, Cen Kefa, Louis Jestin, Boilers and Burners Design and Theory, 1st edition, Springer Publications, New Delhi, 2000.

20BEME7E04 **ADDITIVEMANUFACTURING** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

The goal of this course is for students

1. To know the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Additive Manufacturingtechnologies
2. To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.
3. To introduce process involved in Additive manufacturingtechnology.
4. To understand the importance of knowledge on software's used in additive manufacturingtechnology
5. To enrich the understanding of the working of SLS and othertechniques
6. To provide an overview of additive manufacturing technology in medicalfield and biostream.

COURSE OUTCOMES

On completion of this course, students will be able to

1. Understand the need for additive manufacturingtechnology
2. Explain the process involved in Additive manufacturingtechnology
3. Get knowledge on software's used in additive manufacturingtechnology
4. Describe the working of SLS and othertechniques
5. Apply the additive manufacturing technology in medicalfield
6. Applications of additive manufacturing technology in biostream.

UNITI INTRODUCTION

Overview – History - Need-Classification -Additive Manufacturing Technology in product development- Materials for Additive Manufacturing Technology – Tooling - Applications.

UNITII CAD & REVERSEENGINEERING

Basic Concept – Digitization techniques – Model Reconstruction – Data Processing for Additive Manufacturing Technology: CAD model preparation – Part Orientation and support generation – Model Slicing –Tool path Generation – Software's for Additive Manufacturing Technology: MIMICS,MAGICS.

UNITIII LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURINGSYSTEMS

Classification – Liquid based system – Stereo lithography Apparatus (SLA)- Principle, process, advantages and applications - Solid based system –Fused Deposition Modeling - Principle, process, advantages and applications, Laminated Object Manufacturing

UNITIV POWDER BASED ADDITIVE MANUFACTURINGSYSTEMS

Selective Laser Sintering – Principles of SLS process - Process, advantages and applications, Three-Dimensional Printing - Principle, process, advantages and applications- Laser Engineered Net Shaping (LENS), Electron BeamMelting.

UNITV MEDICAL AND BIO-ADDITIVEMANUFACTURING

Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing- Computer Aided Tissue Engineering (CATE) – Case studies

SUGGESTED READINGS

1. Chua C.K., Leong K.F., and Lim C.S, Rapid prototyping: Principles and applications, 3rd edition, World Scientific Publishers,2010
2. Gebhardt A, Rapid prototyping, 1st edition, Hanser Publications,2003
3. Frank W. Liou, Rapid Prototyping and Engineering Applications: A Toolbox for Prototype Development, 2nd edition, CRC Press,2019.
4. Kamrani, Ali K., Nasr, EmadAbouel, Rapid Prototyping: Theory and practice, 1st edition, Springer,2015
5. Peter Hilton, Rapid Tooling: Technologies and Industrial Applications, 1st edition, CRC Press,2000.

PROFESSIONAL ELECTIVE IV

20BEME7E05 **GAS DYNAMICS ANDJETPROPULSION** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

The goal of this course is for students

1. To understand the basic difference between incompressible and compressibleflow.
2. To understand the phenomenon of shock waves and its effect on flow. To gain some basic knowledge about jet propulsion and RocketPropulsion.
3. To introduce the concepts of various conditions of compressible fluidflows
4. To Study and acquire knowledge on performance analysis of subsonic and supersonicinlets, combustors, afterburners and exhaustnozzles
5. To understand the concept of working of various types of rocketengines
6. To study the features of thrust equation for rocket propulsionsystem

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Analyze various conditions of compressible fluidflows.
2. Calculate mass flow rate in flow through variable areaducts.
3. Carryout simple performance analysis of subsonic and supersonicinlets.
4. Perform performance analysis of combustors, afterburners and exhaustnozzles.
5. Understand the working of various types of rocketengines
6. Use thrust equation for rocket propulsionsystem.

UNITI BASIC CONCEPTS AND ISENTROPICFLOWS

Energy and momentum equations of compressible fluid flows – Stagnation states, Mach waves and Mach cone –Effect of Mach number on compressibility – Isentropic flow through variable area ducts – Nozzle and Diffusers –area ratio as a function of Mach number, mass flow rate through nozzles and diffusers, effect of friction in flow through nozzles. Use of Gas tables.

UNITII FLOW THROUGHDUCTS

Flow through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – Variation of flow properties – Isothermal flow with friction in constant area ducts –Use of tables and charts – Generalised gas dynamics.

UNITIII NORMAL AND OBLIQUESHOCKS

Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl – Meyer relations – Use of table and charts – Applications.

UNITIV JETPROPULSION

Theory of jet propulsion – Thrust equation – Thrust power and propulsive efficiency – Operation principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and turbo prop engines – Aircraft combustors.

UNITV ROCKETPROPULSION

Types of rocket engines – Propellants – Ignition and combustion – Theory of rocket propulsion – solid and liquid propellants, comparison of different propulsion systems .Performance study – Staging – Terminal and characteristic velocity – Applications – Space flights.

(Permitted to use standard Gas Tables in the examination)

SUGGESTED READINGS

1. Yahya.S.M, Fundamentals of Compressible flow, 6thedition,New Age International (P) Ltd., New Delhi, 2018
2. Rathakrishnan.E, Gas Dynamics, 6thedition,Prentice Hall of India, New Delhi,2017
3. Patrick.H.Oosthuizen, WillamE.Carscallen, Introduction to Compressible fluid flow, 2ndedition,CRC press, 2013
4. Zucker,R.D. and Biblarz,O, Fundamentals of Gas Dynamics, 2nd edition, John Wiley & Sons,2002
5. Ganesan .V, Gas Turbines, 3rdedition,Tata McGraw–Hill, New Delhi,2010
6. PhilipGrahamHill,CarlR.Peterson,MechanicsandThermodynamicsofPropulsion,2ndedition,Addison –Wesley Publishing Company, 2009(digital).

20BEME7E06 **DESIGN OFMECHATRONICSYSTEMS** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVE

The goal of this course is for students

1. To impart knowledge about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field ofautomation.
2. To understand the concepts of sensors andtransducers.
3. To provide an overview of actuationsystems.
4. To expose students to controller model for electrical, mechanical and thermalsystems.
5. To provide knowledge about various types ofcontrollers
6. To facilitate the understanding of PLC program using ladderlogic.

COURSE OUTCOME

Upon completion of this course, the students can able to

1. Implement the concepts of sensors andtransducers.
2. Design the actuationsystems.
3. Develop the controller model for electrical, mechanical and thermalsystems.
4. Explain about various types ofcontrollers
5. Create the PLC program using ladderlogic.
6. DesignMechatronicssystem.

UNITI MECHATRONICS SENSORS ANDTRANSDUCERS

Introduction to Mechatronics – Systems – Measurement Systems – Control Systems –Traditional design – Microprocessor based Controllers. Introduction to sensors – Performance Terminology – Static and Dynamic characteristics – Displacement – Position and Proximity – Velocity and Motion – Fluid Pressure – Temperature Sensors – Light Sensors – Selection of Sensors – Signal processing – Servosystems.

UNITII ACTUATORS AND SYSTEMMODELS

Pneumatic and Hydraulic Systems – Directional Control Valves – Rotary Actuators. Mechanical Actuation Systems – Cams – Gear Trains – Ratchet and pawl – Belt and Chain Drives – Bearings. Electrical Actuation Systems – Mechanical Switches – Solid State Switches – Solenoids – D.C Motors – A.C Motors – Stepper Motors.

Introduction to system models– Building block of Mechanical, Electrical, Fluid and Thermal Systems.

UNITIII MICROPROCESSORS IN MECHATRONICS

Introduction – Architecture – pin configuration Instruction set – Programming of Microprocessors using 8085 instructions – Interfacing. Input and output devices – interfacing D/A converters and A/D converters – Application – Temperature control – Stepper motor control.

UNITIV CONTROLLERS

Introduction –Continuous and discrete process Controllers – Control Mode – Two – Step mode – Proportional Mode –Derivative Mode – Integral Mode – PID Controllers –Digital Controllers – Adaptive Control – Digital LogicControl–MicroProcessorsControl.IntroductiontoPLC–BasicStructure–Input/OutputProcessing –Programming–Mnemonics–Timers,Internalrelaysandcounters–DataHandling–AnalogInput/Output – Selection of aPLC.

UNITV DESIGN OF MECHATRONICSYSTEMS

Stages in designing Mechatronics Systems – Traditional and Mechatronic Design – Possible Design Solutions – Case Studies of Mechatronics Systems, Pick and place robot – automatic Car Park Systems – Engine Management Systems – Introduction toMEMS.

SUGGESTED READINGS

1. Bolton W, Mechatronics (Anna University): A Multidisciplinary Approach, 1st edition, Pearson Prentice Hall, Delhi,2008
2. Michael B. Histand David G. Alciatore, Introduction to Mechatronics and Measurement Systems, 4th edition, McGraw–Hill International Editions, New York,2014
3. NitaigourPremchandMahalik, Mechatronics : Principles, Concepts and Applications, 1st edition, McGraw–HillEducation, New Delhi,2003
4. Ghosh P.K and Sridhar P.R, Introduction to Microprocessors for Engineers and Scientist, 3rd edition, Prentice Hall of India, New Delhi,2009

20BEME7E07 LOGISTICS AND SUPPLYCHAINMANAGEMENT 3 H – 3 C

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To know the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Additive Manufacturingtechnologies
2. To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.
3. To explain basics of SCM and logistics
4. To impart knowledge need for inventorymanagement
5. To expose students to value of information inSCM
6. To understand the concept of information technology involved inSCM

COURSE OUTCOMES

On completion of this course, students will learn about

1. Basics of SCM and logistics
2. Understand the need for inventorymanagement
3. Apply the need for value of information inSCM
4. Describe about the various strategicalliances
5. Explain about the various issues in the internationalSCM
6. Get knowledge in information technology involved inSCM

UNIT IINTRODUCTION TO SUPPLY CHAIN MANAGEMENT

Definition, global optimization, Objectives of SCM. Logistics networks– data collection, model and data elevation, solution techniques.

UNITII INVENTORYMANAGEMENT

Introduction, single warehouse, Inventory examples, economic lot size model, effect of demand uncertainty. Risk pooling, centralized and decentralized system, managing inventory in the supply chain, forecasting.

UNITIII VALUE OF INFORMATION

Bullwhip effect, information and supply chain technology. Supply chain integration– push, pull and push–pull system. Demand driven strategies, impact of internet on SCM, distribution strategies.

UNITIV STRATEGIC ALLIANCES

Framework for strategic alliance, third party logistics, retailer, supplies partnership, distributor–integration, procurement and out servicing strategies.

UNIT VINTERNATIONAL ISSUES IN SCM

Introduction, risks and advantages– design for logistics, supplies integration into to new product development, mass customization. Issues in customer value.

Information technology for SCM: Goals, standardization, infrastructure, DSS for supply chain management.

SUGGESTED READINGS

1. Simchi – Levi David, Kaminsky Philip and Simchi–Levi Edith, Designing and Managing the Supply Chain, 3rd edition, Tata M.Graw– Hill Publishing Company Ltd, New Delhi,2007
2. SunilChopraandPeterMeindl,SupplyChainManagement–Strategy, Planning and Operation, 2ndedition, Prentice Hall, New Delhi,2005
3. Ayers J.B, Hand book of Supply Chain Management, 1st edition, The St. Lenciepress, New York,2000
4. Raghuram G and Rangaraj N, Logistics and Supply Chain Management: Cases and Concepts, 2nd edition, Macmillan, New Delhi,2009
5. Schary P.B, Lasen T.S, Managing the global supply chain, 3rd edition, Copenhagen Business School Press DK, New Delhi,2007
6. Thomas E Vollman, Clay Whybark D, Manufacturing Planning and Control for Supply Chain Management, 6th edition, Tata McGraw–Hill, New Delhi,2014.

20BEME7E08 OPERATIONSRESEARCH 3 H – 3 C

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVE

1. To provide knowledge and training in finding optimal solutions under limited resources for the engineering and business problems.
2. To Study and acquire knowledge on engineering and Managerial solutions in Assignment and scheduling problems.
3. To give exposure to inventory in industry.
4. To make the student acquire sound knowledge on sequences to perform operation among various alternatives.
5. To provide an overview of various tools in various sections of industries like marketing, material handling etc.
6. To understand theEngineering and Managerial situations in Transportation.

COURSE OUTCOME

At the end of the course, student will be able to

1. Understand the concepts of Linear programmingtechnique.
2. Apply LPP technique of Transportation models.
3. Understand the techniques ofscheduling and sequencing.
4. Acquire knowledgein Inventory control and Queuingtheory.
5. Perform network analysis for a project.
6. Understand the concept of replacement models.

UNITI INTRODUCTION TO OPERATIONSRESEARCH

Operations research and decision–making – types of mathematical models and constructing the model – Role of computers in operations research –Linear Programming Techniques: Formulation of linear programming problem, applications and limitations, graphical method, simplex method – The Big –M method – the two–phase method.

UNIT II TRANSPORTATION PROBLEMS

Least cost method, North west corner rule, Vogel's approximation method, modified distribution method, unbalance and degeneracy in transportation model, shortest route algorithm – dijkestra algorithm.

UNIT III ASSIGNMENT MODELS AND SCHEDULING

Assignment models - Hungarian algorithm, unbalanced assignment problems - maximization case in assignment problems, traveling salesman problem. Scheduling – processing n jobs through two machines, processing n jobs through three machines, processing two jobs through 'm' machines, processing n jobs through m machines.

UNIT IV INVENTORY CONTROL AND QUEUING THEORY

Variables in inventory problems, inventory models with penalty, shortage and quantity discount, safety stock, multi item deterministic model.

Queuing Models: Queues – Notation of queues, performance measures, The M/M/1 queue, The M/M/m queue, batch arrival queuing system, queues with breakdowns.

UNIT V PROJECT MANAGEMENT AND REPLACEMENT MODELS

Basic terminologies, constructing a project network, network computations in CPM and PERT, cost crashing – Replacement Models: Replacement of Items due to deterioration with and without time value of Money, Group replacement policy, Staff replacement

SUGGESTED READINGS

1. KantiSwarup, Operations Research, 12th edition, Sultan Chand and Sons, New Delhi,2010.
2. Viswanathan N and Narahari Y, Performance Modeling of Automated Manufacturing Systems,2nd edition, Prentice Hall of India,New Delhi,2005
3. Premkumar Gupta and Hira D.S, Operation Research, 1st edition, S Chand and Company Limited, New Delhi,2017

PROFESSIONAL ELECTIVE V

20BEME7E09 DESIGN OF JIGS, FIXTURES ANDPRESSTOOLS 3 H – 3 C

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To impart knowledge on the principles of locating and clamping devices in machining process.
2. To familiarize the students to understand design of jigs for a given component.
3. To Study and acquire knowledge on design fixtures for a given component.
4. To make the student acquire sound knowledge on appropriate type of press tool for a given component.
5. To expose students todrawing die for a given component.
6. To give exposure to the use computer aids for sheet metal forming analysis

COURSE OUTCOMES

Upon the completion of this course the students will be able to

1. Summarize the different methods of Locating Jigs and Fixtures and Clamping principles
2. Design and develop jigs
3. Design and development of fixtures for given component
4. Discuss the press working terminologies and elements of cutting dies
5. Distinguish between Bending and Drawing dies.
6. Design Bending and drawing dies

UNITI PURPOSE TYPES AND FUNCTIONS OF JIGS ANDFIXTURES

Tool design objective – Production devices – Inspection devices – Materials used in Jigs and Fixtures – Types of Jigs – Types of Fixtures–Mechanical actuation–pneumatic and hydraulic actuation–Analysis of clamping force–Tolerance and error analysis.

UNITII JIGS

Drill bushes –different types of jigs–plate latch, channel, box, post, angle plate, angular post, turnover, pot jigs–Automatic drill jigs–Rack and pinion operated. Air operated Jigs components. Design and development of Jigs for givencomponents.

UNITIII FIXTURES

General principles of boring, lathe, milling and broaching fixtures– Grinding, planning and shaping fixtures, assembly, Inspection and welding fixtures– Modular fixtures, Quick change fixtures. Design and development of fixtures for given component.

UNITIV PRESS WORKING TERMINOLOGIES AND ELEMENTS OF DIES AND STRIP LAYOUT

Press working terminology–Presses and press accessories–Computation of capacities and tonnage requirements. Elements of progressive combination and compound dies:Die block–die shoe. Bolster plate–punch plate–punch holder–guide pins and bushes – strippers – knockouts–stops –pilots–Selection of standard die sets strip lay out–strip lay out calculations, SMEDtechnique.

UNITV DESIGN AND DEVELOPMENT OFDIES

Design and development of progressive and compound dies for Blanking and piercing operations. Tool and DIE Materials, Bending dies – development of bending dies–forming and drawing dies–Development of drawing dies. Design considerations in forging, extrusion, casting and plastic dies.

SUGGESTED READINGS

1. Edward G Hoffman, Jigs and Fixture Design, 5th edition, Thomson – Delmar Cengage Learning, Singapore,2012
2. Cyril Donaldson, George H. Lecain and V. C. Goold, Tool Design, 4th edition, Tata McGraw–Hill, New Delhi,2012
3. K. Venkataraman, Design of Jigs, Fixtures and Press Tools, 1st edition, John Wiley & Sons,2015.
4. Joshi P.H, Jigs and Fixtures, 3rd edition, Tata McGraw–Hill Publishing Company Limited, New Delhi, 2010
5. Hiram E Grant, Jigs and Fixtures: Non-Standard Clamping Devices, 1stedition, Tata McGraw–Hill, New Delhi,1971

20BEME7E10 **ADVANCED I.C.ENGINES** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To understand the underlying principles of operation of different IC Engines andcomponents.
2. To provide knowledge on pollutant formation, control, alternate fueletc.
3. To Study and acquire knowledge to Identify parts, terminology and fuel supply system of internal combustionengine
4. To introduce the concepts of cooling and lubrication systems of ICengines
5. To make the student acquire sound knowledge on combustion, knocking and super charging of internal combustionengines
6. To expose students to recent trends associated with ICengines

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Explain the construction and operation of internal combustionengine.
2. Identify parts, terminology and fuel supply system of internal combustionengine.
3. Recognize the component used in cooling and lubrication systems of ICengines.
4. Describe the function of combustion, knocking and super charging of internal combustionengines.
5. Implement strategies for pollution control.
6. Know about the recent trends associated with ICengines

UNITI SPARK IGNITIONENGINES

Mixture requirements – Fuel injection systems – Monopoint, Multipoint & Direct injection - Stages of combustion – Normal and Abnormal combustion – Knock - Factors affecting knock – Combustion chambers.

UNITII COMPRESSION IGNITIONENGINES

Diesel Fuel Injection Systems - Stages of combustion – Knocking – Factors affecting knock – Direct and Indirect injection systems – Combustion chambers – Fuel Spray behaviour – Spray structure and spray penetration – Air motion - Introduction to Turbocharging.

UNITIII POLLUTANT FORMATION ANDCONTROL

Pollutant – Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters, Selective Catalytic Reduction and Particulate Traps – Methods of measurement – Emission norms and Drivingcycles.

UNITIV ALTERNATIVEFUELS

Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel - Properties, Suitability, Merits and Demerits - EngineModifications.

UNITV RECENTTRENDS

Air assisted Combustion, Homogeneous charge compression ignition engines – Variable Geometry turbochargers – Common Rail Direct Injection Systems - Hybrid Electric Vehicles – NOxAdsorbers - OnboardDiagnostics.

SUGGESTED READINGS

1. John Heywood, Internal Combustion Engine Fundamentals, 1st edition, Tata McGraw Hill Education, 2011.
2. V Ganesan, Internal Combustion Engines, 4th edition, Tata McGraw Hill Education,2012
3. Mathur. R.B. and R.P. Sharma, Internal Combustion Engines, DhanpatRai& Sons,2007
4. Duffy Smith, Auto Fuel Systems, 1st edition, The Goodheart Willcox Company, Inc., 2011(Digital)
5. Eric Chowenitz, Automobile Electronics, 1st edition, Newnes Publications,1995.

20BEME7E11 **NON-DESTRUCTIVETESTING** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVE

1. To provide in-depth knowledge on various techniques of non-destructive testing
2. To provide an overview of destructive and non destructive tests and state theirapplications
3. To study the features of NDT techniques for variousproducts.
4. To expose students to skills needed for selection of appropriate NDT technique(s) for new inspectionjobs
5. To understand the established NDE techniques and basic familiarity of emerging NDE techniques.
6. To facilitate the understanding of standard application area ofNDET

COURSE OUTCOME

Student will be able to

1. Understand the codes, standards and specifications related toNDT
2. Classify the destructive and non-destructive tests and state theirapplications
3. Develop NDT techniques for variousproducts.
4. Acquire skills needed for selection of appropriate NDT technique(s) fornew inspectionjobs
5. Acquire sound knowledge of established NDE techniques and basicfamiliarity of emerging NDE techniques.
6. Make use of standards application area ofNDET

UNITI INTRODUCTION

Properties of Materials – Characteristics of Ferrous, Non-ferrous and Alloys. Destructive testing and Non-destructive testing – Classification – Uses and applications. Codes, Standards and Specifications(ASME, ASTM, AWS etc.).

UNITII PENETRANT TESTING AND MAGNETIC PARTICLEINSPECTION

Introduction to Penetrant Testing – Liquid Penetrants and Dye Penetrants - An Illustration of Penetrant Testing, Advantages of Penetrants Testing,Disadvantages of Penetrant Testing. Introduction to Magnetic Particle Inspection - An Illustration of Magnetic Particle Inspection, Advantages of Magnetic Particle Crack Detection, Disadvantages of Magnetic Particle CrackDetection

UNIT III ULTRASONIC FLAW DETECTION AND RADIOGRAPHY INSPECTION

Introduction to Ultrasonic Flaw Detection ,An Illustration of Ultrasonic Flaw Detection , Advantages of Ultrasonic Flaw Detection, Disadvantages of Ultrasonic Flaw Detection, Principle of Radiography Inspection, Radiation sources, Attenuation in the specimen, Radiographic imaging, Inspection Techniques, Application and limitations, Safety.

UNITIV EDDY CURRENT AND ELECTRO-MAGNETICMETHODS

Introduction to Eddy Current Testing.An Illustration of Eddy Current Testing Equipment , Advantages of Eddy Current Testing, Disadvantages of Eddy Current Testing

UNITV NON-DESTRUCTIVE INSPECTION(NDI) AND ITSAPPLICATIONS

Inspection of Raw Products, Inspection For In-Service Damage, Power Plant Inspection, Storage Tank Inspection, Aircraft Inspection, Jet Engine Inspection, Pressure Vessel Inspection, Bridge Inspection, Pipeline Inspection.

SUGGESTED READINGS

1. Louis Cartz, Nondestructive Testing, 1st edition,ASM International,Almere,Netherland,2007(digital)
2. Paul E. Mix, Introduction to Nondestructive Testing, 2nd edition,John Wiley &Sons,Newyork.,2005
3. Baldev Raj, T. and Jayakumar, M. , Practical Non-destructive Testing, 2nd edition,Woodhead Publishing,Cambridge.,2007
4. J. Blitz, G. Simpson, Ultrasonic Methods of Non-destructive Testing,1st edition,Springer Science & Business Media,1996

20BEME7E12 **INDUSTRIALSAFETYENGINEERING** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVE

1. To provide in-depth knowledge on various techniques of non-destructive testing
2. To acquaint the student with the need and awareness of the safetyconcepts
3. To understand the importance of various safety techniques involved in industrialsector
4. To introduce the concepts of accident zone and prepare reports related toit.
5. To equip them with skills to conduct basic safety inspections using strategies that theyhave developed
6. To develop an understanding ofsafetymonitoring

COURSE OUTCOME

At the end of the course, student will be able to

1. Understand the need and awareness of the safetyconcepts
2. Understand the various safety techniques involved in industrialsector
3. Record and investigate the accident zone and prepare reports related toit.
4. Conduct basic safety inspections using strategies that theyhavedeveloped
5. Identify and demonstrate working of safetymonitoring
6. Train about the education and training based onsafety

UNITI CONCEPTS OF SAFETY ENGINEERING

Evolution of modern safety concept- Safety policy - Safety Organization - line and staff functions for safety- Safety Committee- budgeting for safety.

UNITII TECHNIQUES OF SAFETY ENGINEERING

Incident Recall Technique (IRT), disaster control, Job Safety Analysis (JSA), safety survey, safety inspection, safety sampling, Safety Audit.

UNITIII ACCIDENT INVESTIGATION ANDREPORTING

Concept of an accident, reportable and non reportable accidents, unsafe act and condition – principles of accident prevention, Supervisory role- Role of safety committee – Accident causation models - Cost of accident. Overall accident investigation process - Response to accidents, India reporting requirement, Planning document, Planning matrix, Investigators Kit, functions of investigator, four types of evidences, Records of accidents, accident reports

UNITIV SAFETY PERFORMANCEMONITORING

Reactive and proactive monitoring techniques - Permanent total disabilities, permanent partial disabilities, temporary total disabilities -Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety "t" score, safety activity rate – problems.

UNITV SAFETY EDUCATION ANDTRAINING

Importance of training-identification of training needs-training methods – programme, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training. Modern safety equipment and technics – Case study.

SUGGESTED READINGS

1. Accident Prevention Manual for Industrial Operations,3rd edition, N.S.C.Chicago,2010(digital).
2. Heinrich H.W. "Industrial Accident Prevention", 2ndedition, Tata McGraw-Hill Company,New York,1941.
3. Krishnan N.V,Safety Management in Industry,1stedition,Jaico Publishing House, Bombay,1997.
4. John R Ridley,Safety at Work,3rd edition,Elsevier,2014
5. Roland P. Blake ,Industrial Safety, 2ndedition,Prentice Hall, Inc., New Jersey,1973
6. L M Deshmukh,Industrial safety management,1stedition, TATA McGraw Hill,2005

PROFESSIONAL ELECTIVE VI

20BEME8E01 QUALITY CONTROL ANDRELIABILITY ENGINEERING **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To understand the concept of SQC.
2. To enrich the understanding of control charts to analyze for improving the process quality.
3. To familiarize the students to understand different sampling plans
4. To understand the importance of need and types of life testing.
5. To introducethe reliability of a system.
6. To introduce the concepts of quality control and reliability techniques in industries.

COURSE OUTCOMES

Upon the completion of this course the students will be able to

1. Summarize the concept ofQuality
2. Apply Process control forvariables
3. Apply the process control forattributes
4. Explain the concept of sampling and to solveproblems
5. Explain the concept of Lifetesting
6. Explain the concept Reliability and techniquesinvolved

UNITI INTRODUCTION AND PROCESS CONTROL FORVARIABLES

Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality cost–Variation in process– factors – process capability – process capability studies and simple problems – Theory of control chart– uses of control chart – Control chart for variables – X chart, R chart and σ chart.

UNITII PROCESS CONTROL FORATTRIBUTES

Control chart for attributes –control chart for proportion or fraction defectives – P chart and NP chart – control chart for defects – C and U charts, State of control and process out of control identification in charts.

UNITIII ACCEPTANCESAMPLING

Lot by lot sampling – Types – probability of acceptance in single, double, multiple sampling techniques – O.C. curves – producer's Risk and consumer's Risk. AQL, LTPD, AOQL concepts–standard sampling plans for AQL and LTPD– uses of standard samplingplans.

UNITIV LIFE TESTING –RELIABILITY

Life testing – objective: – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability – simple problems. Acceptance sampling based on reliability test – O.C Curves.

UNITV QUALITY AND RELIABLITY

Reliability improvements – techniques– use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development – Product life cycles – Maintenance.

Note: Permitted to use approved statistical table in the examination.

SUGGESTED READINGS

1. Eugene Grant and Richard Leavenworth, Statistical Quality Control, 7th edition, Tata McGraw–Hill, New Delhi,2017
2. Srinath L.S, Reliability Engineering, 4thedition, Affiliated East west press New Delhi,2005.
3. Manohar Mahajan, Statistical Quality Control, 1stedition,DhanpatRai and Sons, New Delhi,2006.
4. Gerald M. Smith, Statistical Process Control and Quality Improvement, 5thEdition, Pearson Int,2004.
5. Danny Samson, Manufacturing and Operations Strategy, 1stedition,Prentice Hall, New Delhi, 2007 (Digital).
6. Patrick D. T. O'Connor, Practical Reliability Engineering, 5th edition, John Wiley, New Delhi,2011.

WEB REFERENCES

1. https://nptel.ac.in/courses/110105039/
2. https://www.qualitygurus.com

20BEME8E02 COGENERATION AND WASTE HEATRECOVERY SYSTEMS **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To study the significance of waste heat recovery systems and carry out its economicanalysis
2. To know the concepts of cogeneration, its types and probable areas ofapplications
3. To enrich the understanding of thermodynamics, heat transfer, and fluid Mechanics principles to design and analysis of thisemerging technology.
4. To impart knowledge on operational issues and challenges cogenerationtechnologies.
5. To Understand the impact of this technology in waste heat recoverysystems
6. To introduce the concepts of various systems involved in waste heat recoveryprocess

COURSE OUTCOMES

The student will be able to

1. Understand the various methods ofcogeneration.
2. Apply knowledge of thermodynamics, heat transfer, andfluid mechanics principles to design and analysis of thisemergingtechnology.
3. Have thorough understanding, operational issuesand challenges in cogenerationtechnologies.
4. Understand the impact of this technology in waste heat recoverysystems
5. Get the knowledge over various systems involved in waste heat recoveryprocess
6. Begin a career as an engineer in an organization, can analyze the economics.

UNITI INTRODUCTION

Introduction – principles of thermodynamics – cycles – topping - bottoming – combined cycle - organic rankine cycles – performance indices of cogeneration systems – waste heat recovery – sources and types – concept of trigeneration.

UNITII COGENERATIONTECHNOLOGIES

Configuration and thermodynamic performance – steam turbine cogeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – combined cycles cogeneration systems – advanced cogeneration systems: fuel cell, Stirling enginesetc.,

UNITIII ISSUES AND APPLICATIONS OF COGENERATIONTECHNOLOGIES

Cogeneration plants electrical interconnection issues – utility and cogeneration plant interconnection issues – applications of cogeneration in utility sector – industrial sector – building sector – rural sector – impacts of cogeneration plants – fuel, electricity and environment

UNITIV WASTE HEAT RECOVERYSYSTEMS

Election criteria for waste heat recovery technologies - recuperators - Regenerators - Economizers - plate heat exchangers - thermic fluid heaters - Waste heat boilers classification, location, service conditions, design Considerations - fluidized bed heat exchangers - heat pipe exchangers - heat pumps – sorption systems.

UNITV ECONOMIC ANALYSIS

Investment cost – economic concepts – measures of economic performance – procedure for economic analysis – examples – procedure for optimized system selection and design – load curves - sensitivity analysis– regulatory and financial frame work for cogeneration and waste heat recovery systems.

SUGGESTED READINGS

1. R.Kehlhofer, B. Rukes, F. Stirnimann, Combined-cycle gas & steam turbine power plants, 3rd edition, PennWell Books,2009
2. A.Thumann, D. Paul Mehta, Handbook of energy engineering, 6th edition, The Fairmont Press Inc,2008
3. B.F.Kolanowski, Small-scale cogeneration handbook, 3rd edition, Fairmont Press,2008
4. M.P. Boyce, Handbook for cogeneration and combined cycle power plants, 2nd edition, ASME Press,2010

20BEME8E03 COMPUTER AIDED DRAFTING ANDCOSTESTIMATION 3 H – 3 C

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVE

1. To gain knowledge in sequence of process planning and cost estimation of variousproducts.
2. To introduce the concepts of dimensional and toleranceanalysis
3. To expose students to manufacturingdrawings
4. To equip them with skills to apply their knowledge in re-dimensioning and tolerancecharting
5. To understand the process chart for a givencomponent
6. To Estimate the cost of a givencomponent

COURSE OUTCOME

Upon completion of this course, the student can able to

1. Apply the various standards and conventions used in a drawingsheet
2. Perform dimensional and toleranceanalysis
3. Understand the manufacturingdrawings
4. Apply their knowledge in re-dimensioning and tolerancecharting
5. Prepare process chart for a givencomponent
6. Estimate the cost of a givencomponent

UNITI STANDARDS ANDCONVENTIONS

Current international standards (ISO) and Indian Standards (IS)- types of lines - principles of presentation - dimensioning - conventional representation of threaded parts, springs, and gears.

UNITII DIMENSIONAL AND FORMTOLERANCES

Limits and fits IT system of tolerances, deviation of fit - geometric tolerance-tolerancing of form, orientation, location and runout - datums and Datum systems-Dimensioning and tolerancing of profiles

UNITIII MANUFACTURINGDRAWINGS

Surface texture indication on drawing - welds symbolic representation of drawings. Given a sub-assembly/assembly to prepare manufacturing drawings of components, Sample exercises on CAD- preparation of manufacturing Drawings.

UNITIV RE-DIMENSIONING AND TOLERANCECHARTING

Introduction to re-dimensioning to suit manufacturing requirements-manufacturing datum-functional datum. Introduction to tolerance charting

UNITV COSTESTIMATION

Preparation of Process chart for a given component-estimation of setting time and machining time-estimation of material cost, labour cost and overhead cost based on supplieddata.

SUGGESTED READINGS

1. Siddeshwar and Kanniah, Machine Drawing, 1st edition, Tata McGraw Hill,2001
2. Ajeet Singh, Machine Drawing, 2nd edition, Tata McGraw Hill,2012.
3. Gopalakrishna, K.R, Machine Drawing, Subhas Stores,2002
4. Wade. O, Tolerance Control in design and manufacturing, Industrial Press,1972
5. R. Kesavan, C. Elanchezhian, B. VijayaRamanath, Process Planning and Cost Estimation, 1st edition, New Age International,2009

20BEME8E04 BATTERY MANAGEMENT SYSTEM 3 H – 3 C

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVE

The goal of the course is:

1. To learn various energy storage systems used for Hybrid Electric Vehicle (HEV) and Electric Vehicle (EV).
2. To learn about design and operation of solid-state Li-ion battery.
3. To gain knowledge on the high temperature application of battery.
4. To learn various technologies for recycling used batteries.
5. To understand the battery electrical and thermal management systems using active and passive cooling system.
6. To Analysis battery performance.

COURSE OUTCOME

At the end of the course the student would be able:

1. Understand the performance and driving cycles of EVs.
2. Canapply their knowledge to manufacture various types of Li-ion batteries.
3. Can apply knowledge on use of Li-ion battery in large scale grid and space crafts.
4. Understand Techno-economic aspects of battery recycling and environmental safety.
5. Understand battery cooling system and safety precautions for high voltage battery.
6. Analysis battery performance.

UNIT – I ENERGY STORAGE SYSTEMS

General background on alternative energy sources and sustainability, Introduction to electric-based transportation, Overview of on-road vehicle electrification, EVs configuration, Energy and power requirements for various HEVs and EVs Vehicle performance and driving cycles.

UNIT – II LITHIUM BATTERIES

Li-ion batteries - Principle of operation, Battery components and design Electrode, cell and battery fabrications, Building block cells, battery modules and packs and applications.All solid-state batteries and future developments, Li-Sulphur battery, Li-Air battery,Sodium-battery, Magnesium battery, Aluminium battery, Silicon battery.

UNIT – III HIGH TEMPERATURE BATTERIES FOR BACK-UP APPLICATIONS

Advance Ni-MH batteries for transportation, Future prospects of Ni-MH batteries vs. lithium ion batteries, Zebra cell, Li-iron sulphide cells, Vanadium and iron-based batteries, Semi-fluid flow batteries for large scale grid application, Ni-H_2 cells for space applications.

UNIT – IV FUEL CELLS AND BATTERY RECYCLING TECHNOLOGY

Introduction to fuel cells, Proton-exchange membrane and alkaline fuel cells for transportation, Solid oxide fuel cells, Technology and economic aspects of battery recycling, Environmental effect and controlling of poisonous chemicals contamination.

UNIT – V BATTERY MANAGEMENT

Fundamentals of battery management systems and controls, Battery Thermal Management - Passive cooling, Active cooling -Liquids & air systems.

Regulations and Safety Aspects of High Voltage Batteries, Code and Standards, Safe handling of Lithium Batteries, Safety of high voltage battery.

SUGGESTED READINGS

1. GerardusBlokdyk, Battery Management System A Complete Guide, Springer, 2019 Edition.
2. Reiner Korthauer, Lithium-Ion Batteries: Basics and Applications, 1st Edition. Springer, 2018
3. Alfred Rufer, Energy Storage: Systems and Components, 1st Edition, CRC Press, 2017.
4. Arno Kwadeand Jan Diekmann, Recycling of Lithium-Ion Batteries: The LithoRec Way (Sustainable Production, Life Cycle Engineering and Management), 1st Edition. Springer, 2018.

WEB REFERANCES

1. https://nptel.ac.in/courses/108/103/108103009/

OPEN ELECTIVES

COURSES OFFERED BY OTHER DEPARTMENTS

20BESHOE** **SOLIDWASTEMANAGEMENT** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To make the students conversant with basics of Solid wastesand itsclassification.
2. To make the student acquire sound knowledge of different treatments of solidwastes.
3. To acquaint the student with concepts of wastedisposals.
4. To develop an understanding of the basic concepts of Hazardous wastemanagements.
5. To acquaint the students with the basics of energy generation from wastematerials.
6. To make the student understand about the disposal and treatment of waste scientifically.

COURSE OUTCOMES

1. Outline the basic principles of Solid waste and separation ofwastes
2. Identify the concepts of treatment of solidwastes
3. Identify the methods of wastesdisposals.
4. Examine the level of Hazardousness and itsmanagement.
5. Examine the possible of the energy production using wastematerials.
6. Integrate the chemical principles in the projects undertaken in field of engineering andtechnology

UNITI SOLIDWASTE

Definitions – Sources, Types, Compositions, Properties of Solid Waste – Municipal Solid Waste – Physical, Chemical and Biological Property – Collection – Transfer Stations – Waste Minimization and Recycling of Municipal Waste

UNITII WASTETREATMENT

Size Reduction – Aerobic Composting – Incineration – batch type and continuous flow type, Medical/ Pharmaceutical Waste Incineration – Environmental Impacts – Measures of Mitigate Environmental Effects due to Incineration

UNITIII WASTEDISPOSAL

Sanitary Land Fill Method of Solid Waste Disposal – Land Fill Classficaition, Types, Methods &Siting Consideration – Layout & Preliminary Design of Land Fills – Composition, Characteristics generation, Movement and Control of Landfill Leachate & Gases – Environmental Monitoring System for Land Fill Gases, Waste landfillRemediation

UNITIV HAZARDOUS WASTEMANAGEMENT

Definition & Identification of Hazardous Waste – Sources and Nature of Hazardous Waste – Impact on Environment – Hazardous Waste Control – Minimization and Recycling -Assessment of Hazardous Waste Sites – Disposal of Hazardous Waste, Underground Storage Tanks Construction, Installation & Closure, Remediaiton, risk assessment.

UNITV ENERGY GENERATION FROM WASTE

Thermal conversion Technologies – Pyrolysis systems, Combustion systems, Gasification systems, Environment control systems, energy recovery systems. Biological & chemical conversion technologies – Aerobic composting, low solids. Anaerobic digestion, high solids anaerobic digestion, Energy production from biological conversion products, other biological transformation processes. Chemical transformation processes.

SUGGESTED READINGS

1. Dara.S.S, Mishra.D.D, A Text book of Environmental chemistry and pollution control, S.Chand and company Ltd,2011
2. NagpalH.Theisen, S. Vigil, Integrated Solid Waste management- Engg. Principles and management issues, George Tchobanoglous, McGraw Hill,2013
3. Frank Kreith, George Tchobanoglous , Hand Book of Solid Waste Management- 2ndedition, McGraw Hill Publishing Ltd., Newyork,2002
4. Shah, L Kanti, Basics of Solid & Hazardous Waste Management Technology, Prentice Hall,1999

20BESHOE** **GREENCHEMISTRY** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To make the students conversant about the green chemistry
2. To make the student acquire sound knowledge of the atom efficient process and synthesis elaborately.
3. To acquaint the student with concepts of green technology.
4. To develop an understanding of the basic concepts of renewable energy resources.
5. To acquaint the students with the basics information on catalysis.
6. To acquaint the students about the green alternate solutions.

COURSE OUTCOMES

1. Outline the basic principles of greenchemistry
2. Examine the different atom efficient process and synthesiselaborately
3. Apply the concepts combustion of greentechnology
4. Identify and apply the concepts of renewableenergy
5. Apply the concepts of green catalysts in thesynthesis
6. Integrate the chemical principles in the projects undertaken in field of engineering andtechnology

UNITI INTRODUCTION TO GREEN CHEMICALPRINCIPLES

Definition, tools, and twelve principles of green chemistry, solvent-less reactions and reactions in water, microwaves and fluorous solvents, green resolution of racemic mixtures, materials for a sustainable economy, chemistry of longer wear, agrochemicals: problems and green alternate solutions.

UNITII ATOM EFFICIENTPROCESSES

Atom efficient processes, evaluating chemical reagents according to their yield and atom efficiency, examples of efficient stoichiometric and catalytic processes, atom economy and homogeneous catalysis, halide-free synthesis and alternatives to Strecker synthesis

UNITIII BIOTECHNOLOGY AND GREENCHEMISTRY

Bio technology and its applications in environmental protection-Bio informatics-Bio remediation, biological purification of contaminated air. Green chemistry for clean technology-Significance of green chemistry-Basic components of green chemistry, Industrial applications of green chemistry, green fuels-e-green propellants and bio catalysts.

UNITIV RENEWABLERESOURCES

Use of renewable materials, evaluating feedstock and starting materials and their origins, toxicity, sustainability and the downstream implications of the choice of feedstock, commodity chemicals from glucose and biomassconversion

UNITV CATALYSIS IN GREENCHEMISTRY

Catalysis, energy requirements and usage, optimization of the reaction by minimizing the energy requirements, examples of efficient catalytic reactions including the use of heterogeneous catalysis, zeolites, oxidation using molecular oxygen.

SUGGESTED READINGS

1. Sanjay K. Sharma, AckmezMudhoo, Green Chemistry for Environmental Sustainability, CRC Press ,2010
2. V. K. Ahluwalia and M.Kidwai, New Trends in Green Chemistry, Anamayapublishers.Newdelhi. Second Edition, 2007
3. Dr.SunitaRatan , A Textbook of Engineering Chemistry, S.K. Kataria and Sons., New Delhi.,2012
4. Mukesh Doble. Ken Rollins, Anil Kumar, Green Chemistry and Engineering, 1st edition, AcademicPress, Elesevier., New Delhi.,2007
5. Desai K. R., Green Chemistry, Himalaya Publishing House, Mumbai.,2005
6. Matlack A. S., Introduction to Green Chemistry, Marcel Dekker: New York,2001

20BESHOE** **APPLIEDELECTOCHEMISTRY** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P: 0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To make the students conversant with the information on electrochemical material.
2. To make the student acquire sound knowledge of conducting polymers.
3. To acquaint the student with concepts of Energy storage devices.
4. To develop energy storage devices.
5. To impart knowledge on basic principles of solar cells and its applications
6. To study about Electro organic chemicals.

COURSE OUTCOMES

1. Outline the basic principles of chemistry in **electrochemicalmaterial**
2. Examine the properties of conductingpolymers
3. Apply the concepts of electrochemistry in storagedevices.
4. Identify the concepts of storage devices and itsapplications.
5. Apply the suitable materials for the manufacturing of storagedevices.
6. Integrate the chemical principles in the projects undertaken in field of engineering andtechnology

UNITI METALFINISHING

Fundamental principles, surface preparation-Electroplating of copper, nickel, chromium, zinc and precious metals (gold & silver)- Electroplating for electronic industry- Alloy plating, brass plating- Electro less plating of nickel- anodizing – Electroforming – Electro winning

UNITII CONDUCTING POLYMERS ANDELECTROCHEMICALS

Electropolymerisation- anodic and cathodic polymerization-effect of reaction parameters on the course of the reaction- Electrochemical preparation of conducting polymers-poly acetylene- Electrolytic production of perchlorates and manganese dioxide- Electro organic chemicals- constant current electrolysis.

UNITIII BATTERIES AND POWERSOURCES-I

Principles of energy conservation- electrochemical energy conservation- thermodynamic reversibility, Gibbs equation. EMF- battery terminology, energy and power density- Properties of anodes, cathodes, electrolytes and separators- Types of electrolytes.

UNITIV BATTERIES AND POWERSOURCES-II

Primary batteries- Dry Leclanche cells, alkaline primary batteries, Lithium batteries- construction, characteristics, problems associated with system- Secondary batteries- Lead acid, nickel cadmium- Fuel cells- Introduction, types of fuel cells, advantages.

UNITV ELECTROCHEMICAL MATERIALSCIENCE

Solar cells- Preparation of CdS/Cu2S solar cells by screen printing techniques and their characteristics - Amorphous silicon solar cells - Photo electrochemical cells(PEC) for conversion of light energy to electrical energy - PEC cells based on Cd/Se and Ga/As characteristics.

SUGGESTED READINGS

1. Cynthia G. Zoski, Hand Book of Electrochemistry, Academic Press, Elesevier., UK,2007
2. D.Pletcher and F.C.Walsh, Industrial Electrochemistry, Chapman and Hall, London,1990
3. M. Barak, Electrochemical Power Sources, I.EEE series, Peter Peregrinius Ltd, Steverage, U.K. ,1997
4. Bruno Scrosati, Applications of Electroactive Polymers, Chapman & Hall, London,1993
5. K.L. Chopra and I. Kaur, Thin Film Devices and their Application, Plenum Press, New York.,1983
6. M.M.Baizer, Organic Electrochemistry, Dekker Inc. New York,1983

20BEEEOE** **ELECTRICHYBRIDVEHICLES** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To understand the basic concepts of electric hybrid vehicle.
2. To gain the knowledge about electric propulsion unit.
3. To gain the concept of Hybrid Electric Drive-Trains.
4. To gain the different Energy Management Strategies.
5. To study about the efficiency manipulation in drives
6. To understand and gain the knowledge about various energy storage devices

COURSE OUTCOMES

1. Summarize the basic concepts in bioprocess Engineering.
2. Explain the concept of Hybrid Electric Vehicles.
3. Understand the concept of Hybrid Electric Drive-Trains.
4. Identify the different Energy Management Strategies.
5. Understand the concept of different Energy Storage devices.
6. Analyze the different motor drives used in Hybrid Electric Vehicles.

UNITI INTRODUCTION

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNITII HYBRID ELECTRIC DRIVE-TRAINS

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

UNITIII ELECTRIC PROPULSIONUNIT

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

UNITIV ENERGYSTORAGE

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

UNITV ENERGY MANAGEMENT STRATEGIES

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

SUGGESTED READINGS

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press,2010
2. MehrdadEhsani, YimiGao, Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press,2009
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley,2012

20BEEEOE** **RENEWABLEENERGYRESOURCES** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To gain the knowledge about environmental aspects of energy utilization.
2. To understand the basic principles of wind energy conversion, solar cells, photovoltaic conversion.
3. To study about solar energy collectors and its storages
4. To study about the inter connected system in wind power
5. To understand the basic principles fuel cell, Geo thermal power plants.
6. To gain the knowledge about hydro energy.

COURSE OUTCOMES

At the end of this course, students will demonstrate the ability to

1. Analyze the Energy Scenario in india
2. Understand the concept of Solar Energy
3. Understand the concept of Wind Energy
4. Understand the concept of Hydro Energy
5. Analyze the different energy sources
6. Students gathered the real time inter connected system modelling in wind power

UNITI INTRODUCTION

Energy scenario - Different types of Renewable Energy Sources - Environmental aspects of energy utilization - Energy Conservation and Energy Efficiency - Needs and Advantages, Energy Conservation Act 2003.

UNITII SOLARENERGY

Introduction to solar energy: solar radiation, availability, measurement and estimation– Solar thermal conversion devices and storage – solar cells and photovoltaic conversion – PV systems – MPPT. Applications of PV Systems – solar energy collectors and storage.

UNITIII WINDENERGY

Introduction – Basic principles of wind energy conversion- components of wind energy conversion system - site selection consideration – basic–Types of wind machines. Schemes for electric generation – generator control, load control, energy storage – applications of wind energy – Inter connected systems.

UNITIV HYDROENERGY

Hydropower, classification of hydro power, Turbine selection, Ocean energy resources, ocean energy routes. Principles of ocean thermal energy conversion systems, ocean thermal power plants. Principles of ocean wave energy conversion and tidal energy conversion.

UNITV OTHERSOURCES

Bio energy and types –Fuel cell, Geo-thermal power plants; Magneto-hydro-dynamic (MHD) energy conversion.

SUGGESTED READINGS

1. Rai.G.D, Non-conventional resources of energy, Khanna publishers ,Fourth edition,2011
2. Khan.B.H, Non-Conventional Energy Resources, The McGraw Hills, Second edition,2009
3. Rao.S. &Parulekar, Energy Technology, Khanna publishers, Fourth edition,2013
4. Godfrey Boyl, Renewable Energy: Power sustainable future, Oxford University Press, Third edition,2012
5. John W Twidell and Anthony D Weir, Renewable Energy Resources, Taylor and Francis,2015

20BECEOE** **HOUSING, PLANANDMANAGEMENT** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To examine the role and tasks of basic housing policies and building bye laws
2. Understand the process of integrated service delivery in the context of economic, social, environmental and institutional factors
3. Analyze the Innovative construction methods and Materials
4. Analyze city management strategies and strengthen the urban governance through a problem solving approach
5. To know the Importance of basic housing policies and building bye laws
6. To use Housing Programmes and Schemes

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Know the Importance of basic housing policies and building bye laws
2. Use Housing Programmes and Schemes
3. Plan and Design of Housing projects
4. Examine Innovative construction methods and Materials
5. Know Housing finance and loan approval procedures
6. Understand Construction as well as managing techniques

UNIT I INTRODUCTION TOHOUSING

Definition of Basic Terms – House, Home, Household, Apartments, Multi storeyed Buildings, Special Buildings, Objectives and Strategies of National Housing Policies, Principle of Sustainable Housing, Housing Laws at State level, Bye-laws at Urban and Rural Local Bodies – levels - Development Control Regulations, Institutions for Housing at National, State and Local levels

UNITII HOUSINGPROGRAMMES

Basic Concepts, Contents and Standards for Housing Programmes - Sites and Services, Neighbourhoods, Open Development Plots, Apartments, Rental Housing, Co-operative Housing, Slum Housing Programmes, Role of Public, Private and Non-Government Organisations.

UNITIII PLANNING AND DESIGN OF HOUSINGPROJECTS

Formulation of Housing Projects – Site Analysis, Layout Design, Design of Housing Units (Design Problems)

UNITIV CONSTRUCTION TECHNIQUES AND COST-EFFECTIVEMATERIALS

New Constructions Techniques – Cost Effective Modern Construction Materials, Building Centers – Concept, Functions and Performance Evaluation

UNITV HOUSING FINANCE AND PROJECTAPPRAISAL

Appraisal of Housing Projects – Housing Finance, Cost Recovery – Cash Flow Analysis, Subsidy and Cross Subsidy, Pricing o f Housing Units, Rents, Recovery Pattern (Problems).

SUGGESTED READINGS

1. Meera Mehta and Dinesh Mehta**,** Metropolitan Housing Markets**,** Sage Publications Pvt. Ltd., New Delhi**,** 2002
2. Francis Cherunilam and Odeyar D Heggade**,** Housing in India**,** Himalaya Publishing House, Bombay**,**2001
3. CMA**,** Development Control Rules for Chennai Metropolitan Area**,** CMA, Chennai**,**2002
4. UNCHS**,** National Experiences with Shelter Delivery for the Poorest Groups**,** UNCHS (Habitat), Nairobi**,** 2000

20BECEOE** **COMPUTER-AIDED CIVILENGINEERINGDRAWING** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. Develop Parametric design and the conventions of formal engineering drawing
2. Produce and interpret 2D & 3D drawings
3. Communicate a design idea/concept graphically/ visually
4. Examine a design critically and with understanding of CAD - The student learn to interpret drawings
5. To produce designs using a combination of 2D and 3D software.
6. Get a Detailed study of an engineering artifact.

COURSE OUTCOMES

The students will be able to

1. Develop Parametric design and the conventions of formal engineering drawing
2. Produce and interpret 2D & 3D drawings
3. Communicate a design idea/concept graphically/ visually
4. Examine a design critically and with understanding of CAD - The student learn to interpret drawings, and to produce designs using a combination of 2D and 3D software.
5. Get a Detailed study of an engineering artifact
6. Planning and designing of structures

UNITI INTRODUCTION

Introduction to concept of drawings, Interpretation of typical drawings, Planning drawings to show information concisely and comprehensively; optimal layout of drawings and Scales; Introduction to computer aided drawing, co- ordinate systems, reference planes. Commands: Initial settings, Drawing aids, Drawing basic entities, Modify commands, Layers, Text and Dimensioning, Blocks. Drawing presentation norms and standards.

UNITII SYMBOLS AND SIGNCONVENTIONS

Materials, Architectural, Structural, Electrical and Plumbing symbols. Rebar drawings and structural steel fabrication and connections drawing symbols, welding symbols; dimensioning standards

UNITIII MASONRYBONDS

English Bond and Flemish Bond – Corner wall and Cross walls - One brick wall and one and half brick wall

UNITIV BUILDINGDRAWING

Terms, Elements of planning building drawing, Methods of making line drawing and detailed drawing. Site plan, floor plan, elevation and section drawing of small residential buildings. Foundation plan. Roof drainage plans. Depicting joinery, standard fittings & fixtures, finishes. Use of Notes to improve clarity

UNITV PICTORIALVIEW

Principles of isometrics and perspective drawing. Perspective view of building.

List of Drawing Experiments:

1. Buildings with load bearing walls including details of doors andwindows.
2. Single storey RCCbuilding
3. Multistorey RCCbuilding

SUGGESTED READINGS

1. Subhash C Sharma &Gurucharan Singh (2005), " Civil Engineering Drawing" , StandardPublishers
2. Ajeet Singh (2002), " Working with AUTOCAD 2000 with updates on AUTOCAD 200I", Tata- McGraw-Hill Company Limited, NewDelhi
3. Sham TickooSwapna D (2009), " AUTOCAD for Engineers and Designers" , PearsonEducation,
4. Venugopal (2007), "Engineering Drawing and Graphics + AUTOCAD", New Age International Pvt.Ltd.,
5. Balagopal and Prabhu (1987), " Building Drawing and Detailing", Spades publishing KDR building, Calicut

20BTCEOE** **INDUSTRIALWASTEWATERTREATMENT** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. Recognize the properties of the basic industries and the environmental impact of waste generated is able to compare.
2. Define the characteristics of industrial wastewater.
3. Establish a relationship between the properties of industrial wastewater.
4. Explain the principles of industrial wastewater refining.
5. Determine the appropriate treatment methods for textile industry wastewater.
6. Allow the properties of textile industry waste waters

COURSE OUTCOMES

After completion of the course, students are able to

1. Examine the constituents of waste water and itseffects.
2. Separate the contaminants from the effluent fortreatability.
3. Determine the biomass yield and substrate utilization rate for biological treatment process and design of activated sludgeprocess.
4. Develop a flow sheet for the waste water treatment from dairy, sugar, pulp and paper, textile and pharmaceuticalindustries.
5. Develop process flow diagram for water reuse and sludgedisposal.
6. Students will learn treatment of industrial waste water.

UNITI INTRODUCTION TO WASTE WATERENGINEERING

Waste Water Engineering - Overview, inorganic non-metallic constituents and metallic constituents, physical and biological Characteristics.

UNITII OPERATIONS AND UNITPROCESS

Screening, Flow Equalization, Mixing, Flocculation, Grit removal, Sedimentation, Coagulation, Precipitation, Oxidation and Neutralization

UNITIII FUNDAMENTALS OF BIOLOGICALTREATMENT

Introduction, Microbial growth kinetics, types of biological process for wastewater treatment -aerobic and anaerobic oxidation,Biological Nitrification and De-nitrification, biological phosphorous removal, activated sludge process (with design Considerations), trickling filters and lagoons.

UNITIV WASTE WATER TREATMENT IN SPECIFICINDUSTRIES

Dairy, Sugar, Pulp and Paper, Textile and Pharmaceutical Industries.

UNITV WATERREUSE

Wastewater reclamation technologies and reuse, Solid processing flow diagrams, sludge and scum pumping, grinding, screening,degritting, blending, anaerobic digestion, composting, conditioning, dewatering and incineration.

SUGGESTED READINGS

1. Metcalf Eddy, Wastewater Engineering -Treatment and Reuse, Fourth Edition, Tata McGraw Hill, New Delhi,2002.
2. Mark J. Hammer, Water and Wastewater Technology, Seventh Edition, Prentice Hall of India Pvt Limited, New Delhi,2012.
3. James M. Montgomery, Water Treatment Principles and Design, First Edition, A WileyInterscience publication, NewYork,1985.

COURSES OFFERED TO OTHER DEPARTMENTS

20BEMEOE01 **COMPUTERAIDEDDESIGN** **3 H – 3 C**

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To apply basic concepts to develop construction (drawing) techniques.
2. To ability to manipulate drawings through editing and plotting techniques.
3. To understand geometric construction and Produce template drawings.
4. To understand and demonstrate dimensioning concepts and techniques.
5. To understand Section and Auxiliary Views.
6. To become familiar with Solid Modelling concepts and techniques.

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. Apply basic concepts to develop construction (drawing) techniques.
2. Ability to manipulate drawings through editing and plotting techniques.
3. Understand geometric construction and Produce template drawings.
4. Understand and demonstrate dimensioning concepts and techniques
5. Understand Section and Auxiliary Views
6. Become familiar with Solid Modelling concepts and techniques.

UNITI OVERVIEW OF CAD SYSTEMS

Conventional and computer aided design processes-advantages and disadvantages. Subsystems of CAD-CAD hardware and software, analytical and graphics packages, CAD workstations. Networking of CAD systems.

UNITII INTERACTIVE COMPUTER GRAPHICS AND GRAPHICSTRANSFORMATIONS

Generative, cognitive and image processing graphics. Static and dynamic data graphics. Transport of graphics data. Graphic standards. Generation of graphic primitives - display transformation in Two- and Three – Dimensional graphics concepts, Graphical input technique, Geometric transformations, Visual Realism, Computer animation, customizing graphics software.

UNITIII GEOMETRIC MODELING

Wireframe, surface, NURBS and solid modeling-applications and advantages. Creating primitive solids, sweeping solids, Boolean operations. Extracting entities from a solid. Filleting of edges of solids. Boundary representation (B-rep) Constructive Solid Geometry (CSG) and Analytical Solid Modeling (ASM)

UNITIV PARAMETRIC DESIGN AND OBJECTREPRESENTATION

Types of co-ordinate systems. Parametric design - definition and advantages. Parametric representation of analytic and synthetic curves. Parametric representation of surfaces and solids - manipulations.

UNITV PRODUCT DESIGN ANDDEVELOPMENT

Automated 2D drafting - basics, mating conditions–Types of translators (IGES, STEP, ACIS and DXF). Mass property calculations.

SUGGESTED READINGS

1. Vera B Anand, Computer Graphics and Geometric Modeling for Engineers,1st edition, John Wiley & Sons, New York,2000
2. Radhakrishnan P and Subramanyan S, CAD/CAM/CIM, 2nd edition, New Age International Pvt. Ltd,2008
3. Ibrahim Zeid, CAD/CAM Theory and Practice,2ndedition,McGraw Hill Inc., New York,2009
4. Barry Hawhes, The CAD/CAM Process,1st edition, Pitman Publishing, London,2007(digital)
5. William M Newman and Robert Sproul, Principles of Interactive Computer Graphics,1stedition,McGraw Hill Inc., New York,2001
6. Rao S S, Optimization Techniques, 1stedition,Wiley Eastern, New Delhi,2006

20BEMEOE02 INDUSTRIAL SAFETYANDENVIRONMENT 3 H – 3 C

Instruction hours / week L : 3 T : 0 P:0 **Marks:** Internal **: 40** External **: 60** Total**:100**

End Semester Exam :3Hours

COURSE OBJECTIVES

1. To recognize and evaluate occupational safety and health hazards in the workplace.
2. To determine appropriate hazard controls following the hierarchy of controls.
3. To analyse the effects of workplace exposures, injuries and illnesses, fatalities.
4. To prevent incidents using the hierarchy of controls, effective safety and health management systems and task-oriented training.
5. To teach student the concept of Industrial Safety & provide useful practical knowledge for workplace safety.
6. To prevent or mitigate harm or damage to people, property, or the environment.

COURSE OUTCOMES

At the end of the course, student will be able to

1. Recognize and evaluate occupational safety and health hazards in the workplace.
2. Determine appropriate hazard controls following the hierarchy of controls.
3. Analyse the effects of workplace exposures, injuries and illnesses, fatalities.
4. Prevent incidents using the hierarchy of controls, effective safety and health management systems and task-oriented training.
5. Understand the concept of Industrial Safety & provide useful practical knowledge for workplace safety.
6. Prevent or mitigate harm or damage to people, property, or the environment.

UNITI CONCEPTS

Evolution of modern safety concept- Safety policy - Safety Organization - line and staff functions for safety- Safety Committee- budgeting for safety.

UNITII TECHNIQUES

Incident Recall Technique (IRT), disaster control, Job Safety Analysis (JSA), safety survey, safety inspection, safety sampling, Safety Audit.

UNITIII ACCIDENT INVESTIGATION ANDREPORTING

Concept of an accident, reportable and non reportable accidents, unsafe act and condition – principles of accident prevention, Supervisory role- Role of safety committee – Accident causation models - Cost of accident. Overall accident investigation process - Response to accidents, India reporting requirement, Planning document, Planning matrix, Investigators Kit, functions of investigator, four types of evidences, Records of accidents, accident reports

UNITIV SAFETY PERFORMANCEMONITORING

Reactive and proactive monitoring techniques - Permanent total disabilities, permanent partial disabilities, temporary total disabilities -Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety “t” score, safety activity rate – problems.

UNITV SAFETY EDUCATION ANDTRAINING

Importance of training-identification of training needs-training methods – programme, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training.

SUGGESTED READINGS

1. Accident Prevention Manual for Industrial Operations, 3rd edition, N.S.C. Chicago,2010(digital).
2. Heinrich H.W. “Industrial Accident Prevention”, 2ndedition, Tata McGraw-Hill Company, New York, 1941.
3. Krishnan N.V, Safety Management in Industry, 1st edition, Jaico Publishing House, Bombay,1997.
4. John R Ridley, Safety at Work,3rd edition,Elsevier,2014
5. Roland P. Blake ,Industrial Safety, 2ndedition,Prentice Hall, Inc., New Jersey,1973
6. L M Deshmukh, Industrial safety management,1stedition, TATA McGraw Hill,2005