UG

Mechanical Engineering

SYLLABUS

2019-Onward

Vision of the department

The department shall strive to act as a podium for the development and transfer of technical competence in academics, impart appropriate skills, entrepreneurship and research in the field of Mechanical Engineering to meet the changing need of society.

Mission of the department

1. To provide modular programmes from skill development to the research level.
2. To impart technical education and training in innovative state-of-the-art technology in the field of mechanical engineering.
3. To disseminate of knowledge and information by organizing seminars/ workshops/short term courses in a planned manner.
4. To provide extension services to rural society, industry professionals, institutions of research and higher learning in the field of mechanical engineering.
5. To interact with the industry, educational and research organizations, and alumni in the fields of curriculum development, training and research for sustainable social development and changing needs of society.

Programme Outcome (PO) s: UG

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and manufacturing/welding specialisation for the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, research literature, and analyse complex mechanical/welding engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex mechanical engineering problems or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.
4. **Conduct investigations of complex problems:** Conduct investigations of complex manufacturing/welding problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** To apply appropriate techniques, resources and engineering and IT tools for modelling of different manufacturing/welding problems with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the manufacturing/welding engineering practice.
9. **Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex manufacturing/welding engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of manufacturing/welding engineering and management principles and apply these to one's

own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognise the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. Participate and succeed in competitive examination for higher studies.

Program specific outcomes (PSO)

1. Graduates will develop ability to identify, analyse and solve engineering problems related to mechanical systems as well as other engineering streams.
2. Graduates will be equipped with technological and managerial skills to become successful Technocrats and Entrepreneurs.
3. Graduates will develop competency to undertake problems related to emerging fields/ thrust areas for pursuing research work.

Title of the course : **Engineering Mathematics I**
Subject Code : **BSMA - 401**

L	T	P	Credits	Weekly Load (hrs.)
3	1	0	4	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Learn about the basic concepts of Mathematics.
CO2: Understand various rules of Mathematics and how it is applied on solve different equations.
CO3: Understand the behavior of differential equations and integration.
CO4: Learn about the mechanism different formulas derivations and theorem.
CO5: Get knowledge about complex matrix, transformations, theorem and their properties.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	3	2	2	2	2	3	2	2	2	2	-	-	-
CO2	3	1	3	1	1	3	3	3	3	2	3	3	1	-	1
CO3	3	3	3	3	1	2	1	1	3	2	3	2	-	-	-
CO4	3	1	3	1	3	2	2	2	2	2	2	2	1	2	1
CO5	3	3	3	3	1	3	1	1	3	2	2	3	-	1	1
Avg.	3	1.8	3	2	1.6	2.4	1.8	2	2.6	2	2.4	2.4	1	1.5	1

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Matrices**	Elementary transformations. Row reduced Echelon forms. Rank of a matrix. Normal form. Linearly dependent and independent vectors. System of linear equations. Linear transformations. Eigen values and eigenvectors. Properties of eigenvalues. Reduction to diagonal form. Verification of Cayley-Hamilton Theorem and its use for finding inverse of a matrix. Idempotent matrices. Complex matrices.	15
	Solid Geometry	Cartesian co-ordinate system. Distance formula. Section formulae. Direction ratios and direction cosines. Equation of a plane. Equations of a straight line. Condition for a line to lie in a plane. Coplanar lines. Shortest distance between two lines. Intersection of three planes. Equation of a sphere. Tangent plane to a sphere. Equations of a cone and a cylinder.	15
Unit-2	**Differentialequation**	Solution of differential equation by variable separable method, homogeneous differential equation of first order and their solution, Exact differential equation.	14

	Lineardifferen tialequations	Solution of linear differential equation of first order. Reducible to linear differential equation. Higher order linear differential equation with constant coefficients, complementary function and particular integral. Method of variation of parameters. Cauchy's and Legendre's equations.	16

Total=60

Recommended Books:

1. R.K. Jain, S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishers.
2. Denial A Murray, Elementary Course in Differential Equations, Longman.
3. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley Eastern Limited.
4. B.V. Ramana, Higher Engineering Mathematics, McGraw Hill.

Title of the course : **Applied Chemistry**
Subject Code : **BSCH-401**

L	T	P	Credits	Weekly Load
3	1	0	4	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Learn about the basic concepts of Chemistry.
CO2: Understand various materials and their properties.
CO3: Understand the behavior of different salt solution.
CO4: Learn about the mechanism of using different chemistry testing equipment's.
CO5: Get knowledge about electrolyte behaviour and their properties.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	3	1	1	1	2	2	1	2	2	1	2	1	3
CO2	3	1	3	1	1	1	1	3	2	2	1	2	1	-	1
CO3	3	3	3	3	1	1	2	1	3	2	2	1	-	2	-
CO4	3	1	3	1	3	1	2	2	2	3	3	1	1	2	1
CO5	3	3	3	3	1	1	1	1	1	1	1	3	-	1	1
Avg.	3	1.8	3	1.8	1.4	1	1.6	1.8	1.8	2	1.8	1.8	1	1.5	1

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Electro-analytical Chemistry**	Conductivity of electrolytes- Specific, molar and equivalent conductivity, Nernst equation for electrode potential, EMF series, hydrogen electrode, calomel electrode, glass electrode, Electrolytic and galvanic cells, cell EMF, its measurement and applications, reversible and irreversible cells, concentration cell, electrode (hydrogen gas electrode) and electrolyte concentration cell, concentration cell with and without transference. Potentiometry: Principle, instrumentation and applications.	**09**
	Fuels	Classification, examples, relative merits,Solid Fuels: Coal, Proximate and Ultimate analysis of coal. Gross and Net Calorific Value, Determination of calorific value by Bomb Calorimeter Carbonization process, Low and High Temperature Carbonization. Liquid fuels: Cracking, Thermal and Catalytic Cracking, Synthetic petrol, Knocking, Antiknocking, Octane number, Cetane Number. Antiknocking agents. Gaseous fuels: Biogas, LPG and CNG. Determination of calorific value by Junker's Calorimeter. Flue gas analysis by Orsat's apparatus, problems.	**10**
	Surface Chemistry	Adsorption, chemisorption and physisorption, application of adsorption of gases on solids. Langmuir's adsorption isotherm, Freundllch's adsorption isotherm, BET theory of multi-layer adsorption (qualitative), adsorption chromatography. Colloidal particles, surfactants, micelles. Enzyme catalysis, Criteria for choosing catalyst for industrial processes.	**09**

Unit-2	**Engineering Materials**	Abrasives – Moh's scale of hardness – natural abrasives (diamond, corundum, emery, garnets and quartz) – synthetic abrasives (silicon carbide, boron carbide) – refractories – characteristics – classification (acidic, basic and neutral refractories) – properties (refractoriness, refractoriness under load, dimensional stability, porosity, thermal spalling) – manufacture of alumina magnesite and zirconia bricks.	**10**
	Lubricants	Classification of lubricant, lubricating oils, semisolid lubricants, solid and synthetic lubricants. Properties of lubricating oils (viscosity, flash and fire points, cloud and pour point, Iodine Value, Acid Value, R. M. Value, mechanical stability and saponification number).	**07**

Total=45

Recommended Books:

1. P. C. Jain & M. Jain, Engineering Chemistry, Dhanpat Rai Publishing Company, New Delhi, 2005.
2. B.R. Puri, L.R. Sharma, M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing Company, 2008.
3. F.W. Billmayer. Textbook of Polymer Science. 3rd Edn, Wiley. N.Y. 1991.
4. C. N. Banwell& E.M. McCash, Fundamentals of Molecular Spectroscopy, 4th Edn, Tata Mc Graw-Hill Edition, 1995.
5. S. S. Dara, S. S. Umare, A Text Book of Engineering Chemistry, S. Chand Publishing, 2011.
6. J. D. Lee, Concise Inorganic Chemistry, 5th Edn., Chapman and Hall, London, 1996.
7. Engineering Chemistry by B. Sivasankar, Tata Mcgraw Hill
8. Engineering Chemistry by A. Mallick, Viva Books, 2008.
9. Organic Chemistry by J. Clayden, Nick Greeves, S. Warren, Oxford Press 2012.
10. Levine, Physical Chemistry, 5/e (7th reprint), Tata McGraw Hill, 2006.
11. Inorganic Chemistry, Principle, structure and reactivity, J.E. Huheey, E.A. Keitler, R.L. Keita, O.K. Medhi, Pearson Education, 4th Ed.
12. Chemistry, J.E. Mcmerry and R.C. Fay, 5th Ed., Pearson Education, 2008

Title of the course : **Elements of Mechanical Engineering**
Subject Code : **ESME - 401**

L	T	P	Credits	Weekly Load
2	1	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Learn about the basic concepts and laws of thermodynamics.
CO2: Apply laws of thermodynamics on various engineering devices.
CO3: Learn various mechanical properties of engineering materials under different types of loads.
CO4: Learn about different mechanisms, inversions and their engineering applications.
CO5: Develop problem solving abilities related to mechanical engineering fundamentals.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	1	-	1	1	1	1	1	1	-	1	1	-	2
CO2	3	3	2	1	1	2	2	1	2	1	-	1	2	2	2
CO3	3	3	2	2	2	2	2	1	1	1	-	1	2	2	2
CO4	3	3	2	2	2	1	1	1	1	1	-	1	2	2	2
CO5	3	3	3	2	2	2	1	1	3	2	1	2	2	2	2
Avg.	3	2.6	2	1.75	1.6	1.6	1.4	1	1.6	1.2	1	1.2	**1.8**	**2**	**2**

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Basic Concept of Thermodynamics**	Definition, Thermodynamic system, boundary and surroundings, Thermodynamic property, Thermodynamic processes, Thermodynamic cycle and its concept, Energy and its forms, Ideal gas and characteristic gas equation, Zeroth law of thermodynamics.	**06**
	First Law of Thermodynamics and its Applications	Definition, Essence and corollaries of the first law, expressions for first law applicable to a process and cycle, concept of internal energy, enthalpy, total energy, specific heats, Closed and open systems, analysis of non-flow and flow processes for an ideal gas under constant volume, constant pressure, constant temperature, adiabatic and polytropic conditions, Analysis of free expansion and throttling processes, analysis of first law to steady flow energy equation and its applications to various engineering devices.	**09**
	Second Law of Thermodynamics	Limitations of first law, statements of second law and their equivalence, heat engine, heat pump and refrigerator. Philosophy of Carnot cycle and its consequences, Carnot	**09**

		theorem for Heat engine, refrigerator and heat pump, Clausius inequality, philosophy and concept of entropy, Third law of Thermodynamics.	
Unit-2	**Mechanics of Solids**	Introduction, stress and strain, Hook's Law, longitudinal and lateral strain, Poisson's ratio, Stress strain diagram for ductile and brittle materials, Factor of safety, strain energy and resilience, Sudden and impact load, Stresses in bars, Thermal stresses, Elastic constants and their significance, relations between Elastic constants.	**18**
	Mechanism and Simple Machines	Introduction, Mechanisms and their concept, Definition of element, link, kinematic chain, mechanism, machine, Examples of mechanisms and their applications, Concept of Basic machines, Law of Lifting Machine, Different systems of pulleys and wheels.	**08**
	Engineering Materials	Materials and Engineering, Classification of Engineering Materials, Mechanical Properties of Engineering Materials, Various properties and Industrial applications of metals (ferrous: cast iron, tool steels, stainless steels and non-ferrous: Aluminum, brass, bronze), polymers, ceramics, composites, smart materials, Conductors, Semiconductors and insulators.	**08**

Total=48

Recommended Books:

1. Nag P.K. Engineering Thermodynamics, Mc. Graw Hill.
2. Yadav R., Thermodynamics and Heat Engines, Central Publishing House, Allahabad
3. Singh V.P., Theory of Machines, Dhanpat Rai and Company, New Delhi.
4. Jindal U.C., Engineering Mechanics, Part-I, Galgotia Publications Pvt.Ltd. , New Delhi.

Title of the course : **Workshop Technology and Practice**
Sub Code : **ESME – 402**

L	T	P	Credits	Weekly Load
1	0	0	1	1

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Learn basic concepts of workshop technology.
CO2: Learn about different hand tools and their safe applications.
CO3: Learn about different machines tools and their safe applications.
CO4: Familiarize with sheet metal, casting, carpentry and fitting operations.
CO5: Apply workshop practices in engineering applications.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	1	1	1	1	1	1	1	-	1	1	1	1
CO2	2	2	1	1	2	1	1	1	1	1	-	1	1	1	1
CO3	3	3	2	2	2	1	1	1	1	1	-	1	2	2	1
CO4	3	2	2	2	2	2	2	1	1	1	1	1	2	2	2
CO5	3	3	2	2	1	2	2	1	1	1	1	1	2	2	2
Avg.	2.6	2.4	1.6	1.6	1.6	1.4	1.4	1	1	1	0.4	1	1.6	1.6	1.4

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Sheet Metal**	Introduction to sheet metal work; GI sheets, aluminium, tin plate, copper, brass etc, Hand tools used in sheet metal shop like steel rule, vernier calipers, micrometer, sheet metal gauge etc., scriber, divider, punches, chisels, hammers, snips, pliers, stakes, rivets etc., Operations -shearing, bending, drawing, squeezing etc.	**06**
	Pattern Making	Introduction to pattern making, moulding and foundry practice. Pattern materials like wood, cast iron, brass, aluminium, waxes etc., different types of patterns, pattern allowances.	**06**
	Foundry	Introduction to casting process, core-boxes, core prints, hand tools-shovel, riddle, rammer, trowel, slick, lifter, sprue pin, bellow, mallet,vent rod, pouring weights etc., moulding sands-green sand, dry sand, loam sand, facing sand etc., grain shape and size, properties of moulding sand, sand preparation and testing etc., Gating Systems- requirements and functions, Functions of risers, Riser and directional solidification. casting- permanent mould casting, centrifugal casting,etc.	**08**
Unit-2	**Carpentry**	Introduction to wood working, Types of wood, seasoning methods, Marking and Measuring Tools-rule, try square, marking gauge, mortise gauge etc., Cutting Tools-rip saw, tenon saw, firmer chisel, mortise chisel, iron jack plane, wooden jack plane etc., Drilling Tools-braces,	**06**

		drill bits etc., Striking Tools-hammers, mallet etc., Holding Tools-bench vice, G-cramp etc., Miscellaneous Tools- rasps, files, screw driver, pincer etc.; Operations-marking, sawing, planning, chiseling, boring, grooving etc., Joints- Corner joints, Tenon and Mortise joint, Briddle cross-joint.	
	Fitting	Introduction to fitting, Tools used in fitting -bench vice, hammers, chisels, files-flat file, square file, half round file, round file, knife edge file, scrapers, hacksaws, try squares, drill machine, drill bits, taps, dies etc, Operations-chipping, filing, scrapping, sawing, marking, drilling, tapping, dieing etc.;	**06**

Total: 32

Recommended Books:

1. Hajra Choudhury, Hazra Choudhary and Nirjhar Roy, 2007, Elements of Workshop Technology, vol. I, Media promoters and Publishers Pvt. Ltd.
2. W A J Chapman, Workshop Technology, 1998, Part -1, 1st South Asian Edition, Viva Book Pvt Ltd.
3. P.N. Rao, 2009, Manufacturing Technology, Vol.1, 3rd Ed., Tata McGraw Hill Publishing Company.
4. Kaushish J.P., Manufacturing Processes, 2008, Prentice Hall India

Title of the course : **English Communication and Soft Skills**
Subject Code : **HSMC - 401**

L	T	P	Credits	Weekly Load
1	0	0	1	1

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Basic concepts of English skills and their use.
CO2: Understand various formation of sentences and how it is applied in general life.
CO3: Learn about the concepts of grammar for the formation of sentences.
CO4: Understand the behavior of words and their impact in writing.
CO5: Differentiatebetween tenses, voice command and phrases in sentence formation.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	1	2	2	2	1	3	2	2	2	-	1
CO2	2	3	3	3	2	1	2	1	1	1	3	1	1	-	1
CO3	3	3	2	3	2	2	1	1	2	3	2	2	-	2	-
CO4	3	3	2	3	1	2	1	2	1	3	1	2	1	2	1
CO5	3	3	2	2	1	1	1	2	2	2	2	2	-	2	1
Avg.	2.8	3	2.2	2.6	1.4	1.6	1.4	1.6	1.4	2.4	2	1.8	1.33333	2	1

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Communication Techniques**	Importance of Communication, One-way and Two-way Communication, Essentials of Good and effective Communication, Barriers to Communication, Techniques to Overcome Barriers	**04**
	Writing Skills	Précis- writing; Essay- writing, Official e-mail writing	**04**
Unit-2	**Report Writing**	Reports and their importance, Types of Routine Reports along with their formats- Annual Confidential Report, Progress Report, Inventory Report, Inspection Report, Lab Report, Structure of Reports; Bibliography & References	**04**
	Grammar & Vocabulary	Tenses, Change of Voice, Change of Narration, Words often confused, Correct use of Prepositions, Use of Idioms and Phrases	**04**
			Total=16

Recommended Books:

1. Bhattacharya, Indrajit**.** An Approach to Communication Skills. Dhanpat Rai & Co.

2. Gibaldi, Joseph. MLA Handbook for Writers of Research Papers. MLA.
3. Sinclair, John. Collins Cobuild English Grammar. Collins.
4. Wren, P.C. &H. Martin. High School English Grammar & Composition. S. Chand & Company Ltd.
5. Sharma, R.C. & Krishna Mohan. Business Correspondence and Report Writing. Tata McGraw-Hill.

Title of the course : **Applied Chemistry Lab**
Subject Code : **BSCH–402**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Basic concepts of English skills and their use.
CO2: Understand various formation of sentences and how it is applied in general life.
CO3: Learn about the concepts of grammar for the formation of sentences.
CO4: Understand the behavior of words and their impact in writing.
CO5: Differentiatebetween tenses, voice command and phrases in sentence formation.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	1	2	2	2	1	3	2	2	1	2	1
CO2	2	3	3	3	2	1	2	1	1	1	3	1	1	-	1
CO3	3	3	2	3	2	2	1	1	2	3	2	2	-	2	1
CO4	3	3	2	3	1	2	1	2	1	3	1	2	1	2	1
CO5	3	3	2	2	1	1	1	2	2	2	2	2	-	2	1
Avg.	2.8	3	2.2	2.6	1.4	1.6	1.4	1.6	1.4	2.4	2	1.8	1	2	1

List of Experiments (10-14):

1. Introducing yourself.
2. Observing and analyzing your environment/ surroundings.
3. Collecting and Using Library Resources.
4. Giving Individual Presentations.
5. English Conversation Skills.
6. Group Discussions.
7. Extempore.
8. Debates.
9. Summarizing newspaper reports.
10. Role Plays.
11. Grammar exercises.
12. Finalization of Team Project Work.
13. Collecting Materials for Project Work & Finalization of Project.
14. Presentation of Project.

Title of the course : **Elements of Mechanical Engineering Lab**
Subject Code : **ESME - 403**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Learn about the basic concepts of thermodynamics.
CO2: Understand various laws of thermodynamics and how it is applied on various engineering devices.
CO3: Understand the behavior of solids under various types of loads.
CO4: Learn about the mechanism of different machines and its applications.
CO5: Get knowledge about properties of engineering materials and its industrial applications.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	1	2	2	2	1	3	2	2	1	2	1
CO2	2	3	3	3	2	1	2	1	1	1	3	1	1	-	2
CO3	3	3	2	3	2	2	1	1	2	3	2	2	-	2	1
CO4	3	3	2	3	1	2	1	2	1	3	1	2	2	1	2
CO5	3	3	2	2	1	1	1	2	2	2	2	2	-	2	1
Avg.	2.8	3	2.2	2.6	1.4	1.6	1.4	1.6	1.4	2.4	2	1.8	1.33333	1.75	1.4

List of Experiments:

1. To verify the Zeroth law of thermodynamics.
2. To study the COP's of Heat pump and Refrigerator.
3. To study the behaviour of ductile and brittle materials under tensile load.
4. To study different types of kinematics links and kinematic chains.
5. To find out the mechanical advantage, velocity ratio and efficiency of first system of pulley.
6. To find out mechanical advantage, velocity ratio and efficiency of a simple lifting machine.
7. To study the classification and properties of various engineering materials.

Title of the course : **Engineering Drawing**
Subject Code : **ESME-404**

L	T	P	Credits	Weekly Load
0	0	4	2	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Understand the universally accepted conventions, symbols and the methods of engineering drawing such as line, lettering, dimensioning, scales etc.

CO2: Draw dimensioned orthographic and isometric projections of engineering objects.

CO3: Develop and interpret the projection of planes, regular & sectioned solids, solids, surfaces.

CO4: To translate geometric and topological information of common engineering object.

CO5: To understand and visualize geometric objects more clearly by using AutoCAD.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	1	2	3	2	3	2	2	1	3	3	2	2	1	2	2
CO2	3	2	3	3	1	2	3	2	1	2	2	2	1	-	2
CO3	2	3	2	1	2	2	2	3	2	3	3	3	-	2	1
CO4	3	2	2	1	2	1	2	3	2	2	3	3	2	1	2
CO5	3	2	3	2	3	2	3	2	3	3	3	2	-	2	1
Avg.	2.4	2.2	2.6	1.8	2.2	1.8	2.4	2.2	2.2	2.6	2.6	2.4	1.33333	1.75	1.6

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction**	Introduction, Objectives, applications, Fundamentals of engineering drawing, Use and handling of different drawing instruments, title block, sheet sizes, first and third angle projections, orthographic projections.	**04**
	Lettering and Dimensioning	Free hand sketching of different types of lines in engineering drawing as per IS specifications, Free hand lettering (alphabet and numerals) - lower case and upper case, vertical and inclined at 75^0 in the ratio of 7:4, Notation of dimensioning, size and location dimensions, aligned and unidirectional systems of dimensioning, general rules for dimensioning, unit of dimensioning.	**04**
	Scales	Uses of scales, sizes of scale, representative fraction, construction of plain and diagonal scales.	**06**
	Projection of Points and Lines	Introduction on theory of projections and orthographic projections, projection of a point in different quadrants, projection of straight lines in different positions (all possible cases)	**12**

Unit-2	**Projection of Planes**	Definition of plane, types of planes, traces of plane, projection of planes in different positions.	**06**
	Projection of Solids	Types of solids, projections of solids in simple and typical positions, introduction on sectioning of solids.	**08**
	Development of Surfaces	Introduction, Development of a right prism, cylinder, pentagonal prism, and a right pyramid, truncated pentagonal pyramid.	**08**
	AutoCAD	Introduction to AutoCAD software, familiarization with various AutoCAD toolbars, use of absolute, relative and polar coordinate system, creating new drawings using drawing tools, editing of drawings using modify commands, dimensioning of 2D and 3D drawings.	

Total = 48

Recommended Books:

1. P S Gill, Engineering Drawing, Kataria and Sons, New Delhi
2. Harvinder Singh, Engineering Drawing & Computer Graphics, Dhanpat Rai, New Delhi.
3. R.K.Dhawan, Engineering Drawing , S. Chand & Co, New Delhi
4. N.D,Bhatt, Engineering Drawing, Charotar Publishing House

Title of the course : **Workshop Technology and Practice Lab**
Subject Code : **ESME-405**

L	T	P	Credits	Weekly Load
0	0	4	2	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Basic concepts of workshop processes.
CO2: Understand various formation equipment and how it is applied on various engineering application.
CO3: Learn about the mechanism of different machines and its applications.
CO4: Understand the behavior of foundry, carpentry tools and their use.
CO5: Differentiate properties of engineering materials and its industrial applications.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	1	2	2	2	1	3	2	2	2	1	2
CO2	2	3	3	3	2	1	2	1	1	1	3	1	1	1	2
CO3	3	3	2	3	2	2	1	1	2	3	2	2	-	2	1
CO4	3	3	2	3	1	2	1	2	1	3	1	2	2	1	2
CO5	3	3	2	2	1	1	1	2	2	2	2	2	-	2	1
Avg.	2.8	3	2.2	2.6	1.4	1.6	1.4	1.6	1.4	2.4	2	1.8	1.66667	1.4	1.6

List of Practical's (10-14) jobs from the following list:

CARPENTRY SHOP

- Making of various joints
- Cross lap joint
- T-lap joint
- Corner lap joint
- Mortise and tenon joint
- Dovetail joint

FITTING SHOP

- Study and use of instruments in fitting shop, like vernier caliper, micrometer and height gauge etc.
- Exercise on simple operations viz. cutting, chipping, sawing, filling, drilling etc.

FOUNDRY SHOP

- Familiarization with different types of patterns and hand tools
- Preparations of green sand mould using single piece pattern.
- Preparations of green sand mould using split piece pattern on bench molding.
- Preparations of green sand mould using solid piece pattern by bedded molding.

PATTERN SHOP

- Familiarization with different tools and patterns in the shop
- Exercise on making of solid piece pattern.
- Exercise on making of split piece pattern.
- Exercise on making of cored pattern.

SHEET METAL SHOP

- Study the layout and different equipment used in sheet metal shop.
- Familiarization with different tools and processes in sheet metal shop
- Exercise on cutting, development, folding, bending, piercing, punching, parting, notching, slitting etc,
- Profile and circle cutting exercise.

Title of the course : **English Communication & Soft Skills lab**
Subject Code : **HSMC – 402**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand concepts of Communication
CO2: Improve Communication Skills
CO3: Understand Concept of Grammar and their usage
CO4: Participate effectively in group discussions, debates and job interviews
CO5: Make oral presentations and be able to use multimedia

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	3	1	1	1	2	1	1	1	1	1	2	2	2
CO2	3	1	3	1	1	1	1	1	1	1	1	1	2	3	2
CO3	3	3	3	3	1	1	1	1	1	1	1	1	1	2	1
CO4	3	1	3	1	3	1	2	2	1	1	1	1	1	2	2
CO5	3	3	3	3	1	1	1	1	1	1	1	3	2	2	2
Avg.	3	1.8	3	1.8	1.4	1	1.4	1.2	1	1	1	1.4	1.6	2.2	1.8

List of Activities of Lab (10-14):

1. Reflecting upon Self and Analyzing Environment.
2. Reading and Improving upon Vocabulary with the Help of Newspapers
3. Collecting and Using Library Resources.
4. Giving Individual Oral Presentations (Will Require Multiple Sessions)
5. English Conversation Skills and Speaking Practice
6. Group Discussions/Debates/Extempores
7. Summarizing a Given Short Story
8. Summarizing NewspaperReports and Events
9. Role Plays/Mock Events
10. Grammar Exercises
11. Finalization of Team Project Work.
12. Collecting Materials for Project Work & Finalization of Project.
13. Presentation of Project.

Title of the course : **Environmental Studies**

Subject Code : **MCCH-401**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Appreciate the need for Environmental integration for sustainable development.

CO2: Understand the importance of biodiversity and its conservation.

CO3: Recognize reasons for environmental pollution and remedial measures.

CO4: Familiarize with national and International environmental regulations

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	1	2	3	3	3	1	2	1	2	2	2	2
CO2	2	2	2	1	2	3	3	3	1	2	1	2	2	1	2
CO3	2	2	2	1	2	3	3	3	3	2	1	2	2	1	2
CO4	2	2	2	1	2	2	3	3	1	2	1	2	3	2	3
Avg.	2	2	2	1	2	2.75	3	3	1.5	2	1	2	2.25	1.5	2.25

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction to Environmental Studies**	Multidisciplinary nature of environmental studies, Scope and importance; Concept of sustainability and sustainable development.	**02**
	Ecosystems	What is an ecosystem? Structure and function of ecosystem; Energy flow in ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems: a) Forest ecosystem b) Grassland ecosystem c) Desert ecosystem d) Aquatic ecosystems(ponds, streams, lakes, rivers, oceans, estuaries)	**06**
	Natural resources: Renewable and Non-renewable resources	Land resources and landuse change; Land degradation, soil erosion and desertification Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal population. Water: Use and over exploitation of surface and ground water, floods, droughts, conflicts over water(international & inter-state). Energy Resources: Renewable and Non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.	**06**

	Biodiversity and Conservation	Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots. India as a mega-biodiversity nation; Endangered and endemic species of India Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions. Conservation of biodiversity: I-situ and Ex-situ conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.	**06**
Unit-2	**Environmental Pollution**	Environmental pollution: types, causes, effects and controls; air, water, soil and noise pollution, Nuclear hazards and human health risks. Solid waste management: control measures of urban and industrial waste. Pollution case studies.	**08**
	Environmental policies and practices	Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture Environmental laws: Environment protection act; Air(Prevention and control of pollution) act, Wildlife protection act, Forest conservation act, International agreement: Montreal and Kyoto protocols and Convention on Biological Diversity(CBD), Nature reserves, tribal populations and rights, and human wildlife conflict in Indian context.	**07**
	Human Communities and the Environment	Human population growth: Impacts on environment, human health and welfare. Resettlement and Rehabilitation of project affected persons; case studies. 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 (example CNG vehicles in Delhi)	**06**
	Field work	Visit to an area to document environmental assets: river/forest/flora/fauna etc. Visit to a local polluted site: urban/rural/industrial/ agriculture. Study of common plants, insects, birds and basic principle of identification. Study of simple ecosystems-pond, river, Delhi ridge etc.	**05**
			Total=46

Recommended Books:

1. Carson, R.2002. Silent Spring, Houghton Mifflin Harcourt.
2. Gadgil, M & Guha, R.1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
3. Glesson, Band Low, N.(eds) 1999. Global Ethics and Environment, London, Routledge.
4. Glerick, P.H. 1993. Water in Crisis. Pacific Institute for Studies in Dev, Environment& security. Stockholm env. Institute, Oxford Univ. Press.
5. Groom, Martha J., Gaery K. Meffe and Carl Ronald Caroll. Principles of conservation Biology. Sunderland: Sinauer Associates,2006.
6. Grumbine, R. Edward, and Pandit,M.K. 2013. Threats from India's Himalaya dams. Science,339:36-37

Title of the course : **Engineering Mathematics II**
Subject Code : **BSMA-402**

L	T	P	Credits	Weekly Load
3	1	0	4	4

COURSE OUTCOMES:

The objective of this course is to familiarize the prospective engineers with techniques in multivariate integration, ordinary differential equations and complex variables. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

Upon completion of this course, students will learn:

CO1: The mathematical tools needed in evaluating multiple integrals and their usage.

CO2: The effective mathematical tools for the solutions of differential equations that model physical processes

CO3: The tools of differential and integrations of functions of a complex variable that are used in various techniques dealing engineering problems.

CO4: Laplace transform and its applications to the solution of differential equations.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	2	3	2	3	3	2	2	2	1	2
CO2	3	3	3	3	2	2	3	2	3	3	2	2	2	1	2
CO3	3	3	3	3	2	2	3	2	3	3	2	2	1	1	1
CO4	3	3	3	3	2	2	3	2	3	3	2	2	2	1	1
Avg.	3	3	3	3	2	2	3	2	3	3	2	2	1.75	1	1.5

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Multivariable Calculus (Integration)**	Multiple Integration: Double integrals (Cartesian and polar), Change in order of Integration in double integrals, Change of Variables (Cartesian and polar). Applications: area and volumes. Triple Integrals (Cartesian), Simple applications involving cube, sphere and rectangular parallelopiped.	**7**
	Ordinary Differential Equations	Exact, Linear and Bernoulli's differential equations, Second order linear differential equations with constant coefficients, method of variation of parameters, Cauchy-Euler equation.	**6**
	Laplace Transform	Laplace transform of elementary functions, properties of Laplace transform, transform of derivatives and integrals, inverse Laplace transform, Convolution theorem, Solution of ordinary differential equations using Laplace transform, Unit step function and unit impulse function, their Laplace transforms.	**8**
Unit-2	**Complex Variable-Differentiation**	Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate. Elementary analytic functions (exponential, trigonometric, logarithm) and their properties. Conformal mapping.	**8**
	Complex Variable-Integration	Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and maximum-modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series. Cauchy residue	**9**

		theorem (without proof), Residue theorem and its applications to real integrals: Integration around unit circle, Integration over semi-circular contours.	
	Vector Integration	Line, surface and volume integrals. Theorems of Green (in plane), Gauss and Stoke (without proof) - their verification and applications.	**7**

Total=45

Recommended Books:

1. G.B. Thomas and R.L.Finney, Calculus and Analytic Geometry, 9th Edition, Pearson, Reprint, 2002.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. W.E.Boyce and R.C. DiPrima, Elementary Differential Equations and Boundary Value Problems. 9thEdn., Wiley India, 2009.
4. S.L.Ross, Differential Equations, 3 Ed. Wiley India, 1984.
5. E.A Coddington, An Introduction to Ordinary Differential Equations, Prentice hall India, 1995.
6. E.L. Ince. Ordinary Differential Equations, Dover Publications, 1958.
7. J.W. Brown and R.V. Churchill, Complex Variables and Applications, McGraw-Hill, 7thEdn., 2011.
8. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2018.

Title of the course : **Applied Physics**
Subject Code : **BSPH-401**

L	T	P	Credits	Weekly Load
3	1	0	4	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the basic knowledge about waves and oscillations, Quantum mechanics, Laser and fibre optics, Electronic, Dielectric, magnetic and superconducting properties of materials and their applications.
CO2: Know the conceptual physics and its use in solving the physical problems.
CO3: Apply the principles/laws of physics for various engineering applications.
CO4: Describe the acquired knowledge of physics in his /her words.
CO5: Identify the reasons for physical happenings.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	1	1	1	1	2	2	3	2	1	3	2	2	2
CO2	3	3	3	2	3	2	2	1	2	1	2	2	1	1	1
CO3	3	1	2	1	1	3	3	3	3	2	3	3	2	1	2
CO4	3	3	1	1	1	2	2	2	2	3	1	1	1	2	1
CO5	2	1	3	1	1	2	3	2	2	2	2	2	2	1	1
Avg.	2.8	1.8	2	1.2	1.4	2	2.4	2	2.4	2	1.8	2.2	1.6	1.4	1.4

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Waves and Oscillations**	Simple harmonic motion, damped and forced simple harmonic oscillator, Mechanical and electrical simple harmonic oscillators, damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators, electrical and mechanical impedance.	**08**
	Quantum Mechanics	Need of quantum mechanics, de-Broglie hypothesis, wave packet; particle, group and phase velocities and their relationships, properties of wave function, Schrödinger's time independent and time dependent wave equations, energy and momentum operators, Eigen values and Eigen functions, expectation values of physical quantities (position, momentum and energy), application of time independent wave equation for a particle in a box (one dimension).	**08**
	Lasers & Fibre Optics	Absorption of radiation, spontaneous and stimulated emission of radiation, Einstein's coefficients, basic requirements of laser system - population inversion, optical pumping; Helium-Neon and Ruby lasers, Applications of laser, basic theory and physical structure	**08**

		of optical fiber, acceptance angle and numerical aperture, fiber materials, types of fibers, losses in optical fibers and basic ideas about optical sensors.	
Unit-2	**Electronic Materials**	Free electron theory of metals, Bloch's theorem for particles in a periodic potential, Energy band diagrams, Kronig-penny model (to introduce origin of band gap), Energy bands in solids, E ~ k diagram, Brillouin zone and effective mass, direct and indirect band gaps, Distinction between metals, semiconductors and insulators.	**08**
	Dielectric properties of materials	Introduction of dielectric materials, polar and non-polar dielectric, basic concept of polarization, Different types of polarization, polarizability, temperature and frequency dependence of polarizability, Clausius-Mossotti relation, dielectric breakdown, dielectric loss, ferroelectric and piezoelectric materials and their applications.	**06**
	Magnetic materials and Superconductivity	Origin of magnetism, basic idea of diamagnetic, paramagnetic, ferromagnetic and ferrite materials, Soft and hard magnetic materials, magnetostriction, magnetic anisotropy and applications of magnetic materials. Superconductivity, Introduction, type I and type II superconductors, Meissner's effect, isotope effect, effects of magnetic field, London's equations, penetration depth, specific heat, BCS theory (qualitative idea), high temperature superconductors, applications of superconductivity.	**10**

Total=48

Recommended Books:

1. The physics of vibrations and waves, H. J. Pain, Wiley, 2006
2. Engineering Physics, H K Malik and AK Singh, Tata McGraw Hill
3. Concepts of Modern Physics, A. Beiser, Tata McGraw Hill
4. Introduction to Solids, L V Azaroff, Tata McGraw Hill
5. Introduction to Solid State Physics, Charles Kittel, Wiley India Pvt. Ltd.
6. Laser theory & Applications, K Thygrajan, A K Ghatak, Mc Millan India Ltd.
7. Materials Science, M S Vijaya, G Rangarajan, Tata McGraw Hill
8. Quantum Mechanics, D. J. Griffiths, Pearson Education

Title of the course : **Elements of Electrical Engineering**
Subject Code : **ESEE-401**

L	T	P	Credits	Weekly Load
2	1	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Apply the knowledge of Electrical Engineering principles to solve DC and AC circuits.
CO2: Formulate and analyze electrical circuits.
CO3: Understand basic principles of electromagnetism to implement in electrical machines and transformers.
CO4: Identify and select various electrical machines according to the applications.
CO5: **A**pply the ethical principles for troubleshooting & installation of safety devices as per norms of engineering practice.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	1	1	1	1	1	1	2	2	1	3	1	2	2
CO2	2	3	1	1	1	1	1	1	2	1	1	2	1	1	2
CO3	3	1	1	1	1	1	1	1	2	1	1	3	3	1	1
CO4	3	2	1	1	1	1	1	1	2	2	1	1	2	1	2
CO5	1	1	1	1	1	3	1	3	2	1	1	2	2	2	1
Avg.	2.4	1.6	1	1	1	1.4	1	1.4	2	1.4	1	2.2	1.8	1.4	1.6

Theory:

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Basic Element**	Concepts of electric charge, current and electromotive force, potential and potential difference; conductor, semiconductor insulator and dielectric, electrical power and energy; basics of instruments used for measuring current, voltage, power and energy, methods and precautions, introduction to digital measuring instruments.	**6**
	Concepts of DC	Ohm's law, resistance, and color coding; capacitance and inductance, their ratings; effects of temperature on resistance, series and parallel connection of resistance, capacitances, Kirchhoff's laws and applications, network theorems	**6**
	AC Fundamentals	Concept of alternating voltage and alternating current, difference between AC and DC, various terms related with AC waves; RMS and average values, concept of phase difference and phasor, single phase and three phase supply; alternating voltage applied to pure resistance, pure inductance, pure capacitance and their combinations, concept of impedance and power in AC circuit.	**6**
	Three phase AC	Phasor representation of three phases, star and delta connections, inter-relation between phase and line values of voltage/current, power measurement in three phase system.	**6**
Unit-2	**Electromagnetic Induction**	Concept of magnetic field, magnetic flux, reluctance, magneto motive force (MMF), permeability; self and mutual induction, basic electromagnetic laws, effects on a conductor moving in a magnetic field, various losses in magnetic circuits.	**6**
	Electrical Machines	Elementary concepts and classification of electrical machines, common features of rotating electrical machines, basic principle of a motor and a generator, need of starters	**9**

		and their classifications. transformer- classification, principle of operation, construction, working and applications.	
	Basic Electrical Installation and Protection	Basic testing and faults diagnosis in electrical systems, oscilloscopes, signal generators etc. basics of various protection and safety devices e.g. fuses, earthing, miniature circuit breaker (MCB) and earth leakage circuit breaker (ELCB) and their applications, replacement of different passive components e.g. lamps and lamp holders, switches, cables, cable connectors, electromagnetic relays.	**9**

Total=48

Recommended Books:

1. Edward Hugh, Electrical Technology, Pearson Education
2. D P Kothari & I J Nagrath, Basic Electrical Engineering, Tata McGraw Hills
3. D P Kothari & I J Nagrath, Electrical Machines, Tata McGraw Hills
4. S K Bhattacharya, Electrical Machines, Tata McGraw Hills
5. B.L. Thereja, A Textbook of Electrical Technology, S Chand; Twenty Third edition,2002.

Title of the course : **Elements of Computer Engineering**
Subject Code : **ESCS-401**

L	T	P	Credits	Weekly Load
2	0	0	2	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Get acquainted with basics of computer system along with its various components
CO2: Know about various operating systems and memory
CO3: Study the C programming basics and learn the concept of operators
CO4: Understand the concept of decision statements and loops
CO5: Learntheuseoffunctions, pointers, arrays, structures, union etc. For modular programming

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	1	2	3	2	3	1	1	1	3	3	2	2	1	2	2
CO2	3	2	3	3	1	1	1	1	1	2	2	2	1	2	2
CO3	2	3	2	1	2	1	1	1	2	3	3	3	2	1	1
CO4	3	2	2	1	2	1	1	1	2	2	3	3	1	2	2
CO5	3	2	3	2	3	1	1	1	3	3	3	2	2	3	1
Avg.	2.4	2.2	2.6	1.8	2.2	1	1	1	2.2	2.6	2.6	2.4	1.4	2	1.6

Theory:

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction**	Introduction and characteristics of computer system,Generations,Classifications, Applications, CentralProcessingUnit,Memory,I/Odevices,Introductiontooperatingsystem andits types,Algorithm,Flowchart.	**04**
	C Programming Basics	Basic program construction, Structure of a C program, Compilation process, preprocessor directives, Comments, Data types, Type conversions, Operators - arithmetic, Relational, Logical, Conditional, Increment/decrement, Library functions, Header files.	**04**
	Loops and Decision Statements	*for* loop, *while* loop, *do* loop, Various forms of *if* statement,*switch* statement, *break* statement, *continue* statement, *go to* statement.	**04**
	Functions	Defining functions, Passing arguments to functions, Returning values from functions, Reference arguments, Storage classes.	**04**
Unit-2	**Pointers**	Pointers, Pointers to pointers, Declaring and initializing pointers, Pointer expressions, Pointers and arrays, Pointers and strings.	**04**
	Arrays	Arrays and strings, Declaring an array, Initializing arrays, Accessing the array elements, Working with multidimensional arrays, Declaring and initializing string variables, String handling functions.	**04**

	Structures and Union	Declaring and initializing a structure, Accessing the members of a structure, Nested structures, Array of structures, Using structures in functions, Pointers and structures, Declaring and initializing a union.	**04**
	Files	Reading and writing to text and binary files, Character I/O, String I/O, File pointers, Error handling, Redirection, Command line arguments.	**04**

Total=32

Recommended Books:

1. RajaRamanV.,Fundamentals ofComputers,PHI.
2. Kernighan Brian W. and Ritchie, Dennis M, The C Programming language, Dorling Kingsley.
3. Balagurusamy, E., Programming in ANSI C, TMH Publications

Title of the course : **Elements of Electronics Engineering**
Subject Code : **ESEC-401**

L	T	P	Credits	Weekly Load
2	0	0	2	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Design simple combinational and sequential logic circuits.
CO2: Characterize semiconductors, diodes and transistors.
CO3: Apply the basics of diode and transistor to analyse the operation of electronic devices.
CO4: Design electronic circuits such as rectifiers, filters, voltage regulators, transistor amplifiers and operational amplifiers.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	3	1	1	1	2	2	1	2	2	1	2	1	3
CO2	3	1	3	1	1	1	1	3	2	2	1	2	1	-	1
CO3	3	3	3	3	1	1	2	1	3	2	2	1	-	2	-
CO4	3	1	3	1	3	1	2	2	2	3	3	1	1	2	1
Avg.	3	1.5	3	1.5	1.5	1	1.75	2	2	2.25	2	1.25	1	1.25	1.25

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Number system and codes Logic gates and flip flops**	Decimal, binary, octal, and hexadecimal number system and their inter-conversions, Gray code, Excess-3 code. Definitions, symbols and truth table of NOT, OR, AND, NAND, NOR, XOR, XNOR gates, De-Morgan's theorems, realization of basic gates using universal gates; realization of simple Boolean equations using universal gates, introduction to K- map (3 variables), logic diagram, truth table and operation of latches and flip flops: RS, T, D, JK.	**8**
	Semiconductor devices	Semiconductor materials: Ge, Si, intrinsic and extrinsic semiconductors, p-type, n-type, p-n junction theory and diodes, its V-I characteristic, equivalent model, diode applications-half wave, full wave and bridge rectifier circuits, filter circuits: inductor filters, capacitor filters, L- section filters, π- section filters, comparison of filters, clippers and clampers, Zener diode, its characteristics and application as a voltage regulator, LED, photodiode.	**8**
Unit-2	**Transistors**	Bipolar junction transistor (BJT): basic operation, biasing, concept of dc load line and operating point selection, CB, CE, and CC configurations, BJT as an amplifier and switch, introduction to JFET and MOSFET: construction and operation.	**8**
	Operational amplifiers (Op-Amps.)	Introduction, basic characteristics of ideal and practical Op-Amp, IC741 pin configuration, Op-Amp in different modes: inverting and non-inverting amplifier, basic applications: adder, subtractor, voltage follower, multiplier, differentiator & integrator, instrumentation amplifier.	**8**

Total=32

Recommended Books:

1. Boylstad&Nashelsky, Electronic Devices & Circuits
2. Millman &Halkias, Integrated Electronics
3. Malvino, Electronic Principles
4. V.K. Mehta, ShaluMelta, Principles of Electronics
5. Donald L. Shilling & Charles Belowl, Electronic Circuits

Title of the course : **Applied Physics Lab**
Subject Code : **BSPH-402**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Verify the theoretical formulations/ concepts of physics.
CO2: Know the art of recording the observations of an experiment scientifically.
CO3: Learn by doing.
CO4: Handle and operate the various elements/parts of an experiment.
CO5: Understand the importance of an experiment in engineering &technology

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	1	1	1	1	2	2	3	2	1	3	1	1	1
CO2	3	3	3	2	3	2	2	1	2	1	2	2	2	1	3
CO3	3	1	2	1	1	3	3	3	3	2	3	3	1	1	1
CO4	3	3	1	1	1	2	2	2	2	3	1	1	2	1	3
CO5	2	1	3	1	1	2	3	2	2	2	2	2	2	1	3
Avg.	2.8	1.8	2	1.2	1.4	2	2.4	2	2.4	2	1.8	2.2	1.6	1	2.2

List of Experiments:

1. To determine the frequency of a tuning fork using sonometer.
2. To determine the frequency of an electrically maintained tuning fork by Melde's experiment.
3. To investigate resonance in forced oscillations and to find the spring constant.
4 To verify the inverse square law of radiation using Photoelectric effect.
5. To determine the value of Planck's constant and photoelectric work function of the material of the cathode using photoelectric cell.
6. To determine the frequency of an unknown signal by drawing the Lissajous patterns for various frequency ratios and evaluative the phase difference between two sinusoidal signals applied to X and Y inputs of cathode ray oscilloscope.
7. Determination of the value of e/m of an electron by helical method/Thomson method.
8. To determine the numerical aperture (NA) of a given multimode optical fibre by using laser beam.
9. To study the V-I characteristics of semiconductor diode.
10. To find the band gap of the semiconductor material using diode in reverse bias.
11. To determine the wavelength of He-Ne laser by diffraction method.
12. Use of Michelson-Morley interferometer for determining the wavelength of He-Ne laser.
13. To find the Curie temperature of the given ferrite material.
14. To calculate the dielectric constant of the given dielectric material.
15. To determine the specific rotation of sugar solution using Laurent's half-shade polarimeter.

Title of the course : **Elements of Electrical Engineering Lab**
Subject Code : **ESEE-402**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Apply the knowledge of Electrical Engineering principles to solve DC and AC circuits.
CO2: Formulate and analyze electrical circuits.
CO3: Understand basic principles of electromagnetism to implement in electrical machines and transformers.
CO4: Identify and select various electrical machines according to the applications.
CO5: **A**pply the ethical principles for troubleshooting & installation of safety devices as per norms of engineering practice.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	1	1	1	1	1	1	2	2	1	3	1	2	2
CO2	2	3	1	1	1	1	1	1	2	1	1	2	1	1	2
CO3	3	1	1	1	1	1	1	1	2	1	1	3	3	1	1
CO4	3	2	1	1	1	1	1	1	2	2	1	1	2	1	2
CO5	1	1	1	1	1	3	1	3	2	1	1	2	2	2	1
Avg.	2.4	1.6	1	1	1	1.4	1	1.4	2	1.4	1	2.2	1.8	1.4	1.6

List of Experiments: (At least 10 experiments)

1. Study of various passive components and measuring instruments and their connections in electrical circuits.
2. Verification of Kirchhoff's current and voltage laws.
3. Measurement of voltage, current, phase angle, power and power factor in RL, RC and RLC circuits.
4. Implementation of various types of earthing.
5. Study of various types of protection devices e.g. fuses, Miniature circuit Breaker (MCB) and Earth leakage circuit Breaker (ELCB)
6. Verification of Faraday's laws and Lenz's law.
7. Starting and reversing of DC and AC motors with various types of starters.
8. Verification of turns ratio of transformer
9. Determination of voltage regulation of transformer.
10. Fault diagnosis and removal in general electrical connection /apparatus.
11. To study the breakdown strength of transformer oil.
12. To measure the Insulation resistance of cable
13. Demonstration of cut-out sections of various machines.

Title of the course : **Elements of Computer Engineering Lab**
Subject Code : **ESCS-402**

L	T	P	Credits	Weekly Load
0	0	4	2	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Solve basic mathematical problems using programming
CO2: Demonstrate the use of loop statements to solve iteration problems
CO3: Implementtheconceptofmodularprogrammingandrecursionusingfunctions
CO4: Implementation of decision statements and loops
CO5: Create a file and add, append retrieve data using file handling

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	3	3	1	1	3	3	3	2	2	1	2
CO2	3	3	3	2	2	2	1	1	3	3	3	2	1	1	1
CO3	3	3	3	2	3	2	1	1	3	2	3	3	2	1	1
CO4	3	3	3	3	3	3	1	1	3	2	3	3	1	1	1
CO5	3	3	3	3	3	3	1	1	3	3	3	3	1	1	1
Avg.	3	3	3	2.4	2.8	2.6	1	1	3	2.6	3	3	1.4	1	1.2

List of Experiments:

1. WAP to find multiplication of two numbers.
2. WAP to swap two numbers without using third variable.
3. WAP to calculate temperature in Fahrenheit to Celsius using formula C= (F- 32)/1.8.
4. WAP to calculate Sum and Average of N numbers using sequence of statements.
5. WAP to convert integer arithmetic to a given number of day and month using switch case.
6. WAP to find maximum out of 3 numbers a, b &c using Control Statements (if, else, nested if, nested else).
7. WAP to find minimum out of 3 numbers a, b & c using Control Statements (if, else, nested if, else)
8. WAP to find whether entered number is palindrome or not.
9. WAP to check entered number is even or odd .
10. WAP to find whether entered year is leap year or not.
11. WAP to find factorial of positive integer using for loop.
12. WAP to print all the number between 1 to 100 which are divisible by7 using the concept of loops.
13. WAP to generate Fibonacci series up to n using loops.
14. Write a program to calculate area of circle using function.

15. Write an iterative function to calculate factorial of given number.
16. Write a recursive function to calculate factorial of given number
17. WAP to find even & odd up to a given limit using the concept of array and loops.
18. WAP to reverse a string.
19. WAP to find addition of two matrix of n*n order using the concept of 2 dimensional array
20. WAP to find multiplication of two matrix of n*n order using the concept of 2 dimensional array.
21. WAP program to study the concept of structure.
22. WAP to implement the concept of switch and break statements.
23. WAP to implement the concept of continue statements.
24. WAP to create a data file, retrieve data from the file.

Note: The above-mentioned list of experiments is suggested list. Teacher may add more programs/ experiments as per requirement.

Title of the course : **Elements of Electronics Engineering Lab**
Subject Code : **ESEC-402**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Analyze and design various digital circuits using basic gates and flip flops.
CO2 Design practical circuits using semiconductor diodes.
CO3: Analyze various modes of transistors in different configurations.
CO4: Design circuits using transistors and Op-Amps.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	3	3	2	2	1	1	3	2	1	2	2	1	2
CO2	3	3	3	3	2	2	1	1	3	2	1	1	2	1	1
CO3	3	3	1	3	2	2	1	1	3	2	1	2	1	1	1
CO4	3	3	3	3	2	2	1	1	3	2	1	2	2	1	1
Avg.	3	2.5	2.5	3	2	2	1	1	3	2	1	1.75	1.75	1	1.25

List of Experiments:

1. Verification of the truth tables ofbasic gates, e.g., 7400, 7402, 7404, 7408, 7432, 7486.
2. Design all other gates using NAND and NOR gates.
3. Design S-R flip-flop using NOR/NAND gates.
4. Verify the truth table of J-K flip-flop (7476), D flip-flop (7474) and T flip-flop.
5. To observe and analyze V-I characteristics of PN junction diode.
6. To observe and analyze V-I characteristics of Zener diode.
7. Design and analysis of half wave rectifier with capacitor filter.
8. Design and analysis of center tap full wave rectifier with capacitor filter.
9. Design and analysis of bridge type full wave rectifier with capacitor filter.
10. Design and analysis of Zener as a voltage regulator.
11. To observe V-I characteristic of PNP and NPN transistor in common base configuration.
12. Design and analysis of Op-Amp as an inverting amplifier & non-inverting amplifier.
13. Design and analysis of Op-Amp as an integrator & differentiator.
14. To observe V-I characteristic of JFET.
15. To observe V-I characteristic of MOSFET.

Title of the course : **Engineering Mechanics**
Subject Code : **ESME-501**

L	T	P	Credits	Weekly Load(hrs)
3	1	0	4	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the importance of mechanics in the context of engineering.
CO2: Analyze the various forces acting on engineering components
CO3: Apply the different principles to study the motion of a body, and concept of relative velocity and acceleration.
CO4: Analyse various forces acting on elements of truss
CO5: Identify the basic elements of a mechanical system and write their constitutive equations.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	2	1	1	1	1	-	1	2	1	2
CO2	3	3	3	3	2	2	1	1	1	1	-	1	2	1	2
CO3	3	3	3	3	2	2	1	1	1	1	-	1	2	1	2
CO4	3	3	3	3	2	2	1	1	1	1	-	1	2	1	2
CO5	3	3	3	3	2	2	1	1	1	1	1	1	2	1	2
Avg.	3	3	3	3	2	2	1	1	1	1	1	1	2	2	2

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Fundamental of Mechanics**	Mechanics and its relevance, Fundamental concept of mechanics and applied mechanics, idealization of mechanics, Basic dimensions and units of measurements, concept of rigid bodies, Laws of Mechanics	**03**
	Laws for Forces	Control Scalars and Vectors, Vector operations, Vector addition of forces, Force and its effects, characteristics of force vector, Bow's notation Force systems: Coplanar and Space force systems. Coplanar concurrent and non-concurrent forces. Free body diagrams	**04**
	Resultant and components of forces	Concept of equilibrium; Parallelogram law of forces, equilibrium of two forces; super position and transmissibility of forces, Newton's third law, triangle law of forces, different cases of concurrent, coplanar two forces systems, extension of parallelogram law and triangle law to many forces acting at one point.	**04**
	Polygon law of forces	Triangle law to many forces acting at one point - polygon law of forces, method of resolution into orthogonal components for finding the resultant, graphical methods, special case of three concurrent, coplanar forces, Lami's theorem	**04**
	Moments & Couples	Concept of moment, Varignon's theorem, Principle of moments, Moment of forces about a specified axis, concept of couple - properties and effect, Moment of couple, Movement of	**04**

		force on rigid body, Resultant of force and couple system, Reduction of force and couple system, Parallel forces - like and unlike parallel forces, calculation of their resultant.	
	Trusses	Simple trusses, analysis of simple truss, Method of Joints, Method of sections	**04**
Unit-2	**Friction**	Concept of friction, Characteristics of Dry friction, Laws of Coulomb friction, limiting friction, coefficient of friction; sliding friction and rolling friction, Belt friction, Ladder friction.	**04**
	Centre of gravity and Moment of Inertia	Concept of gravity, gravitational force, centroid and centre of gravity, centroid for regular lamina and centre of gravity for regular solids. Position of centre of gravity of compound bodies and centroid of composite area. CG of bodies with portions removed, Moment of Inertia: First and second moment of area; Radius of gyration, Moment of inertia of simple and composite bodies.	**06**
	Simple Lifting Machines	Concept of machine, mechanical advantage, velocity ratio and efficiency of a machine, their relationship, law of machine, Simple machines: Wheel and axle, pulley systems, Simple screw jacks	**03**
	Kinetics of a particle	Types of motion, linear motion with uniform velocity, uniform & varying acceleration, motion under gravity, motion of projectiles, concept of relative and resultant velocity. Newton's laws of motion, equation of motion for system of particles, D' Alembet's Principle, Motion of connecting bodies. Concept of momentum, Impulse momentum, Conservation of momentum and energy, Principle of work and energy	**06**
	Kinetics of a rigid body	Introduction, Equation of motion for a rigid body, Angular Motion of Rigid Bodies, D'Alembert's principle applied to bodies having linear and angular motion. Equation of dynamic equilibrium, Maximum acceleration and retardation of vehicles running on inclined planes.	06

Total=48

Recommended Books:

1. J. L. Mariam & L. G. Kraige , Engineering Mechanics. John Wiley & Sons
2. R. C. Hibbeler, Engineering Mechanics (Static & Dynamics), Prentice Hall
3. Beer & Johnston, Engineering Mechanics (Static & Dynamics), McGraw Hill
4. Boresi&Schimidt, Engineering Mechanics (Static & Dynamics), Cengage Learning
5. R. K. Rajput, Engineering Mechanics, Dhanpat Rai Publication, New Delhi
6. S. Rajshekharan, Engineering Mechanics, VIkas Publishing House , New Delhi

Title of the course : **Applied Thermodynamics**
Subject Code : **PCME 511**

L	T	P	Credits	Weekly Load (hrs)
3	1	0	4	4

COURSE OUTCOMES:
After successful completion of course, the students should be able to
CO1: Able to identify the various types of engines along with their working.
CO2: Able to conduct experiments on performance analysis of engines.
CO3: Develop the basic knowledge the steam engines/ steam nozzle/ steam turbine.
CO4: Able to conduct experimentation on performance analysis of jet propulsion/ compressors.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	3	2	3	2	3	2	2	2	2	1	1
CO2	3	3	3	3	1	3	2	3	2	3	2	3	1	2	1
CO3	3	3	3	2	2	3	2	2	2	2	3	2	1	2	2
CO4	3	3	3	2	2	3	2	3	3	3	2	2	2	1	2
Avg.	3	3	2.75	2	2	2.75	2.25	2.5	2.5	2.5	2.25	2.25	1.5	1.5	1.5

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Internal Combustion Engines**	Introduction to I.C. Engines and their classification, Engine components, Nomenclature, Comparison of S.I. & C.I. engine, Working principles of 2-stroke and 4-stroke engine, Comparison of 2-stroke and 4-stroke engine, Gas power cycle, Introduction of different cycles, Carnot cycle, Otto, Diesel cycle, Dual cycle. Analysis of Otto cycle, Diesel cycle & Dual cycles.	**07**
	Combustion in S.I. Engine	Introduction, Combustion in S.I. engine, Flame front propagation, Factor influencing flame speed, pre-ignition, abnormal combustion, Phenomena of knock in S.I. engine, Effect of engine variables on knocking.	**07**
	Combustion in C.I. Engine	Stages of Combustion in C.I. engine, Factors affecting delay period, Phenomena of knocking in C.I. engine, Comparison of knocking in S.I. & C.I. engine	**06**
	Steam Engines:	Parts of steam engine and their function, Working of steam engine, Indicator diagram (Theoretical & actual), Diagram factor, IHP, BHP, Mechanical efficiency, Compounding of steam engines.	**04**
Unit-2	**Steam Nozzles and Steam Turbines:**	Introduction to nozzles & types, Equation of continuity, Steady flow energy equation, Momentum equation, Nozzle efficiency, Calculation of nozzle area in adiabatic and frictionless flow, Mass flow rate through nozzle. Steam Turbines:Rankine's cycle, Principle of operation of steam turbine, Types of steam turbines, Simple impulse turbine, Compounding of impulse turbine, impulse reaction turbine, Reaction turbine, Velocity diagram of impulse turbine, effect of blade friction on velocity diagram, Blade or diagram efficiency, gross stage efficiency.	**08**

	Gas Turbines:	Simple open cycle gas turbine, Actual Brayton's cycle, Rate & work ratio, Open cycle gas turbine with regeneration, Open gas turbine cycle with reheat, Open gas turbine with inter cooler, Comparison between closed cycle gas turbine & open cycle gas turbine, advantages & disadvantages of gas turbine over steam turbine, application of gas turbine.	**07**
	Jet Propulsion	Introduction to turbojet engine, Thrust power propulsive efficiency, Thermal efficiency relations, Advantages & disadvantages of jet propulsion over other system, Operation of rocket engine using solid, Liquid propellant.	**04**
	Compressors	Types of compressors, Reciprocating, centrifugal, screw comp. etc., Work done in single & multi cylinder compressor, Inter-cooling, Principle of minimum work for multi compressor, Efficiency.	**05**
			Total-48

Recommended Books:

1. Mathur & Sharma, I.C. Engine. Dhanpat Rai & Sons Pubilsher
2. P.K.Nag, Thermodynamics, TMH Pubilsher
3. Thermodynamics (Vol. I-III) R.Yadav, CPH Pubilsher
4. V.P.Vasandhani, Heat Engineering, Khanna Pubilsher
5. P.L.Ballaney, Thermal Engineering, Khanna Pubilsher
6. O.P.Single, Engineering Thermodynamics, TMH Pubilsher

Title of the course : **Manufacturing Processes**
Subject Code : **PCME-512**

L	T	P	Credits	Weekly Load (hrs)
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Learn about the principles of various manufacturing processes.
CO2: Identify the tool materials used in various manufacturing processes.
CO3: Learn about various metal forming, joining, and finishing operations such as welding, metal spraying & coating etc.
CO4: Perform operations on lathe, milling, shaping, planning, drilling, broaching etc.
CO5: Develop problem-solving abilities related to the manufacturing processes.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	2	2	2	3	2	3	2	2	1	1	1
CO2	2	3	3	2	3	3	3	2	3	2	3	3	2	2	1
CO3	2	2	3	3	2	2	2	3	2	3	2	2	1	2	3
CO4	2	3	3	3	3	3	2	3	3	2	3	2	2	1	2
CO5	3	2	3	2	3	2	2	2	3	2	2	2	2	1	3
Avg.	2.4	2.6	2.8	2.6	2.6	2.4	2.2	2.6	2.6	2.4	2.4	2.2	1.6	1.4	2

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Cutting Tools and Cutting tool Materials**	Various types of single point and multi point cutting tools and their uses. Cutting speed, feed and depth of cut. Machinability and tool life, use of coolants, types of cutting fluids. Cutting Tool Materials -Properties of cutting tool material, study of various cutting tool materials viz. high-speed steel, tungsten carbide, stellite, ceramics and diamond.	**04**
	Foundry	Introduction to casting, advantages & limitations, sand moulding- materials, properties of moulding sand, types of moulding sand, testing of moulding sand. Safety precautions in foundry, Pattern- types & materials, pattern allowances, core prints, cores. Types of moulds, Step involved in making a mould, Molding boxes, hand tools used for mould making, Molding processes: Bench molding, floor molding, pit molding and machine molding. Elements of gating system, Pouring basin, sprue, runner, gates, Types of risers, location of risers, Directional solidification. Principle, working and applications of Die casting: Pressure die casting, Investment and Centrifugal casting.	**04**
	Forming processes	Press Working - Types of presses, type of dies, Press Operations-Shearing, piercing, trimming, punching, notching, shaving, gearing, embossing, stamping. Introduction to forging, extrusion and rolling processes.	**04**
	Lathe	Principle of turning, Description and function of various parts of a lathe, work holding devices, lathe operations :- plain and step turning, facing, parting off, taper turning, eccentric turning, drilling, reaming, boring, threading and knurling, form turning, spinning,	**04**

		machining time. lathe accessories: - centers, dogs, different types of chucks, collets, face plate, angle plate, mandrel, steady rest, follower rest, taper turning attachment, tool post grinder. brief description of capstan and turret lathe. Principle of boring, classification of boring machines.	
	Drilling	Principle of drilling, classification of drilling machines and their description, various operations performed on drilling machine – drilling, spot facing, reaming, boring, counter boring, counter sinking, hole milling, tapping, speeds and feeds during drilling, machining time, types of drills and their features, nomenclature of a drill, drill holding devices, types of reamers.	**04**
Unit-2	**Welding**	Principle of welding, Classification of welding processes, Advantages and limitations of welding, Industrial applications of welding, types of welding joints, Welding positions and techniques, symbols. Safety precautions in welding shop. Soldering and brazing. Gas and Arc Welding Processes.	**04**
	Milling	Specification and working principle of milling machine, classification, brief description and applications of milling machines, up milling and down milling. column and knee type milling machine, milling machine accessories and attachment – arbors, adaptors, collets, vices, circular table, indexing head and tail stock, vertical milling attachment shover chuck and rotary table, work holding devices, other milling operations – face milling, angular milling, form milling, straddle milling and gang milling, cutting speed and feed, simple numerical problems.	**04**
	Shaping and Planing	Working principle of shaper and planer, type of shapers, type of planers, quick return mechanism applied to shaper and planer machine, work holding devices used on shaper and planer, types of tools used and their geometry, specification of shaper and planer, speeds and feeds in above processes.	**04**
	Broaching	Introduction, types of broaching machines – Single ram and duplex ram horizontal type, vertical type pull up, pull down, push down, elements of broach tool, broach tooth details – nomenclature, types, and tool material	**04**
	Metal Finishing Processes	Purpose of finishing surfaces, Surface roughness-Definition and units, grinding, various elements of grinding wheel – abrasive, grade, structure, bond, common wheel shapes and types of wheel, specification of grinding wheels as per BIS, truing, dressing, balancing and mounting of wheel, grinding methods – surface grinding, cylindrical grinding and centreless grinding, Honing Process, its applications, Description of hones, Brief idea of honing machines, Lapping process, its applications, Description of lapping compounds and tools, Brief idea of lapping machines, Polishing, Buffing	**04**
			Total =40

Recommended Books:

1. Malik & Ghosh, Manufacturing Science, EWP
2. Pandey & Singh, Production Engineering Science, standard publisher
3. A.Bhattacharya, Metal Cutting Theory, Central Publisher
4. Kalpakjian, Manufacturing Engineering And Technology, Pearson Publisher

Title of the course : **Fluid Mechanics and Machinery**
Subject Code : **PCME 513**

L	T	P	Credits	Weekly Load
3	1	0	4	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: To learn fluid properties, types of fluid and to apply this knowledge for understand of static fluid behaviour.
CO2: Understand the principles of submerged surface and floating surfaces
CO3: Understand the kinematics and dynamics of fluid flow
CO4: Differentiate between various turbines and its principle.
CO5: Understand mechanics of various pumps and its characteristics

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2	2	3	2	3	2	1	3	1	2	2
CO2	3	2	3	3	3	2	3	3	2	3	2	3	2	3	1
CO3	2	3	3	2	2	1	2	2	2	3	2	3	3	1	2
CO4	3	3	3	3	3	3	2	3	2	2	1	2	1	2	3
CO5	2	1	2	3	3	3	2	2	2	2	2	3	1	2	2
Avg.	2.6	2.4	2.8	2.6	2.6	2.2	2.4	2.4	2.2	2.4	1.6	2.8	1.6	2	2

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Fundamental concepts**	Definition of fluid, distinction between solid and fluid, fluid properties: viscosity, surface tension, capillarity, vapour pressure; types of fluid	**03**
	Fluid statics	Control volume, forces on fluid element, fundamental equation of fluid statics, pressure and devices for its measurement, centre of pressure, buoyancy, centre of buoyancy, meta-centre, meta-centric height, hydrostatic thrust on submerged bodies	**06**
	Kinematics of fluid	Scalar and vector fields, flow field and methods of describing fluid motion, classification of fluid flow, motion of fluid particle along a curved path, velocity and acceleration of fluid particle, rate of discharge, continuity equation in differential form in different co-ordinate systems, velocity potential, rotation, circulation, vorticity, stream lines, path lines, streak lines, stream function, flow net, conservation of momentum- equation of motion and momentum theorey	**06**
	Dynamics of fluid flow	Fluid dynamics, control volume and control surface, energy and its different form used in fluid mechanics, Euler's equation of motion, Bernoulli's theorem, application of Bernoulli's theorem, Euler's equation along a streamline, Application of Bernoulli's theorem. Different types of flow syllabus.	**06**
Unit-2	**Impact of jet**	Dynamic force exerted by fluid jet on stationary/ moving, vertical, inclined, flat and curved plates.	**03**

	Pelton Wheel and impulse turbine	Element of hydroelectric power plant, efficiencies of hydraulic turbines; Classification of turbines. Pelton wheel turbine, main component and their function, turbine power, nozzle and jet diameter, No. of jets, mean diameter of a Pelton runner, selection of a speed, jet ratio, minimum no. of buckets and other impulse turbine. Design of Pelton turbine runner. Force, power and efficiency. Unit and specific quantities, Specific speed.	**05**
	Reaction turbine	Francis turbine, work done and efficiency of Francis turbine, Design of Francis turbine runner. Kaplan turbine, work done & efficiency of Kaplan turbine, Cavitation and its effect. Draft tube theory and it's type, efficiency of draft theory.	**04**
	Reciprocating pumps	Classification of pumps, main parts of a reciprocating pump, working principle. Discharge, work done and power requirement in a reciprocating pump. slip of a reciprocating pump. Effect of accelerating piston on velocity and acceleration in the suction and delivery pipe. Indicator diagram. Air vessel	**04**
	Centrifugal pumps	Working principle and operation, classification, Main components, discharge, Head of a pump, power, determination ofdifferent losses of head in pipe line and pipe fitting. Efficiencies of Centrifugal pump. Priming of pump. Cavitation in pumps. Net positive section head. Selection of a centrifugal pump.	**04**
	Hydraulic Machines		**03**
			Total=44

Recommended Books:

1. White, Fluid Mechanics, McGraw Hill
2. Munson , Fundamentals of Fluid Mechanics, John Wiley & Sons
3. Cenegal, Fluid Mechanics, McGraw Hill
4. Modi & Seth, Fluid Mechanics & Fluid Machines, Standard Publishers
5. D. S. Kumar, Fluid Mechanics & Fluid Machinery, Kataria& Sons
6. A.K Jain, Fluid Mechanics, Khanna Publishers
7. Om & Biswas, Fluid Mechanics & Fluid Machines, Tata McGraw-Hill.
8. J. Lal, Fluid Mechanics, Metropolitan

Title of the course : **Principles of Management**
Subject Code : **HSMC-501**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: The scope of this paper is to familiarize students with the concepts of OB knowledge to management practices.
CO2: This course aims to provide insights necessary to understand behavioural processes at individual, team and organizational level
CO3: To enable students to learn how to influence the human behaviour in organisations.
CO4: To understand the behaviour of employees which affect the organisational environment.
CO5: To achieving higher productivity and accomplishing goals of the organization.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	1	1	1	1	2	1	2	1	2	1	2	1
CO2	3	3	3	1	1	1	2	3	3	2	2	2	1	2	2
CO3	3	3	3	1	1	2	1	3	2	2	1	2	1	2	1
CO4	3	3	3	1	1	2	3	2	2	1	1	2	1	1	2
CO5	3	3	3	1	1	1	1	2	3	1	2	2	1	3	1
Avg.	3	3	3	1	1	1.4	1.6	2.4	2.2	1.6	1.4	2	1	2	1.4

Theory:

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1		Definition of management, science or art, manager vs. entrepreneur; Types of managers managerial roles and skills; Evolution of management- scientific, human relations, system and contingency approaches, Corporate Social Responsibility	**10**
		Current trends and issues in management. Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies, Strategic Management, Planning Tools and Techniques, Decision making steps & processes.	**12**
Unit-2		Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, Career planning and Management.	**14**
		Directing, individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication.	**12**

		Controlling, system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting.	

Total-48

Recommended Books:

1. Robins S.P. and Couiter M., Management, Prentice Hall India, 10th ed., 2009.
2. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education, 2004.
3. Tripathy PC & Reddy PN, Principles of Management, Tata McGraw Hill, 1999.

Title of the course : **Applied Thermodynamics Lab**
Subject Code : **PCME 514**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Able to identify the various types of engines along with their working.
CO2: Able to conduct experiments on performance analysis of engines.
CO3: Develop the basic knowledge the steam engines/ steam nozzle/ steam turbine.
CO4: Able to conduct experimentation on performance analysis of jet propulsion/ compressors.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	3	2	3	2	3	2	2	2	1	2	1
CO2	3	3	3	3	1	3	2	3	2	3	2	3	2	2	1
CO3	3	3	3	2	2	3	2	2	2	2	3	2	1	2	3
CO4	3	3	3	2	2	3	2	3	3	3	2	2	2	1	2
Avg.	3	3	2.75	2	2	2.75	2.25	2.5	2.5	2.5	2.25	2.25	1.5	1.75	1.75

List of Experiments:

1. Constructional details and working of 2-stroke petrol engine.
2. Constructional details and working of 4-stroke petrol engine.
3. Constructional details and working of 4-sytokr diesel engine.
4. To find the performance of a diesel engine (B.H.P, thermal efficiency, fuel consumption, air consumption.)
5. Make a heat balance sheet of 4-stroke single cylinder diesel engine.
6. Morse test on 4-stroke 4 cylinder petrol engine.
7. To Analyses the exhaust gases of a vehicle with the help of a exhaust gas analyses.
8. To find out the flash point and fire point of kerosene.
9. Constructional details and working of steam engine.
10. Constructional details and working of turbojet engine.

Title of the course : **Fluid Mechanics and Machinery Lab**
Subject Code : **PCME 515**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: To learn fluid properties, types of fluid and to apply this knowledge for understand of static fluid behaviour.
CO2: Understand the kinematics and dynamics of fluid flow
CO3: Differentiate between various turbines and its principle.
CO4: Discuss the mechanics of various pumps and its characteristics

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	3	2	1	3	2	2	1	2	1	2	1
CO2	3	2	3	3	3	2	2	2	3	2	2	2	2	2	1
CO3	3	1	3	2	2	1	3	2	2	3	2	2	1	2	3
CO4	3	2	3	3	3	3	2	3	2	3	1	2	2	1	2
Avg.	3	2	2.75	2.75	2.75	2	2	2.5	2.25	2.5	1.5	2	1.5	1.75	1.75

List of Experiments:

1. Determination of Viscosity of a Liquid by Redwood viscometer.
2. Verification of Bernoulli's Theorem.
3. To determine Coefficient of Discharge of Venturimeter.
4. To determine Coefficient of Discharge of orifice meter.
5. To determine Coefficient of Discharge of Weir.
6. To study the constructional details of a Pelton turbine and measure its efficiency.
7. To study the constructional details of a Francis turbine, Kaplan turbine
8. To study the constructional details of a Centrifugal Pump and measure its efficiency
9. To study characteristics curves of Reciprocating Pump.

Title of the course : **Indian Constitution**
Subject Code : **MCMH– 501**

L	T	P	Credits	Weekly Load (hrs)
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: History, formation and silent features of Indian Constitution.
CO2: Fundamentals Rights and Duties.
CO3: Directive Principle of State Policy.
CO4: Various Protections in respect of Life and Personal Liberty.
CO5: Various Rights pertaining to religion, cultural and education.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	3	-	3	2	-	-	2	-	2	-
CO2	-	-	-	-	-	3	-	3	2	-	-	2	-	2	-
CO3	-	-	-	-	-	3	-	3	2	-	-	2	-	2	-
CO4	-	-	-	-	-	3	-	3	2	-	-	2	-	2	-
CO5	-	-	-	-	-	3	-	3	2	-	-	2	-	2	-
Avg.	-	-	-	-	-	3	-	3	2	-	-	2	-	2	-

Theory:

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction to Indian Constitution**	Salient features of Indian Constitution, Nature of Indian Constitution-Unitary or Federal, Preamble of Constitution, Citizenship	**10**
	Fundamental Rights-I	Definition of State (Article-12), Laws inconsistent with Fundamentals Rights (Article-13), Right to Equality (Article 14-18)	**10**
Unit-2	**Fundamental Right-II**	Freedom of speech & Expression (Art 19), Protection in respect of conviction of offences (Art 20), Protection of Life & Personal Liberty (Art21), Safeguards against arbitrary arrest & detention (Art 22)	**10**
	Fundamental Right-III	Right against Exploration (Art 23-24), Right to Freedom of Religion (Art 25-28). Cultural & Educational Right (Art 29-30). Right to Constitutional remedies(Art 32-35)	**10**
	Directive Principles &Fundamental Duties	Directive Principles of State Policy (Art 36-51), Fundamental Duties (Art 51A), Basic Features of Constitution & Procedure for Amendment of Constitution	**08**
			Total = 48

Recommended Books:

1. N.Shukla, Constitution of India, Eastern Book Agency, 2014
2. P.Jain Indian Constitution Law, Lexis Nexis, 2013
3. D. Basu, Introduction to Indian Constitution, of India (20th Ed.2009)
4. M.Seervai, Constitutional Law of India, Universal Law Publishing Co. Reprint 2013
5. Glanville Austin, Indian Constitution -cornestone of the Nations, Oxford University Press, 1999
6. M.Bakshi The constitution of India, Universal Law Publishing Co 2014
7. D.Basu shorter Constitution of India (14th Ed.2008, reprint 2010)

Title of the course : **Numerical and Statistical Methods**
Subject Code : **BSMA– 501**

L	T	P	Credits	Weekly Load (hrs)
3	0	0	3	3

COURSE OUTCOMES:

The course aims to shape the attitudes of learners regarding the field of statistics. Specifically, the course aims to motivate in students an intrinsic interest in statistical thinking and Instil the belief that statistics is important for scientific research.
Upon completion of this course, the student will be able to:

CO1: Understand the concept of errors in numerical methods.
CO2: Find the roots of equations using different methods and discuss the convergence of the solution.
CO3: Understand the concept of different operators and their applications in solving numerical differentiation and integration.
CO4: Solve numerically ordinary differential equations of first order.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	2	3	2	3	3	2	2	3	1	2
CO2	3	3	3	3	2	2	3	2	3	3	2	2	3	2	2
CO3	3	3	3	3	2	2	3	2	3	3	2	2	3	1	3
CO4	3	3	3	3	2	2	3	2	3	3	2	2	3	1	2
Avg.	3	3	3	3	2	2	3	2	3	3	2	2	3	1.25	2.25

Theory:

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Errors and Solution of Equations**	Errors in arithmetic operations and functions: Round-off error, truncation error, absolute error, relative error, percentage error. Intermediate value property, Descartes Rule of signs. Bisection method, Method of false position, Secant Method, Newton-Raphson method, Iteration method. Convergence of these methods. Gauss Elimination method (with and without partial pivoting). Jacobi, Gauss-Seidel methods.	**10**
	Finite Difference and Interpolation	Finite differences: forward, backward and central differences, Shift and averaging operators, Newton's forward, backward and divided difference interpolation formulae, Lagrange's formula.	**6**
	Numerical differentiation, integration and solution of ODEs	Numerical differentiation using Newton's forward and backward difference formulae. Numerical integration: Trapezoidal rule, Simpson's one third and three-eighth rules. Error in integration. Solution of ODE of first order: Taylor series method, Picard's method, Euler method, Modified Euler's method and Runge-Kutta methods.	**7**
Unit-2	**Curve fitting**	Curve fitting by the method of least squares: fitting of straight lines, second degree parabolas and more general curves.	**5**

	Statistics	Measures of central tendency, measures of dispersion, coefficient of variation, relation between measures of dispersion, moments, skewness, kurtosis, Karl Pearson coefficient of correlation.	**8**
	Probability	Definition of probability, laws of probability, Baye's theorem, Random variable, Mathematical Expectation, Moment generating function, Probability distributions: Binomial, Poisson and Normal.	**9**
			Total = 45

Recommended Books:

1. S.S. Sastry, Introductory Method of Numerical Analysis, PHI (2005).
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computations, New Age International (2007).
3. B. S. Grewal, Numerical Methods in Engineering & Science, Khanna Publishers, 2011.
4. S.C. Gupta & V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons(2014).
5. A. M. Goon, M. K. Gupta and B. Dasgupta, An Outline of Statistical Theory, Vol. I , World Press Pvt. Ltd (2013).
6. S. P. Gupta, Statistical Methods, S. Chand & Co., 43rd Edition, 2017

Title of the course : **Physical Metallurgy**
Subject Code : **PCME-521**

L	T	P	Credits	Weekly Load (hrs)
2	0	0	2	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand crystal structure, solid solutions, solubility limit, diffusion in solids and phase diagrams.

CO2: Learn about the plastic deformation and work hardening effects, crystal defects, slip & twinning, and strengthening mechanisms.

CO3: Learn about the allotropic transformation of iron and steel, Iron carbon equilibrium diagram.

CO4: Learn about the principles of heat treatment and capable of deciding/selecting a suitable heat treatment process for a given application.

CO5: Develop an understanding of principles of various surface hardening process and their respective applications.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	2	2	3	3	2	2	1	2	2	1	2
CO2	3	2	3	2	2	2	2	2	3	2	2	2	2	2	1
CO3	3	3	3	3	2	2	3	2	2	3	2	2	1	2	3
CO4	3	2	3	2	3	2	2	3	2	3	1	2	2	1	2
CO5	3	3	3	3	2	2	1	3	2	2	1	3	2	1	3
Avg.	3	2.4	3	2.4	2.2	2	2.2	2.6	2.2	2.4	1.4	2.2	1.8	1.4	2.2

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Structure of solids**	Introduction to metals, non-metals and alloys, crystal structure, solid solutions and its types, component, solubility limit, diffusion in solids.	**06**
	Plastic deformation and work hardening	Crystal defects and their classifications, edge and screw dislocations, stress strain relationship, plastic deformation by slip & twinning, review of strengthening mechanisms.	**08**
	Phase Transformation I	Phase diagram: Introduction, importance and objectives of phase diagram, Allotropic transformation of iron and steel, cooling curves of pure metal alloys, Gibbs's phase rule, Lever rule, common types of phase diagram: eutectic and eutectoid systems, peritectic and peritectoid systems, Properties of austenite, ferrite, pearlite, martensite.	**10**
Unit-2	**Phase Transformation II**	Introduction, Nucleation and Growth, Ingot structure, solidification and crystallization, recovery, re-crystallization and grain growth, Iron carbon equilibrium diagram, Transformation of austenite to pearlite, Transformation of austenite at constant temperature: time temperature transformation(TTT), continuous cooling transformation (CCT).	**10**
	Heat Treatment	Heat Treatment: Principles, purpose, classification of heat treatment processes, annealing, normalizing, stress relieving, hardening, tempering. hardenability.	**08**
	Surface Hardening	Carburizing: Gas, Pack, Liquid, Nitriding, cyaniding, flame and induction hardening. Surface hardening applications.	**06**

Total=48

Recommended Books:

8. Yuri Lakhtin, Engg. Phy. Metallurgy &Heat Treatment, Mir Publishers
9. Donalk S Clark, Physical Metallurgy, East West Press
10. Raghvan, Material Science and Engineering, PHI Publishers
11. Rajan and Sharma, Heat treatment principles and applications, PHI Publishers
12. Anil Kumar Sinha, Physical metallurgy handbook,McGRAW Hill Publishers

Title of the course : **Kinematics of Machines**
Subject Code : **PCME-522**

L	T	P	Credits	Weekly Load (hrs)
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to

CO1: Study of working and analyzing various machines and mechanisms based on the prior knowledge of mathematics and sciences.
CO2: Formulate the mechanism for the solution to simple and complex engineering problems w.r.t society and environment
CO3: Design the cam for transmission of desired motion in various industrial applications using modern tools.
CO4: Analyze the mechanism for optimal power transmission which results in minimizing the loss of energy leading to sustainable development.
CO5: Design a machine consists of various mechanism and power transmission systems.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
CO1	3	3	1	1	-	1	1	1	-	-	1	2	3	-	-
CO2	1	2	3	3	2	3	3	2	2	2	2	2	3	2	2
CO3	2	2	3	3	3	2	2	2	2	2	2	2	2	1	2
CO4	2	2	2	2	2	3	3	3	2	2	2	2	2	1	2
CO5	1	2	2	2	3	2	2	2	3	3	3	3	3	3	2
Avg.	1.8	2.2	2.2	2.2	2.5	2.2	2.2	2	2.25	2.25	2	2.2	2.6	1.75	2

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Review of Mechanism & Machine**	Concepts and classification of links, pairs, kinematic symbols, kinematic chains, plane motion; Constraints and degrees of freedom, mechanism and machines, inversion, conversion of mechanisms.	**07**
	Kinematic Analysis	Kinematic quantities and their relationships, absolute and relative motions and their vector representation, instantaneous centers, Kennedy's theorem; Relative velocity method, method of instantaneous centres, resolution and orthogonal velocity methods; Acceleration analysis, Coriolis acceleration, mathematical analysis of slider crank mechanism, special graphical methods; Klein's construction, Ritterhau construction & Bennet construction for velocity & acceleration analysis of single slider crank mechanism.	**10**
	Cams	Classification, types of motion curves and their analytical expressions, graphical construction of cam profiles for different types of followers, pressure angle and cam size, cams with specified contours.	**07**
Unit-2	**Gears and Gear Train**	Introduction, Classification. Terminology. Law of Gearing Spur Gear; velocity of sliding in mating teeth. Involute and Cycloidal teeth & their construction and comparison. Involute	**10**

		Profile Gears; Length of path of contact, Contact Ratio, Interference, number of teeth on wheel, pinion & rack to avoid interference. Introduction to helical and worm gears. Introduction of simple, compound, reverted, epicyclic gear train & compound epicyclic gear train. Applications of various gear trains.	
	Belt, Rope & Belt Drive	Introduction, flat and V-belt drive, velocity ratio, Creep, slip in belt drive, velocity law, compression in belt, tension in belt, and angle of contact, power transmission. Belt, chain and rope drive.	**08**
	Applied Linkages	Radial engines and mater crank, straight line motion and indicator mechanisms, steering mechanisms, quick return mechanisms, intermittent motion mechanisms, Geneva mechanism, analog computing mechanisms, various types of ingenious mechanisms and their functioning	**06**
			Total=48

Recommended Books:

1. Martin, G.H., “Kinematics and Dynamics of Machines”, McGraw-Hill,
2. Ghosh, A., and Mallik, A.K., “Theory of Mechanisms and Machines”, Affiliated East-West Press,
3. Bevan, T., “Theory of Machines”, 3rd Ed., CBS Publishers.
4. Vicker, J.J., Shigley, J.E., and Penock, G.R., “Theory of Machines and Mechanisms”,.Oxford University Press,.
5. Hannah, J., and Stephens, R.C., “Mechanics of Machines: Elementary Theory and Examples”, Viva Books,
6. Rattan S.S., “Theory of Machines”, TMH, New Delhi,

Title of the course : **Strength of Materials**
Subject Code : **PCME-523**

L	T	P	Credits	Weekly Load (hrs)
3	1	0	4	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Determine the simple stresses and strains when members are subjected to axial loads.

CO2: Draw the Mohr's circle for stress & strains and shear force and bending moment diagrams for the beam subjected to different loading conditions

CO3: Evaluate stresses induced in different cross-sectional members subjected to shear loads tension, compression, torsion, bending, and combined stresses using the fundamental concepts of stress, strain, and elastic behavior of materials.

CO4: Evaluate & analyze the deflections in beams subjected to different loading conditions

CO5: Perform engineering work in accordance with ethical and economic constraints related to the analysis of shafts and thin cylinders & shells, springs, columns & struts.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	2	2	2	3	3	2	2	3	2	1	2
CO2	3	3	3	2	2	1	2	2	3	2	2	3	1	2	1
CO3	3	3	2	3	2	1	2	2	2	2	2	3	2	1	1
CO4	3	3	3	3	2	2	2	2	2	2	2	3	1	1	2
CO5	3	3	3	3	2	2	2	3	2	2	2	3	2	1	1
Avg.	3	3	2.6	2.8	2	1.6	2	2.4	2.4	2	2	3	1.6	1.2	1.4

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Properties Of Material**	Introduction, uni-axial tension test, idealized stress-strain diagrams, isotropic linear elastic, visco-elastic and plastic materials, compression test, impact test, fatigue test, torsion and bending test.	**03**
	Simple Stress & Strain	Concept of stresses and strains, relationship between elastic constants, stresses and strains in bars subjected to axial loading, in compound bars. Temperature stress and strain due to axial loads and variation of temperature Extension of uniform bar & tapered bar under its own weight and due to load applied	**04**
	Compound Stresses and Strain	Twodimensional stress at a point on a plane, principal stresses and principal planes, Mohr's circle & ellipse of stress, and their applications. Two dimensional strain systems, principal strains, circle of strain, Principal stresses determined from principal strain.	**04**
	Shear Force and Bending Moment In Beams	Shear Force and Bending Moment diagram of beams under various types of loading for cantilevers, simply supported and fixed beams with or without overhangs. Relation between unit load, Force and Moment. Calculation of maximum BM and SF and the point of contra	**08**

		flexure under concentrated loads, uniformly distributed loads over the whole span or part of span, combination of concentrated loads (two or three) and uniformly distributed loads, uniformly varying loads, application of moments.	
	Theory of bending stresses	simple bending theory, derivation of bending formula: its application to beams of various sections (rectangular, circular and channeletc.) Shear Stresses- Derivation of formula ,Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle sections, Composite beams, bending and shear stresses in composite beams	**06**
Unit-2	**Slope & Deflection of Beams**	Relationship between moment, slope and deflection. Deflection by Macaulay's methods, Moment area method, method of deflection coefficient	**06**
	Torsion	Derivation of torsion equation, applications. Torsion equation for hollow and solid circular shafts, Torsional rigidity. Combined torsion and bending of circular shafts, Analysis of close-coiled-helical springs under axial loading	**04**
	Thin Cylinders and Spheres	Introduction, hoop stress, longitudinal stress in thin cylinder and sphere subjected to internal pressures	**03**
	Columns and Struts	Definitions and examples of instability; criteria for stability of equilibrium, Buckling of Columns, Euler's theory of columns, Slenderness ratio. Equivalent length. Columns under uni-axial load, buckling, Euler's equation for various end restraints, Rankine formula, eccentrically loaded struts. Rankine Gordon's empirical formula	**08**

Total=46

Recommended Books:

1. Popov, Mechanics of Solids, PHI Publishers
2. Sadhu Singh, Strength of Materials, Khanna
3. Ryder G.H, Strength of Materials,ELBS
4. Gambhir, Mechanics of Solids,PHI
5. R. S. Lehri, Strength of Materials, Kataria
6. Pytel A H and Singer F, Strength of Materials, Harper Collins, New Delhi

Title of the course : **Biology for Engineers**
Subject Code : **BSBL- 501**

L	T	P	Credits	Weekly Load (hrs)
2	0	0	2	2

COURSE OUTCOMES:

On successful completion of the subject, the students will be able to

CO1 Learn about correlation between biological science and engineering.
CO2 Understand about the concept of microbiology, genetics, and macromolecules.
CO3 Learn the techniques of microbiological enumerations, food spoilage and preservation.
CO4 Familiarize with economic aspects of biological intervention.
CO5 Familiarize with various aspects of metabolic pathways.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	2	3	3	1	3	3	3	3	1	3	1	2
CO2	3	3	1	3	3	3	3	3	3	3	3	2	2	2	2
CO3	1	3	3	2	3	3	3	3	3	3	3	1	3	2	3
CO4	1	3	2	1	3	1	3	3	3	3	3	3	3	2	2
CO5	3	3	3	3	3	3	3	3	3	1	3	3	2	2	2
Avg.	2	2.6	2.2	2.2	3	2.6	2.6	3	3	2.6	3	2	2.6	1.8	2.2

Theory:

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction**	Importance of biology in engineering, development of technological subjects imitating nature's biological entity, major discoveries in biology, economic aspects of biology in exploitation.	**2**
	Classification	Concept of scientific classification of living entity, discuss the classification (with suitable example) based on: (a) cellularity- unicellular and multicellular (b) ultrastructure- prokaryotes and eukaryotes (c) energy and carbon utilization- autotrophs, heterotrophs and lithotrophs (d) ammonia excretion- aminotelic, uricotelic and ureotelic (e) molecular taxonomy- three major kingdoms of life, classification of microorganisms based on: (a) temperature (b) salt concentration (c) oxygen requirement	**4**
	Genetics	Concept of genetics, Mendel's laws, segregation and independent assortment, allele, meosis and mitosis, recessiveness and dominance, how genetic material passes from parent to offspring, difference between phenotypic and genotypic characteristics, DNA fingerprinting, exploitation of genetics in crop improvement and microbial potential towards fermentation/ fermented product.	**4**
	Microbiology	Microorganisms, classification of microorganisms, techniques such as serial dilution, pour plating, streak plating, spread plating, nutrient agar and broth. Techniques for enumeration of bacteria, growth kinetics, concept of food spoilage and preservation technique.	**5**
Unit-2	**Biomolecules**	Biomolecules as building blocks of biological subjects, introductory information about carbohydrates, proteins, nucleotides, and DNA/RNA, structure of protein (primary, secondary,	**4**

		tertiary, quaternary), structure of selected monosaccharides (glucose, fructose), disaccharides (sucrose, maltose) and polysaccharides (starch, cellulose).	
	Enzymes	Enzyme, enzymology, role of enzymes in biological system, mechanism of enzymatic action, role of prosthetic group, co-factor and co-enzymes in enzymatic reactions, classification of enzymes, application of enzymes in: (a) juice clarification (b) meat tenderization (c) enzymatic browning.	**4**
	Metabolism	Concept of thermodynamics and application in biological system, photosynthesis, glycolysis, Krebs cycle, exothermic and endothermic reactions, endergonic and exergonic reactions.	**5**
			Total=28

Recommended Books:

1. Neil A. Campbell, Biology: A global approach
2. Eric E Conn, Outlines of biochemistry
3. Prescott, Microbiology
4. Gunther S. Stent, Molecular genetics

Title of the course : **Numerical and Statistical MethodsLab**
Subject Code : **BSMA– 502**

L	T	P	Credits	Weekly Load (hrs)
0	0	2	1	2

COURSE OUTCOMES:

The course aims to shape the attitudes of learners regarding the field of statistics. Specifically, the course aims to motivate in students an intrinsic interest in statistical thinking and Instil the belief that statistics is important for scientific research.
Upon completion of this course, the student will be able to:

CO1: Understand the concept of errors in numerical methods.
CO2: Find the roots of equations using different methods and discuss the convergence of the solution.
CO3: Understand the concept of different operators and their applications in solving numerical differentiation and integration.
CO4: Solve numerically ordinary differential equations of first order.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	2	3	2	3	3	2	2	3	1	2
CO2	3	3	3	3	2	2	3	2	3	3	2	2	3	2	2
CO3	3	3	3	3	2	2	3	2	3	3	2	2	3	1	3
CO4	3	3	3	3	2	2	3	2	3	3	2	2	3	1	2
Avg.	3	3	3	3	2	2	3	2	3	3	2	2	3	1.25	2.25

List of Programmes:

1. Finding roots of the equation $f(x) = 0$ using
   i) Bisection Method ii) Secant Method iii) Method of false position
2. Finding roots of the equation $f(x) = 0$ using
   i) Iterative Method ii) Newton - Raphson's Method
3. To check consistency and finding Solution of a system of linear algebraic equations using
   i) Gauss elimination Method ii) Gauss - Seidal Method iii) Jacobi Method
4. Interpolation using
   i) Newton's forward difference formula ii) Newton's backward difference formula
5. Interpolation using
   i) Newton's divided difference formula ii) Lagrange's interpolation formula
6. Numerical differentiation using
   i) Newton's forward interpolation formula ii) Newton's backward interpolation formula
7. Numerical Integration using
   i) Trapezoidal rule ii) Simpson's 1/3rd rule
   iii) Simpson's 3/8th rule
8. Solution of Ist order ordinary differential equations using
   i) Taylor's series method ii) Picard's method
   iii) Euler's method iv) Euler's modified method
9. Solution of Ist order ordinary differential equations using Runge-Kutta methods.

10. Fitting a curve using given data.
    i) linear curve
    ii) quadratic curve
    iii) cubic curve
    iv) any other
11. Finding the following, using given data:
    i) mean, median and mode.
    Ii) standard deviation and mean deviation.
    iii) moments, skewness and kurtosis of various order.
    Iv) rank correlation.

Title of the course : **Kinematics of Machines Lab**
Subject Code : **PCME-524**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:
After successful completion of course, the students should be able to

CO1: Understand the various mechanism and its inversions for application in different machines.
CO2: Understand the different types of cams and follower as per specific outcomes.
CO3: Construct the different cam profiles for transmission of desired motion in various industrial applications using modern tools.
CO4: Understand the different types of gear and gear trains for transmission of motion and energy in various machine parts.
CO5: Construct the cycloidal and involute gear profiles for transmission of flawless energy and motion.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	1	1	1	2	1	2	1	3	3	1	1
CO2	3	3	2	1	1	2	2	2	1	2	1	2	2	1	1
CO3	2	3	3	3	3	2	2	3	3	2	3	3	2	1	2
CO4	3	3	2	1	1	2	2	2	1	2	1	2	2	1	1
CO5	2	3	3	3	3	2	2	3	3	2	3	3	2	1	2
Avg.	2.6	3	2.4	1.8	1.8	1.8	1.8	2.4	1.8	2	1.8	2.6	2.2	1	1.4

List of Experiments:

1. Study of kinematic pairs and kinematic chain.
2. Study of different kinds of planar mechanism; four bar mechanism, single slider crank mechanism, double slider mechanism.
3. Construction of velocity and acceleration diagram for planar mechanism.
4. Demonstration of different kinds of CAM and Follower arrangements.
5. Construction of CAM with different types of followers for various kind of motion.

a. Knife edge follower with various kind of motion.
b. Roller follower with various kind of motion.
c. Flat faced follower with various kind of motion.
d. Spherical faced follower with various kind of motion.

6. Demonstration of different types of Gears.
7. Generation of profile of Gear teeth

a. For Involute profile
b. For Cycloidal profile.

8. Demonstration of different type of gear trains.

Title of the course : **Strength of Materials Lab**
Subject Code : **PCME-525**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Apply the basic concepts and principles of strength of materials.

CO2: Calculate stresses and deformations of the objects under different loadings.

CO3: Analyze and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials.

CO4: Utilize appropriate materials in design considering engineering properties, sustainability, cost and weight.

CO5: Perform engineering work in accordance with ethical and economic constraints related to the design of structures And machine parts.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	2	2	2	3	3	2	2	3	1	2	3
CO2	3	3	3	2	2	1	2	2	3	2	2	3	1	2	1
CO3	3	3	2	3	2	1	2	2	2	2	2	3	2	1	1
CO4	3	3	3	3	2	2	2	2	2	2	2	3	1	1	2
CO5	3	3	3	3	2	2	2	3	2	2	2	3	2	1	1
Avg.	3	3	2.6	2.8	2	1.6	2	2.4	2.4	2	2	3	1.4	1.4	1.6

List of Experiments:

1. Tension test.
2. Bending tests on simply supported beam / Cantilever beam.
3. Torsion test.
4. Hardness tests (Brinell and Rockwell).
5. Tests on close coiled and open coiled Helical springs.
6. Compression test on wood or concrete.
7. Impact test.
8. Shear test.
9. Fatigue Test.

Title of the course : **Machine Drawing**
Subject Code : **PCME-526**

L	T	P	Credits	Weekly Load
0	0	4	2	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Identify the concept of basic engineering drawing

CO2: Understand and represent a machine component or machine by lines according to certain set rules

CO3: Understand and apply the knowledge of machine drawing as a system of Communication in which ideas are expressed clearly and all information fully conveyed.

CO4: Apply the techniques, skills and modern engineering tools necessary for creating and assembling with the concept of virtual work.

CO5: Design a system, component or process to meet desired needs within, realistic constraints such as manufacturability, economic, environmental, safety & sustainability etc. to represent the part drawing and assembly drawings.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	2	1	1	2	2	2	3	2	1	2	1
CO2	3	3	3	2	3	1	1	3	2	2	2	3	2	2	1
CO3	3	2	2	2	3	1	1	2	2	3	3	3	1	3	2
CO4	3	3	3	2	2	1	2	3	2	2	3	3	1	1	2
CO5	3	3	3	2	2	2	2	2	2	2	2	3	1	1	3
Avg.	3	2.6	2.6	2	2.4	1.2	1.4	2.4	2	2.2	2.6	2.8	1.2	1.8	1.8

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Basics of Machine Drawing**	Machining symbols, surface finish characteristics, surface roughness symbols, limits, fits and tolerances.	**04**
	Fasteners	Drawings of various views of Screw threads, metric and BSW threads, Square thread and multi start threads. Nut, bolt and washer; types of nuts, types of bolts.	**06**
	Welded Joints	Types of welded joints, representation of a welds, welding symbols according to B.I.S.	**08**
Unit-2	**Keys, Cotters and Joints**	Introduction, proportions of a key, types of keys and their applications. A Cotter and a Gib with their uses. Types of joints used for connecting rods.	**08**
	Rivets and Riveted Joints	Types of rivets, types of riveted joints, general terms/rules used for riveted joints.	**08**
	Assembly and detail drawings	One assembly drawings of a Tail stock, details (drawings of different elements) of a screw jack assembly.	**14**

Total = 48

Recommended Books:

1. N D Bhatt, Machine Drawing, Khanna Publishers
2. P S Gill ,Machine Drawing, Standard Publishers
3. R.K. Dhawan ,MachineDrawing,S. Chand Publishers
4. Goutam Pohit& Goutam Ghosh, Machine Drawing, Pearson Education Publishers

Title of the course : **Physical Metallurgy Lab**
Subject Code : **PCME 527**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understanding crystal structure, solid solutions and its types, component, solubility limit, diffusion in solids.

CO2: Learning about the Crystal defects and their classifications, edge and screw dislocations, stress strain relationship, plastic deformation by slip & twinning, review of strengthening mechanisms.

CO3: Need and importance of phase diagram, unary & binary phase diagrams, Allotropic transformation of iron and steel, analysis of phase diagrams, Iron carbon equilibrium diagram.

CO4: Select a suitable heat treatment process for a given application.

CO5: Understand various hardening process.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	2	2	3	3	2	2	1	2	2	1	2
CO2	3	2	3	2	2	2	2	2	3	2	2	2	2	2	1
CO3	3	3	3	3	2	2	3	2	2	3	2	2	1	2	3
CO4	3	2	3	2	3	2	2	3	2	3	1	2	2	1	2
CO5	3	3	3	3	2	2	1	3	2	2	1	3	2	1	3
Avg.	3	2.4	3	2.4	2.2	2	2.2	2.6	2.2	2.4	1.4	2.2	1.8	1.4	2.2

List of Experiments:

1. Introduction to the crystal lattice of solids.
2. Familiarization and specimen preparation with the following examinations
   i. Macro examination of specimens of ferrous materials.
   ii. Micro examination of specimens of ferrous materials
   iii. Macro examination of specimen of non-ferrous material.
   iv. Micro examination of specimen of non-ferrous material.
3. To carry out microstructural studies on different steel specimens e.g. cast specimens, welded specimens etc.
4. Study the effect of varying cooling rate on the microstructure of steel and comparing in terms of grain size and mechanical properties.
5. To carry out following heat treatments of the given steel specimen
   i. Annealing.,
   ii. Normalizing
   iii. Hardening
6. To conduct following case hardening treatment of the given specimen.
   i. Carburizing.
   ii. Flame hardening.

7. Analysis of the microstructural changes in the specimens after giving different heat treatments as above

Title of the course : **Machine Design-I**
Subject Code : **PCME-611**

L	T	P	Credits	Weekly Load
3	1	0	4	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Apply the theories of failure in design of machine elements.
CO2: Analyse and design of boiler joint based on application.
CO3: Design the temporary and permanent joints such as welding, riveted, screw joint.
CO4: Design a machine element such as shaft under dynamic loading.
CO5: Identify and suggest appropriate rolling contact bearing, gasket and seal from the standard catalogue based on loads.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	3	2	2	2	2	2	2	2	2	2	1	1
CO2	2	3	3	3	2	2	2	2	2	2	3	2	2	3	1
CO3	2	2	2	3	2	2	2	2	3	2	2	2	1	3	2
CO4	2	3	2	2	2	2	2	2	2	2	2	2	2	1	2
CO5	3	3	3	2	2	2	3	2	3	2	2	3	1	1	1
Avg.	2.4	2.6	2.6	2.6	2	2	2.2	2	2.4	2	2.2	2.2	1.6	1.8	1.4

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction**	Introduction to design procedure, design requirements, review of force analysis concepts, factor of safety concepts, concept and mitigation of stress concentration, material selection and mechanical Properties. General design considerations like fatigue, creep, fabrication methods, economic considerations, material selection and ergonomics.	**04**
	Riveted & Welded Joint	Type of riveted joints. Possible failure of riveted joints. Strength and efficiency of Butt (Single plate & double cover plate) and Lap riveted joints. Design of Boiler joints and pressure vessels, Joint of Uniform strength, Axially and eccentrically loaded riveted joint. Common types of welded joints. Design for V-butt welded joints. Transverse fillet and parallel fillet welded joint. Axially and eccentrically loaded welded joint.	**07**
	Screwed Joint	Introduction to term screw and various definitions of screw threads. Advantages and Disadvantages of screwed joints. Form of screw threads. Bolts of Uniform strength. Bolted joint for eccentric loading. Common types of screw fastening; through bolt, tap bolt, stud, cap screw, machine screw and set screw. Designation of screw threads. Stresses in screw fastening. Design of bolts for cylindrical cover	**07**
	Power Screw	Power to screw drive, efficiency of screw like square, trapezoidal threads, stresses in screw and design procedure of screw Jack. Condition for self locking.	**06**
Unit-2	**Cotter Joint and Knuckle Joint**	Design of cotter. Design of Socket. Design of Spigot. Design of knuckle joint; Design of rod. Design of Pin.	**07**

	Shafts	Design for static and dynamic loading; stresses in shaft, design of shaft subjected to bending moment or torsion moment and combined bending and torsion moments, shafts subjected to axial load in addition to combined bending and torsion moments failure theories; shafts subjected to fluctuating load conditions, cyclic loading, endurance limit, Soderberg, Gerber & Goodman diagrams, fatigue strength and the S-N diagram, Design of shaft on the basis of rigidity.	**10**
	Bearings	Classification of bearing; Design, Specification and selection of Journal bearing, rolling contact bearing for given application.	**07**
			Total=48

Recommended Books:

1. Shigley, J.E., and Mischke, C.R., "Mechanical Engineering Design (in S.I. Units)", 6th Ed., Tata McGraw-Hill, 2006.
2. Juvinall, R.C., and Marshek, K.M., "Fundamentals of Machine Component Design", 4th Ed., John Wiley & Sons, 2006.
3. Sharma & Aggarwal, "A Text book of Machine Design" Katson.
4. Machine Design-An Integrated Approach, Norton, Pearson Education.
5. Mahadevan, K., and B., Reddy, "Design Data Hand Book", CBS Publishers, 2003.
6. P. S. G, "Design data handbook", P. S. G., Coimbatore.

Title of the course : **Measurements and Instrumentation**
Subject Code : **PCME-612**

L	T	P	Credits	Weekly Load
2	1	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Access the suitability of measuring instruments, their calibration and use of standard measurement practices.
CO2: Understand the basic principle of sensing in measurement of physical quantities and automation of instruments.
CO3: Understand the basics of micron and submicron level measurements by mechanical and optical methods and latest development in such measurements.
CO4: Use and develop sustainable measurement systems for shop floor.
CO5: Handle various measuring instruments

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	1	1	1	1	2	1	1	3	2	1	1
CO2	3	3	2	2	3	1	1	1	2	3	1	3	2	3	1
CO3	3	2	2	1	3	1	1	1	1	3	2	2	1	3	2
CO4	2	2	3	2	1	1	1	1	2	1	2	2	2	1	2
CO5	2	2	2	1	1	1	1	1	1	1	1	2	1	1	1
Avg.	2.6	2.2	2.2	1.6	1.8	1	1	1	1.6	1.8	1.4	2.4	1.6	1.8	1.4

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction**	Introduction, methods of measurement, measurements in design, factors in selection of measuring instrument, measurement systems, time element in measurement, error in measuring instruments, temperature problem, static & dynamic characteristics of measuring instruments, calibration, errors, classification, system error analysis, theoretical relationships.	**07**
	Standard of Measuremens	Introduction, legal status, present measurement system & its advantage over previous system, standard of length, mass, time, temp. etc.	**05**
	Displacement &Dimensional Measurement	Problems of dimensional measurement, gauge block, surface plate, temp problem etc., use of different type of comparators, optical method, application of monochromatic light & optical flats, use of optical flats & monochromatic light for dimensional comparison, interferometer.	**07**
	Surface Testing &Measurement	Surface roughness, definition, various methods to measure surface roughness, different instruments used for measuring surface roughness, roughness standard.	**05**
Unit-2	**Speed Measurement**	Introduction, use of counters, stroboscope, direct application of frequency standard by comparative methods, calibration of frequency sources, tachometers: different types-mechanical, electrical, frequency tachometer etc.	**06**

	Stress Strain Measurements & Strain Graphs	Introduction, mechanical strain gauges, optical strain gauges, electrical strain gauges, stress measurement by variable resistance strain gauge, sensing element materials, forms of strain gauge sensing elements, strain gauge adhesive, protective coating, strain gauge mounting techniques.	**06**
	Measurement of Force & Torque	Introduction, force measurement by using elastic transducers, strain gauges, load cells, piezo type load cells, hydraulic & pneumatic system, torque measurement: dynamometer, classification, various types and characteristics.	**06**
	Screw Thread Measurements	Errors in threads, screw thread gauges, measurement of elements of the external & internal threads using caliper gauges, various other methods to measure screw thread parameters	**03**
	Spur Gear Measurement	Geometry of spur gear, measurement of various spur gear parameters like: run out, pitch, profile, lead, backlash, tooth thickness, various other methods to measure spur gear parameters.	**03**

Total=48

Recommended Books:

1. Nakra& Chaudhary, Instrumentation, Measurement & Analysis; Tata McGraw Hill
2. E. O. Doebelin, Measurement Systems, Application & Design; Tata McGraw Hill
3. J.W. Dally, R.F. William and Mc Connell, Instrumentation for Engg. Measurement; John Wiley and Sons
4. K.J. Aume, Metrology & Interchange ability; McDonald and Company Ltd.
5. T. G. Beckwith, L.N. Buck and R. D. Marangoi, Mechanical Measurements; Addison Wesley Reading

Title of the course : **Power Plant Engineering**
Subject Code : **OEME-611 A**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the present scenario of energy production in India and understand the different working aspects of hydro power plant

CO2: Explain the construction detail and the working of thermodynamic cycle of the thermal as well as gas power plant

CO3: To understand the power production techniques of nuclear power plant and to apply the knowledge for power plant economics for different load situations

CO4: Explore the knowledge in the field of non-conventional power generation methods and the direct energy conversion methods

CO5: Understand the pollution effects of power generation and ways to control them for the betterment of society

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	2	2	3	2	3	2	2	2	3	2	2	1
CO2	3	3	2	2	2	2	2	2	2	3	2	3	2	3	1
CO3	3	3	3	3	2	2	2	2	2	3	3	3	1	3	2
CO4	2	2	2	2	2	3	3	3	2	2	2	3	2	1	2
CO5	2	2	2	2	2	3	3	3	2	2	2	3	1	2	1
Avg.	2.4	2.4	2.2	2.2	2	2.6	2.4	2.6	2	2.4	2.2	3	1.6	2.2	1.4

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction**	Energy resources and their availability, Present power position and future planning in India & World, Types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants. Load estimation, load curves, various terms and factors involved in power plant calculations. Effect of variable load on power plant operation, Selection of power plant units.	**03**
	Hydroelectric power plants	Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, Advantages and comparison with other types of power plants.	**05**
	Steam power plants	Flow sheet and working of modern-thermal power plants, Classification of turbine, their working and governing, analysis of Re-heat cycle, Regenerative cycle, reheat –regenerative cycle and binary cycle Turbine problems, Condenser, cooling ponds, cooling towers, Feed water treatment, site selection, coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection mechanical dust collector and electrostatic precipitator.	**08**

	Gas & Steam turbine combined cycles	Constant pressure gas turbine power plants, Arrangements of combined plants (steam & gas turbine power plants), re-powering systems with gas production from coal, using PFBC systems with organic fluids, parameters affecting thermodynamic efficiency and performance of combined cycles..	**08**
Unit-2	**Nuclear power plants**	Principles of nuclear energy, basic nuclear reactions, nuclear reactors-PWR, BWR, CANDU, Gas-cooled reactors, liquid –metal cooled reactors, organic moderated cooled reactors, fast breeder reactor, Location of Nuclear power plants, Advantages and limitations, nuclear power station, Shielding Materials, Effect of nuclear radiation, waste disposal.	**07**
	Power plant economics	Load curve, different terminology and definitions, cost of electrical energy, tariff methods of electrical energy, performance & operating characteristics of power plants- incremental rate theory, input-output curves, efficiency, heat rate, economic load sharing.	**06**
	Non-conventional power generation	Solar radiation estimation, solar energy collectors, low, medium & high temperature power plants, OTEC, wind power plants, tidal power plants, geothermal power plants.	**07**
	Direct energy conversion systems	Fuel cell, MHD power generation-principle, open & closed cycle systems, thermoelectric power generation, and thermionic power generation	**02**
	Pollution and its control	Introduction, Air and water pollution by thermal power plants, Radioactive pollution of environment by nuclear power plants, Noise pollution, Methods for reducing the pollution.	**02**
			Total=48

Recommended Books:

1. Power Plant Engineering by P.K. Nag
2. Power Plant Engineering by P.C. Sharma
3. Power Plant Engineering by M. Wakil
4. Power Plant Engineering by ARORA.S. DOMKUNDWAR

Title of the course : **AUTOMOBILE ENGINEERING**
Subject Code : **OEME-611 B**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the basic knowledge of automobile component, different systems and its performance.

CO2: Assess the basics about Automotive Engine System and fuel supply System and apply to different type of vehicles.

CO3: Understand the concept of Automobile Chassis, hydraulically operated clutch, fly wheel, and automotive brake system.

CO4: Understand about Automotive Transmission, types of gear, working of gear box and apply the knowledge to Gear selector mechanism, differentials and drive axles.

CO5: Learn the basic concepts of Automotive Electronic and Electrical Equipment and application to various parts of automobile

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	3	2	1	2	2	2	2	2	3	1	2	1
CO2	3	2	3	3	2	2	2	2	2	2	2	3	2	2	1
CO3	3	3	3	2	3	1	2	2	2	2	2	3	1	1	2
CO4	3	2	3	2	2	2	2	2	2	2	2	3	2	1	2
CO5	3	3	3	2	2	1	2	2	1	1	2	3	1	2	3
Avg.	3	2.4	3	2.4	2.2	1.4	2	2	1.8	1.8	2	3	1.4	1.6	1.8

Theory

Unit	Main Topic	Course outline	Lectures
Unit-I	**Engine fundamentals and performance.**	Introduction-Engine fundamentals, engine operations, engine type and construction. Engine measurement and performance.	**6**
	Automobile Engine Components:	Automobile Engine Components: connecting rods, rod bearings, piston rings, crank shaft, cylinder blocks, valves & valves train,	**6**
	Engine fuel supply System	Automotive engine fuels, fuel and exhaust system, carburetors, carburetor fuel system service, diesel fuel engines injection system, gasoline fuel injection system.	**6**
	Automotive Engine System	Engine lubricating system, engine cooling systems, emission control & tune up. .	**6**
Unit-II	**Automotive Chassis**	Automotive Chassis: Spring and suspension system, steering systems, automobile clutches, hydraulically operated clutch, pressure plate, fly wheel, adjusting wheel, spacing, and automotive brake system.	**8**
	Automotive Transmission:	Automotive Transmission: Gear ratio, types of gear, types of gear box, working of gear box, Gear selector mechanism, planetary type gear box, universal joints, and differentials and drive axles.	**8**

	Automotive Electronic and Electrical Equipment:	Automotive Electronic and Electrical Equipment: The automotive electrical system, starting system, central point ignition, electronic ignition system, automotive battery.	**8**

Total-48

Recommended Books:

1. Nakre;Automobile Engineering; Standard Publication.
2. Crouse;Automobile Mechanics;Tata McGraw Hill Publication.
3. Kirpal Singh;Automobile Engineering; Standard Publication.
4. Mathur & Sharma;A Text Book of IC Engine; Dhanpat Rai Publication

Title of the course : **Welding- Processes, Codes and Standards**
Subject Code : **OEME-611 C**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Apply the knowledge of welding fundamentals including the processes and their capabilities, commonly used welding codes and standards to solve welding problems.

CO2: Should be able to select a suitable welding process for a specific application and **p**repare WPS and PQR for Industrial welding applications, prepare WPS for pipeline for petroleum applications and understanding of basic testing methods for weld qualification.

CO3: Understand the impact of welding operations on environment aquire knowledge about industrial materials, welding consumables and their applications

CO4: Apply the ethical principles regarding health, safety and legal issues during operations of welding machines and Generate ethical values by knowing about welding codes and standards

Nil

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	2	2	2	3	2	2	2	1	2	2	1
CO2	3	2	3	3	2	1	2	2	2	2	3	2	1	2	1
CO3	2	2	3	2	2	2	3	1	2	2	2	3	1	2	2
CO4	3	2	3	2	2	3	3	2	2	2	2	2	2	1	2
Avg.	2.75	2	3	2.25	2	2	2.5	2	2	2	2.25	2	1.5	1.75	1.5

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Theory

Unit	Main Topic	Course outline	Lectures
Unit-I	**Introduction to Welding Processes**	Classification of welding processes and their principles in brief with applications**. Gas welding**-Principle, different gases used & their properties, types of flames, welding techniques, safety and applications, **Brazing**- Difference between brazing and soldering, braze welding, wetting and spreading characteristics, brazing and soldering consumables, application of brazing and soldering.	**6**
	Arc welding	**SMAW process**-welding arc, arc starting methods, arc stability, arc efficiency, arc blow, power sources, VI characteristics of power source, electrode polarity, duty cycle, classification and coding of SMAW electrodes. **GTAW process-** Gas tungsten arc welding- Principle, equipment and welding parameters, polarity, shielding gases and their effect, advantages, disadvantages and applications of the process. **GMAW process-** Gas metal arc welding- principle, equipment, process variables, shielding gases and their effect on bead geometry, applications of the processes.	**10**
	Submerged arc welding and	**Submerged arc welding-** Principle, equipment used, welding parameters, SAW fluxes, classification, flux- wire combination, multi wire, strip cladding and narrow gap welding applications of the process. Resistance welding-Basic principle, brief	**8**

	Resistance Welding	introduction to spot, seam, projection and flash butt welding, welding variables, resistance welding equipment, heat balance, applications.	
Unit-II	**Weld Joints and welding symbols**	Types of weld joints, Types of welds, Essential elements of a basic welding symbol, Primary and secondary weld symbols, various information and location of this information on welding symbol.	**4**
	Pressure vessel fabrication and consumable standards	Introduction to ASME section VIII- division I, fabrication methods, joint categories, welding and inspection requirements, post weld heat treatment and hydro-testing. Introduction to ASME section II part A and C; introduction to base materials and consumables standards, consumables testing and qualification as per ASME/AWS requirements.	**8**
	Welding procedure specifications (WPS) and Indian Boiler Regulations (IBR)	Introduction to ASME section IX; introduction to Welding Procedure Specification (WPS)- essential, non-essential and supplementary essential variables, procedure qualification, Procedure Qualification Records (PQR); welders performance qualification, welder and welding operator. Introduction to IBR-1950, workmanship for fabrication of shell type welded boilers, qualification and requalification of welders to be engaged for welding of boilers.	**8**
	Cross Country Pipe line Welding	Introduction to API 5L welding code, Process and product standards for manufacturing of pipes, welding procedure and welder qualification, field welding and inspection requirements.	**4**

Total-48

Recommended Books:

1. Welding Processes and Technology by R.S Parmar (Publisher: Khanna Publishers)
2. Modern Arc Welding Technology by S.V. Nadkarni (Publisher: Oxford & IBH)
3. Modern Arc Welding Technology by Hobart B. Cary (Publisher; Prentice Hall Cambridge Univ. Press)
4. Indian Boiler Regulations-1950
5. API 5L
6. ASME Section VIII - Division 1
7. ASME Section IX
8. ASME Section II Part A and Part C

Title of the course : **Refrigeration and Air Conditioning**
Subject Code : **OEME- 612 A**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the operation of vapour comperation and vapur absorption system.
CO2: Analyze the refrigeration cycles and methods of improving performance.
CO3: Familiarize the components of refrigeration systems.
CO4: Design air-conditioning system using cooling load calculations.
CO5: Identify the applications of refrigeration and air-conditioning systems.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	2	2	2	2	2	2	2	3	2	2	1
CO2	3	3	2	2	2	2	2	2	2	2	2	3	1	2	1
CO3	3	2	2	3	2	2	2	2	2	2	2	2	1	2	2
CO4	3	2	3	2	2	2	2	2	2	2	2	2	2	1	2
CO5	3	2	2	2	2	2	2	2	2	2	2	2	1	2	3
Avg.	3	2.2	2.2	2.2	2	2	2	2	2	2	2	2.4	1.4	1.8	1.8

Theory

Unit	Main Topic	Course out line	Lectures
Unit-I	**Air Refrigeration Systems**	Introduction, types of air refrigeration systems, reversed control cycle, Bell Coleman air refrigerator, Necessity of air-craft refrigeration, regenerative and reduced ambient type cycles, compression and bootstrap cycle.	**12**
	Refrigeration Systems	Vapor compression refrigeration system,T-S,H-S,P-H diagram for VCR, COP. Performance of VCR, advantages and disadvantages, Methods for improving COP, Multiload system, Single and multi compressions. Introduction, actual aqua ammonia absorption system, electrolux refrigerator, COP Compression between VCR and absorption refrigeration system.	**12**
Unit-II	**Refrigerants and Refrigeration Equipments**	Classifications of refrigerants, properties of ideal refrigerants, anti-freeze solutions, selection of refrigerants, nomenclature of refrigerants. Ozone layer depletion, eco-friendly refrigerants.Construction details of different types of compressors, condensers, evaporator, expansion devices, dehydrators	**12**
	Air Conditioning Systems	Types of air-conditioning systems, central AC, unitary AC load circulation load calculation based on various parameters, like solar radiations, transmission through building, fresh air ventilation occupancy load, internal heat gain such as lights, appliances, machine etc, state and quantity of supply air for different type of air-conditioning system.	**12**

Total-48

Recommended Books

1. C. P. Arora;Refrigeration and Air conditioning TMH Publication.
2. Domkondwar Refrigeration and Air conditioning Khanna Publication.
3. Balleney; Refrigeration and Air conditioning Khanna Publication.
4. Gupta & Prakash Ref and Air Conditioning New Chand Publication.

Title of the course : **Measurements and Instrumentation**
Subject Code : **OEME-612 B**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Access the suitability of measuring instruments, their calibration and use of standard measurement practices.
CO2: Understand the basic principle of sensing in measurement of physical quantities and automation of instruments.
CO3: Understand the basics of micron and submicron level measurements by mechanical and optical methods and latest development in such measurements.
CO4: Use and develop sustainable measurement systems for shop floor.
CO5: Handle various measuring instruments

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	2	1	1	1	2	2	1	3	2	2	1
CO2	3	3	2	1	2	2	1	1	1	2	1	3	1	2	1
CO3	3	2	2	1	2	1	1	1	1	2	2	2	1	2	2
CO4	2	2	3	2	1	1	2	1	2	1	2	2	2	1	2
CO5	2	2	2	1	2	1	1	2	1	2	3	2	1	2	3
Avg.	2.6	2.2	2.2	1.4	1.8	1.2	1.2	1.2	1.4	1.8	1.8	2.4	1.4	1.8	1.8

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction**	Introduction, methods of measurement, measurements in design, factors in selection of measuring instrument, measurement systems, time element in measurement, error in measuring instruments, temperature problem, static & dynamic characteristics of measuring instruments, calibration, errors, classification, system error analysis, theoretical relationships.	**07**
	Standard of Measurements	Introduction, legal status, present measurement system & its advantage over previous system, standard of length, mass, time, temp. etc.	**05**
	Displacement &Dimensional Measurement	Problems of dimensional measurement, gauge block, surface plate, temp problem etc., use of different type of comparators, optical method, application of monochromatic light & optical flats, use of optical flats & monochromatic light for dimensional comparison, interferometer.	**07**
	Surface Testing &Measurement	Surface roughness, definition, various methods to measure surface roughness, different instruments used for measuring surface roughness, roughness standard.	**05**
Unit-2	**Speed Measurement**	Introduction, use of counters, stroboscope, direct application of frequency standard by comparative methods, calibration of frequency sources, tachometers: different types-mechanical, electrical, frequency tachometer etc.	**06**

	Stress Strain Measurements & Strain Graphs	Introduction, mechanical strain gauges, optical strain gauges, electrical strain gauges, stress measurement by variable resistance strain gauge, sensing element materials, forms of strain gauge sensing elements, strain gauge adhesive, protective coating, strain gauge mounting techniques.	**06**
	Measurement of Force & Torque	Introduction, force measurement by using elastic transducers, strain gauges, load cells, piezo type load cells, hydraulic & pneumatic system, torque measurement: dynamometer, classification, various types and characteristics.	**06**
	Screw Thread Measurements	Errors in threads, screw thread gauges, measurement of elements of the external & internal threads using caliper gauges, various other methods to measure screw thread parameters	**03**
	Spur Gear Measurement	Geometry of spur gear, measurement of various spur gear parameters like: run out, pitch, profile, lead, backlash, tooth thickness, various other methods to measure spur gear parameters.	03

Total=48

Recommended Books:

1. Nakra& Chaudhary, Instrumentation, Measurement & Analysis; Tata McGraw Hill
2. E. O. Doebelin, Measurement Systems, Application & Design; Tata McGraw Hill
3. J.W. Dally, R.F. William and Mc Connell, Instrumentation for Engg. Measurement; John Wiley and Sons
4. K.J. Aume, Metrology & Interchange ability; McDonald and Company Ltd.
5. T. G. Beckwith, L.N. Buck and R. D. Marangoi, Mechanical Measurements; Addison Wesley Reading

Title of the course : **Finite Element Methods**
Subject Code : **OEME-612C**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Analyse strain-displacement and stress-strain relations with and without the temperature effect.
CO2: Create a finite element mesh using different elements for a continuum domain.
CO3: Analyse the implementation of FEM to solve static, scalar field and dynamic problems.
CO4: Solve a simple mechanical problem using appropriate finite element software.
CO5: Create a computer program for the finite element method.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	2	1	1	2	2	2	3	2	1	2	1	1
CO2	3	3	2	3	1	1	3	2	2	2	3	2	2	1	1
CO3	2	2	2	3	1	1	2	2	3	3	3	1	3	2	1
CO4	3	3	2	2	1	2	3	2	2	3	3	1	1	2	2
CO5	3	3	2	2	2	2	2	2	2	2	3	1	1	3	2
Avg.	2.6	2.6	2	2.4	1.2	1.4	2.4	2	2.2	2.6	2.8	1.2	1.8	1.8	1.4

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction**	Historical Background, Stresses and equilibrium, Boundary Conditions, Strain-Displacement Relations, Stress-Strain Relations, Temperature Effects, Vectors and Matrices.	**06**
	Introduction & Fundamental Concepts	Introduction, legal status, present measurement system & its advantage over previous system, standard of length, mass, time, temp. etc.	**06**
	1-D FE Modelling	Finite Element Modelling, Coordinates and Shape Functions, The Potential Energy Approach, The Galerkin's Approach, Assembly of Global Stiffness matrix and Load vector, Properties of Stiffness Matrix, Treatment of Boundary Conditions and Temperature Effects.	**08**
	2-D FE Modelling	Finite Element Modelling, Constant Strain Triangle (CST).	**04**
Unit-2	**2-D FE Modelling**	The Four Node Quadrilateral, Numerical Integration, Higher Order Elements; Nine Node Quadrilateral, Eight Node Quadrilaterals, Six Node Triangle.	**05**
	Truss	Introduction, Plane Trusses, Assembly of Global Stiffness Matrix and Load Vector. (For 1D and 2D problems only)	**08**
	Scalar Field Problems	Introduction, Steady-state heat transfer, Potential Flow, Fluid Flow in ducts.	**04**

	Dynamic Considerations	Element Mass Matrices, Evaluation of Eigen Values and Eigen Vectors. (Introduction only)	**04**
	Computer Implementation	Introduction; Computer Program Organization for Calculation of System Matrices.	**03**

Total=48

Recommended Books:

1. Chandrupatla and Belegundu, Introduction to Finite Elements in Engineering, PHI.
2. K.J. Bathe, Finite Element Procedures, PHI.
3. J. N. Reddy, An Introduction to Finite Element Method, TMH.
4. Huebner, The Finite Element Methods for Engineers, John Wiley.
5. O.C. Zienkiewicz, The Finite Element Method, TMH.
6. Buchanan, Finite Element Analysis, McGraw Hill.

Title of the course : **Theory of Metal Cutting and Forming**
Subject Code : **PEME-611A**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understanding of basic concepts, chip formation mechanism, cutting forces and their impact on machining, optimization of machining operations.

CO2: Awareness on different cutting tool materials, tool wear and wear mechanism of cutting tools, machinability and tool life principles.

CO3: Study the design considerations and development of lathe, drilling and milling dynamometers.

CO4: Understand the theory of plasticity and its application in metal forming operations to give insight to the students on theoretical and practical applications of metal forming operations.

CO5: To evaluate and analyze the stresses produced during rolling, wire drawing and strip drawing processes.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	3	3	1	1	2	2	1	2	3	2	2	1
CO2	1	2	3	3	3	1	1	1	2	1	2	3	1	2	1
CO3	1	2	3	3	3	1	1	1	2	2	2	3	1	2	2
CO4	2	1	3	3	3	1	1	2	1	2	2	3	2	1	2
CO5	1	2	3	3	3	1	1	1	2	3	2	3	1	2	3
Avg.	1.4	1.8	3	3	3	1	1	1.4	1.8	1.8	2	3	1.4	1.8	1.8

Theory

Unit	Main Topic	Course out line	Lectures
Unit-I	**Metal Machining**	Kinematics, Elements involved in metal cutting action, classifications of cutting tools, Single point tools, multi point tools, principle angles on a single point cutting tool, tool signature, ASA system, ORS system, NRS system, Interrelation ship between ASA, ORS & NRS Systems. Concept of oblique cutting and orthogonal cutting	**04**
	Chip Formation Mechanism	Mechanics of chip formation, types of chips, adverse effect of BUE formation, Chip reduction coefficient, cutting ratio, shear plane, shear strain, chip velocity & velocity of shear, Factors involved in chip formation analysis, effect of cutting variables on chip reduction coefficient, Chip formation in Milling & drilling	**08**
	Force System in Machining	Force system during turning, Merchant circle diagram for cutting force, Frictional force system at chip tool interface, Force system at interface, Effect of obliquity, nose radius & wear land on force system, Forces in drilling & milling. Fundamentals of dynamometry, lathe dynamometer, drilling & milling dynamometer.	**08**
	Thermal Aspect in Machining	Heat generation in metal cutting, tool wear & temperature, coolants & their applications.	**03**

	Tool Wear	Types of tool wear, Machine ability, Tool life analysis & tool life equation.	**03**
Unit-II	**Metal Forming: Plastic Deformation & Yield Criterion**	Plasticity, True stress, True strain, Elastic & plastic strain, Yield stress, Plastic incompressibility, Poisson's ratio for plastic deformation, Von Misses yield criterion, Tresca yield criterion, generalized strain hardening curve	**06**
	Rolling	Analysis of the processes, Roll separating force, Torque on the rolls, Effect of front & back Tension, Effect of support rolls	**04**
	Wire & Strip Drawing	Analysis of the processes	**06**
	Plain Strain Forging	Analysis of the processes, Deep drawing of circular blanks-analysis of process, Extrusion- analysis of process.	**06**

Total-48

Recommended Books:

1. Malik & Ghosh;Manufacturing Science EWP
2. Pandey & Singh Production Engineering Science Standard Publishers
3. A.Bhattacharya Metal cutting Theory;Central Book Publishers

Title of the course : **Advanced Strength of Materials**
Subject Code : **PEME-611B**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Calculate the stresses and strains in various materials
CO2: Analyse the failure of curved beam.
CO3: Develop formulation/ design of various kind of thick cylinder.
CO4: Determine stresses in various kinds of rotating discs and cylinders.
CO5: Evaluate various failures in 3D stress systems in structural elements.

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CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	3	3	2	2	3	2	3	2	3	2	2	1
CO2	2	3	3	3	2	3	3	2	3	2	3	2	1	2	2
CO3	3	2	3	3	2	3	3	3	2	3	2	3	1	2	1
CO4	3	3	2	3	3	2	3	2	3	2	3	2	2	1	2
CO5	3	2	2	2	3	2	2	3	2	3	2	3	1	2	1
Avg.	2.8	2.4	2.4	2.8	2.6	2.4	2.6	2.6	2.4	2.6	2.4	2.6	1.4	1.8	1.4

Theory

Unit	Main Topic	Course out line	Lectures
Unit-I	**Strain Energy and Deflection**	Expression for Strain Energy due to various types of loading, Using Castigliano's theorem: Calculate the horizontal and vertical deflection in the different beams, Expression for strain energy of dilation and distortion due to 3-D stress system, Maxwell's Reciprocal Theorem.	**05**
	Bending of Curved Bars	Introduction, Stresses in bar of small initial curvature and of large initial curvature, Winker-Bach Theory, Stresses in crane hook, Ring and other links of various cross section. Deflection of curved beams by Castigliano's Theorem	**05**
	Thick Pressure Vessels	Thick cylinder, Lame theory, Compound cylinders and hub-shrunk on solid shaft, Thick spherical shells	**05**
	Springs	Close and Open Coiled Helical Springs, Leaf Spring, Flat Spiral Spring	**03**
	Theories of Elastic Failure	Maximum Principal Stress Theory, Maximum Principal Strain Theory, Maximum Strain Energy Theory, Maximum Shear Stress Theory, Maximum Distortion Energy Theory, Graphical Representation and Comparison of Different Theories of Failure	**04**

Unit-II	**Unsymmetrical Bending**	Introduction, Stress in a beam due to the unsymmetrical bending, Principal axes and deflection of beam due to unsymmetrical bending, shear centre for channel and unequal I- section.	**06**
	Centrifugal Stresses	Introduction, Stresses in rings, disc and cylinders due to rotation, Disc of uniform strength.	**06**
	3-D Stress System	Differential equilibrium equations in Cartesian and cylindrical coordinate system for 3-D stress system, Mohr's circle, stress invariant, stress component on an arbitrary plane, principal stresses	**05**
	Plastic Limit Analysis.	Plastic limit analysis of beams, portal frames – collapse loads	**04**
		Total	**48**

Recommended Books:

1. Popov's Engineering Mechanics of Solids Pearson Education
2. Gere's Mechanics of Materials Thomson Books
3. Ryder G.H 's Advanced Strength of Materials ELBS
4. Crandall & Dahl's, An Introduction to the Mechanics of Solids McGraw Hill
5. L.S. Srinath's, Advanced Mechanics of Solid Tata McGraw Hill
6. E.J. Hearn's Mechanics of Materials B & H
7. U C Jindal Strength of Materials Umesh Publication

Title of the course : **Welding- Processes, Codes and Standards**
Subject Code : **PEME-611 C**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Apply the knowledge of welding fundamentals including the processes and their capabilities, commonly used welding codes and standards to solve welding problems.

CO2: Should be able to select a suitable welding process for a specific application and **p**repare WPS and PQR for Industrial welding applications; prepare WPS for pipeline for petroleum applications and understanding of basic testing methods for weld qualification.

CO3: Understand the impact of welding operations on environment aquire knowledge about industrial materials, welding consumables and their applications

CO4: Apply the ethical principles regarding health, safety and legal issues during operations of welding machines and Generate ethical values by knowing about welding codes and standards

Nil

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	2	2	2	3	2	2	2	1	1	2	1
CO2	3	2	3	3	2	1	2	2	2	2	3	2	1	2	2
CO3	2	2	3	2	2	2	3	1	2	2	2	3	1	2	1
CO4	3	2	3	2	2	3	3	2	2	2	2	2	2	1	2
Avg.	2.75	2	3	2.25	2	2	2.5	2	2	2	2.25	2	1.25	1.75	1.5

Theory

Unit	Main Topic	Course out line	Lectures
Unit-I	**Introduction to Welding Processes**	Classification of welding processes and their principles in brief with applications**. Gas welding**-Principle, different gases used & their properties, types of flames, welding techniques, safety and applications, **Brazing**- Difference between brazing and soldering, braze welding, wetting and spreading characteristics, brazing and soldering consumables, application of brazing and soldering.	**6**
	Arc welding	**SMAW process**-welding arc, arc starting methods, arc stability, arc efficiency, arc blow, power sources, VI characteristics of power source, electrode polarity, duty cycle, classification and coding of SMAW electrodes. **GTAW process-** Gas tungsten arc welding- Principle, equipment and welding parameters, polarity, shielding gases and their effect, advantages, disadvantages and applications of the process. **GMAW process-** Gas metal arc welding- principle, equipment, process variables, shielding gases and their effect on bead geometry, applications of the processes.	**10**
	Submerged arc welding and	**Submerged arc welding-** Principle, equipment used, welding parameters, SAW fluxes, classification, flux- wire combination, multi wire, strip cladding and narrow gap	**8**

	Resistance Welding	welding applications of the process. Resistance welding-Basic principle, brief introduction to spot, seam, projection and flash butt welding, welding variables, resistance welding equipment, heat balance, applications.	
Unit-II	**Weld Joints and welding symbols**	Types of weld joints, Types of welds, Essential elements of a basic welding symbol, Primary and secondary weld symbols, various information and location of this information on welding symbol.	**4**
	Pressure vessel fabrication and consumable standards	Introduction to ASME section VIII- division I, fabrication methods, joint categories, welding and inspection requirements, post weld heat treatment and hydro-testing. Introduction to ASME section II part A and C; introduction to base materials and consumables standards, consumables testing and qualification as per ASME/AWS requirements.	**8**
	Welding procedure specifications (WPS) and Indian Boiler Regulations (IBR)	Introduction to ASME section IX; introduction to Welding Procedure Specification (WPS)- essential, non-essential and supplementary essential variables, procedure qualification, Procedure Qualification Records (PQR); welders performance qualification, welder and welding operator. Introduction to IBR-1950, workmanship for fabrication of shell type welded boilers, qualification and requalification of welders to be engaged for welding of boilers.	**8**
	Cross Country Pipeline Welding	Introduction to API 5L welding code, Process and product standards for manufacturing of pipes, welding procedure and welder qualification, field welding and inspection requirements.	**4**

Total-48

Recommended Books:

1. Welding Processes and Technology by R.S Parmar (Publisher: Khanna Publishers)
2. Modern Arc Welding Technology by S.V. Nadkarni (Publisher: Oxford & IBH)
3. Modern Arc Welding Technology by Hobart B. Cary (Publisher; Prentice Hall Cambridge Univ. Press)
4. Indian Boiler Regulations-1950
5. API 5L
6. ASME Section VIII - Division 1
7. ASME Section IX
8. ASME Section II Part A and Part C

Title of the course : **Engineering Economics and Entrepreneurship**
Subject Code : **HSMC-603**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the identify the type of interest simple, compound, preset worth comparison equivalent, annual worth comparison with interest tables

CO2: Knowledge of obtaining annual payment monthly payment cash flow diagram depreciation.

CO3: Able to acquire skills regarding direct costs components of costs financial statement profit and loss account,

CO4: Analyse the stability of profit planning balance sheet scope of finance functions.

CO5: Understand shrinking fund application concepts using formulas compound interest tables.

Nil

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	1	1	2	2	1	1	1	1	1	2	2	2	1	2	2
CO2	1	1	1	1	1	2	2	2	1	1	1	2	1	1	1
CO3	1	1	1	1	1	1	1	2	2	1	1	3	1	2	2
CO4	1	1	1	1	1	2	2	2	1	1	1	2	1	1	1
CO5	1	1	1	1	1	1	1	2	2	1	1	3	1	2	2
Avg.	1	1	1.2	1.2	1	1.4	1.4	1.8	1.4	1.2	1.2	2.4	1	1.6	1.6

Unit	Main Topic	Course outline	Lectures
Unit-I	**Introduction**	Engineers and Economics, Utility of its study, Managerial Economics, Nature and scope, basic terms and concept of economics like goods, kinds of goods.	**02**
	Theory of Demand and Supply	Meaning of Demand, Individual and Market demand schedule, Law of demand, shape of demand curve, Elasticity of demand, The meaning of Supply, Supply function, Law of supply- Explanation of law of supply.	**08**
	Environment Analysis	Concept of National income- GDP, GNP, Monetary policy, Fiscal Policy.	**05**
	Entrepreneurship-Enterprise	Conceptual issues, Entrepreneurship vs. Management, Concept of Social Entrepreneurship and Women Entrepreneurship, Roles and functions of engineer in relation to the enterprise and in relation to the economy.	**05**
	Business Excellence	Role of creativity and innovation and business research, Sources of business idea, TQM,Six Sigma	**02**
Unit-II	**The process of setting up a small business**	Preliminary screening and aspects of the detailed study of the feasibility of the business idea, Preparation of Project Report and Report on Experiential Learning of successful and unsuccessful entrepreneurs.	**04**

	Communication skills	Introduction, process of communication, barriers to communication, Removal of barriers, channels of communication, Verbal and non-verbal communication.	**03**
	Issues in small business marketing	The concept and application of product life cycle,Advertising and publicity, sales and distribution management, National, state level and grass-root level financial and non-financial institutions in support of small business development, MSME Act	**07**
	Human Resource Management	Introduction, definition, types, tools of motivation,Theories of motivation- Alderfer's ERG theory, Herzberg's theory of motivation, Mc Clelland theory.Introduction , objectives, scope, functions. Factory Act 1948	**06**

Total-42

Recommended Books:

1. Dutta A.K., Materials Management: Procedures, Text and cases, Prentice Hall of India Pvt. Ltd., New Delhi.
2. Gopalakrishnan, P. and Sundareson, M., Materials Management: An Integrated Approach, Prentice Hall of India Pvt. Ltd., New Delhi.
3. Varma, M.M., Essentials of Storekeeping and Purchasing, Sultan Chand and Sons, New Delhi.
4. Shah N.M. An Integrated concept of Materials Management, Indian Institute of Materials Management, Baroda Branch, Baroda.
5. Sharma S.C., Material Management and Materials Handling, Khanna Publishers, New Delhi.
6. Arnold, Champman and Ramakrishnan, Introduction to Materials Management 5th ed., 2007 Pearson Education, Inc.
7. Pooler Victor H. Purchasing and Supply Management, Creating the Vision, New York, Chapman & Hall, 1997.
8. Moore, J.M., Plant layout and Design, Macmillan New York.

Title of the course : **Measurements and Instrumentation Lab**
Subject Code : **PCME-613**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Access the suitability of measuring instruments, their calibration and use of standard measurement practices.
CO2: Understand the basic principle of sensing in measurement of physical quantities and automation of instruments.
CO3: Understand the basics of micron and submicron level measurements by mechanical and optical methods and latest development in such measurements.
CO4: Use and develop sustainable measurement systems for shop floor.
CO5: Handle various measuring instruments

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	1	1	1	1	2	1	1	3	2	1	1
CO2	3	3	2	2	3	1	1	1	2	3	1	3	2	3	1
CO3	3	2	2	1	3	1	1	1	1	3	2	2	1	3	2
CO4	2	2	3	2	1	1	1	1	2	1	2	2	2	1	2
CO5	2	2	2	1	1	1	1	1	1	1	1	2	1	1	1
Avg.	2.6	2.2	2.2	1.6	1.8	1	1	1	1.6	1.8	1.4	2.4	1.6	1.8	1.4

List of Experiments:

1. Linear measurement of the test samples by
   a) Vernier caliper, b) Micrometer, c) Vernier depth gauge and d) height gauge
2. Study and measurements using telescopic gauge and bore gauge
3. Study and measurement using dial test indicator
4. Study and measurements using profile projector
5. Study and measurements using tool room microscope
6. Angle measurement of test sample using sinebar
7. Study and measurement using electronic comparator
8. Speed measurement of shaft by stroboscope and tachometer
9. Measurement of surface roughness by SURFCODER
10. Calibration of dial gauge by dial calibration tester
11. Calibrate of pressure gauges with dead weight calibrator
12. Calibration of vernier caliper and micrometer

Title of the course : **Advance Manufacturing Processes**
Subject Code : **HDME-611**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Ability to apply current knowledge and adapt to emerging and Advance process to produce engineering components
CO2: Get a wide knowledge in the field of CIM and various new concepts like GT, CMS, FMS
CO3: To motivated in field of automation.
CO4: To analyse and determine material fabrication processes.
CO5: Reveal Modernization ways of manufacturing enhancement

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	2	1	3	2	3	3	3	2	2	3	3	2	2
CO2	3	2	2	1	3	2	3	3	3	2	3	3	3	2	3
CO3	1	3	3	2	3	2	2	3	2	1	3	2	2	2	2
CO4	2	3	3	3	2	2	3	3	2	2	2	3	3	1	2
CO5	3	3	2	1	3	3	2	3	3	1	2	2	2	2	3
Avg.	2.4	2.4	2.4	1.6	2.8	2.2	2.6	3	2.6	1.6	2.4	2.6	2.6	1.8	2.4

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Product Life Cycle Management**	Product Life Cycle Phases, Product information, Product data management (PDM), QFD, Concept of Design for Manufacture	**7**
	Computer Integrated Manufacturing System	Types of manufacturing systems, material handling systems, computer control systems, human labour in manufacturing systems, CIMS benefits. Robots: anatomy, configuration and control. Conveyor system, automated guided vehicle (AGV), automated storage and retrieval systems (AS/RS), flexible manufacturing systems (FMS).	**9**
	Group Technology and Cellular Manufacturing Systems	Concept of Group Technology, Design attributes and manufacturing features, GT implementations, Part family, Selection of classification and coding system, Concept of cellular manufacturing, Quantitative analysis in Cellular Manufacturing.	**7**
Unit-2	**Advances in Casting, Metal Forming and Welding**	Computer Aided design of Castings, -Recent trends in casting, Low pressure die casting, Squeeze casting, full mould casting process. Automation in welding-Welding robots Overview of automation of welding, Advanced Metal Forming Processes,Introduction to-high energy rate forming (HERF) process, Electro-magnetic forming, explosive forming Electro-hydraulic forming, Stretch forming, Contour roll forming	**9**
	Additive Manufacturing Systems	Classification – Liquid based system – Stereolithography Apparatus (SLA)- Principle, process, advantages and applications – Solid based system –Fused Deposition Modeling –	**7**

		Principle, process, advantages and applications, Laminated Object Manufacturing,Selective Laser Sintering.	
	Recent Trends in Manufacturing	Concurrent Engineering: concept, Collaborative design. Deign for 'X', Reverse Engineering.Agile manufacturing, Lean Manufacturing,Nanotechnology – an Introduction, E-Manufacturing	**9**

Total=48

Recommended Books:

1. Groover & Zimmer;Automation, production systems;CIM PHI
2. McMohan& Browne;CAD/CAMPearson Education
3. Chang, Wysk and Wang Computer aided manufacturing PHI
4. Besant and Lui Computer Aided Design and Manufacturing
5. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.
6. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.
7. Heine Loper& Rosenthal, "Principles of Metal Casting", Tata McGraw Hill, 2005.
8. R S Parmer, "Welding Engineering Technology", Khanna publishers, 2 nd Edition, 2008.
9. E.P. DeGarmo, J. T Black, R.A.Kohser Materials and Processes in Manufacturing" (8th Edition), ,Prentice Hall of India, New Delhi (ISBN 0-02-978760).
10. A. Ghosh, and A.K. Mallik Manufacturing Science", Affiliated East-West Press Pvt. Ltd. New Delhi.
11. G.F.Benedict, Nontraditional Manufacturing Processes, , Marcel Dekker, Inc. New York (ISBN 0-8247-7352-7).

Title of the course : **Advance Manufacturing Processes Lab.**
Subject Code : **HDME-612**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Ability to apply current knowledge and adapt to emerging and Advance process to produce engineering components
CO2: Get a wide knowledge in the field of CIM and various new concepts like GT, CMS, FMS
CO3: To motivated in field of automation.
CO4: To analyse and determine material fabrication processes.
CO5: Reveal Modernization ways of manufacturing enhancement

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	2	1	3	2	3	3	3	2	2	3	3	2	2
CO2	3	2	2	1	3	2	3	3	3	2	3	3	3	2	3
CO3	1	3	3	2	3	2	2	3	2	1	3	2	2	2	2
CO4	2	3	3	3	2	2	3	3	2	2	2	3	3	1	2
CO5	3	3	2	1	3	3	2	3	3	1	2	2	2	2	3
Avg.	2.4	2.4	2.4	1.6	2.8	2.2	2.6	3	2.6	1.6	2.4	2.6	2.6	1.8	2.4

List of Experiments:

1. Study and analysis of Typical Product Development Process & Product Life Cycle.
2. To study and familiarize the concepts of Computer Integrated Manufacturing and Group Technology
3. Exercise on manual Robotic programming.
4. Exercise on Computer Aided design of various castings.
5. To perform various welding joints using welding robotrs.
6. Design and manufacturing of products using Additive Manufacturing.

Title of the course : **Modelling and Simulation**
Subject Code : **HDME-613**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Identify the underlying concepts; advantages, limitations and usefulness of modeling & simulation of engineering systems in general, and that of manufacturing systems in particular.

CO2: Construct mathematical model for continuous and discrete engineering systems.

CO3: Obtain random samples by generating & testing random numbers [0, 1], and converting to random variates as per appropriate statistical (probability) distribution.

CO4: Simulate the problems of manufacturing systems and management science using appropriate set of random samples.

CO5: Design the simulation experiment for static, dynamic and stochastic systems.

CO/PO Mapping: Strong(3) / Medium(2) / Weak(1) indicates strength of correlation:															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	3	3	2	2	2	1	1	2	3	1	1	1
CO2	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO3	2	2	3	3	3	2	2	2	1	1	2	3	2	2	2
CO4	2	2	3	3	3	2	2	2	1	1	2	3	2	3	3
CO5	2	2	3	3	3	2	2	2	1	1	2	3	1	1	2
Avg.	2	2	3	3	3	2	2	2	1	1	2	3	1.4	1.8	1.8

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction**	Concept of system & environment, elements of systems, types of systems, system modelling, types of models. System simulation, simulation as a management laboratory, advantages & limitations of system simulation.	**5**
	Simulation of Continuous system	Examples of continuous system simulation – pure pursuit problem, chemical reactor problem; simulation using MatLAB programming, characteristics of continuous systems, comparison of numerical integration with continuous system simulation, selection of integration formula for simulation.	**7**
	Simulation of Discrete System	Time flow mechanisms, generation of random numbers, testing of random numbers for uniformity & statistical independence. Discrete and continuous probability density functions (binomial, uniform, exponential, normal and beta density functions). Generation of random variates for discrete probability distribution, generation of random variates for continuous probability distribution. Combination of discrete-event and continuous models, simulation using MatLAB programming.	**7**

	Simulation of queuing system	Concept of queuing theory, characteristics of queues, measure of system performance, Kendell's notation. Simulation of single-server and double-server queues. Queues involving complex arrivals and service times with balking, reneging and jockeying, stationary and time dependent queue, auto covariance and auto correlation function, auto correlation effects in queuing system, simulation using MatLAB programming.	**7**
Unit-2	**Simulation of inventory system**	Rudiments of inventory theory – analytical approach. necessity of simulation, simulation of inventory systems. demand forecasting and regression analysis; time series analysis, exponential smoothing and simulation-based forecasting approaches, simulation using MatLAB programming.	**6**
	Simulation of project management problems	Introduction to PERT & CPM for project management, time estimates, identification of critical path for estimation of project completion time, necessity of simulation, simulation of project management problem(s), simulation using MatLAB programming.	**6**
	Design of simulation experiments	Length of simulation run, run length for static stochastic simulation, run length for dynamic stochastic simulation - elimination of transients (initial bias), auto-correlated observations, blocking, etc. Variance reduction techniques - antithetic sampling, correlated sampling, importance sampling, control variates, stratified sampling, etc.	**6**
	Simulation Languages	Continuous and discrete simulation languages block structure continuous languages, special purpose simulation languages.	**4**

Total=48

Recommended Books:

1. Loffick; Simulation and Modeling — Tata McGraw Hill
2. Deo Narsingh; System Simulation with Digital Computer; — Prentice Hall of India
3. D.S. Hira;System Simulation — S. Chand & Co.
4. Gorden, System Simulation — Prentice Hall
5. David Kelton, Simulation Modeling & Analysis — Tata McGraw Hill

Title of the course : **Modelling and Simulation Lab**
Subject Code : **HDME-614**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Identify the underlying concepts; advantages, limitations and usefulness of modeling & simulation of engineering systems in general, and that of manufacturing systems in particular**.**

CO2: Construct mathematical model for continuous and discrete engineering systems.

CO3: Obtain random samples by generating & testing random numbers [0, 1], and converting to random variates as per appropriate statistical (probability) distribution.

CO4: Simulate the problems of manufacturing systems and management science using appropriate set of random samples.

CO5: Design the simulation experiment for static, dynamic and stochastic systems.

CO/PO Mapping: Strong(3) / Medium(2) / Weak(1) indicates strength of correlation:															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	3	3	2	2	2	1	1	2	3	1	1	1
CO2	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO3	2	2	3	3	3	2	2	2	1	1	2	3	2	2	2
CO4	2	2	3	3	3	2	2	2	1	1	2	3	2	3	3
CO5	2	2	3	3	3	2	2	2	1	1	2	3	1	1	2
Avg.	2	2	3	3	3	2	2	2	1	1	2	3	1.4	1.8	1.8

List of Experiments:

Part-A: ***Continuous System Simulation – Any three of the following exercises***

1. Develop a mathematical model for the pure pursuit problem involving an object A chasing (at a constant speed) the object B moving with predetermined path in a two-dimensional space. Obtain the simulation results in MatLAB.

2. Develop a mathematical model for the pursuit problem involving an object A chasing (at a constant speed) the object B moving on a path changing the direction of motion randomly in a two-dimensional space. Obtain the simulation results in MatLAB.

3. Develop a mathematical model for simulation of a serial chase problem involving four object A, B, C and D located at 4-vortices of a square (of a given side), chasing each other with same (given) uniform velocity. Obtain the simulation results in MatLAB. Analyse the results with change in (a) length of side of square, and (b) value of the chasing velocity.

4. Develop a mathematical model for simulation of path of a projectile, considering air resistance to be proportional to some power of velocity (v^n). Obtain the simulation results in MatLAB considering (a) 'g' to be constant, (b) 'g' to be variable as per laws of gravitation.

5. Develop a mathematical model for simulation of a chemical reactor problem involving three products A, B, C reacting together, with 1 gm each producing the 3 gm of the product D in forward reaction, and decomposition in the reverse reaction. Obtain the simulation results in MatLAB.

Part B: ***Discrete Event System Simulation – Any three of the following exercises***

1. Attempt the following using MatLAB.

a. Develop a set of 500 IID R[0, 1] using linear congruential method. Select values of constants as per the guidelines given in the textbook, based on number theory.
b. Conduct a test for (i) uniformity, and (ii) statistical independence, on the set of random numbers obtained in 'a'.
c. Generate a set of random variates for (i) N(10, 2), and (ii) Exp(5), using IIDR[0, 1] generated above.

2. Develop a simulation model for variation in population in the country considering various real-world factors. Obtain the simulation results in MatLAB.

3. Develop a simulation model for a (i) single server, (b) double server, (c) 3-server queue for a railway reservation problem, involving complex arrivals and service times with balking, reneging and jockeying. Obtain the simulation results in MatLAB.

4. Develop a simulation model for (a) an inventory system, (b) demand forecast. Obtain the simulation results in MatLAB. Take values of input parameters from textbook.

5. Develop a simulation model for obtaining the criticality index of various paths (sequence of activities) for completion of the project for a given PERT problem using MatLAB.

Title of the course : **Advanced Welding Processes**
Subject Code : **HDWL-611**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1 : Learn about fundamental knowledge of various advanced welding processes.
CO2: Recommend a suitable welding process along with process parameters for a particular application.
CO3: Compare different welding processes in terms of quality, productivity and economics.
CO4: Apply the knowledge of welding processes for solving materials joining problems.
CO5: Apply the ethical principles regarding health, safety and environmental issues during welding operations.

Conventional Welding Processes

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	3	2	2	1	1	2	2	3	3	3	1
CO2	3	3	3	3	3	2	2	3	1	1	3	3	3	3	2
CO3	3	3	3	3	3	2	3	2	2	1	3	3	3	3	3
CO4	3	3	3	3	3	3	2	3	1	2	3	3	3	3	2
CO5	3	1	1	2	2	3	3	3	1	1	2	3	2	2	3

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Solid State Welding Processes**	Friction and friction stir welding, explosive welding, diffusion bonding, ultrasonic welding- Basic principle, process variables, weld characteristics and applications.	**08**
	Thermit Welding	Principle of operation, thermit mixtures, area of application.	**06**
	Surfacing and Thermal Spraying	Introduction to surfacing, type of surfacing (cladding, hard facing, built-up and buttering), different welding methods used for surfacing, different surfacing materials used and their characteristics, introduction to spraying, different spraying methods and applications.	**10**
Unit-2	**Electro Slag and Electro Gas Welding**	Principle of operation, equipment-power source, wire feeder and oscillator, guide tube consumable and non-consumable, retaining shoes, welding head with control, travel carriage, process variation, advantages, disadvantages and applications, comparison between EGW and ESW.	**09**
	Electron Beam Welding	Principle of operation, equipment details, EBW in different degree of vacuum- high, medium and non-vacuum, process characteristics (keyhole penetration), process variables (acceleration voltage, beam power, spot size, travel speed, powder density), advantages, disadvantages and applications.	**09**
	Laser Beam Welding	Principle of operation, different laser medium (CO_2, Ruby and Nd-YAG), advantages, limitation and applications.	**06**

Total=48

Recommended Books:

1. Welding Processes and Technology by R.S Parmar (Publisher: Khanna Publishers)
2. Modern Arc Welding Technology by S.V. Nadkarni (Publisher: Oxford & IBH)
3. Modern Arc Welding Technology by Hobart B. Cary (Publisher; Prentice Hall Cambridge Univ. Press)

Title of the course : **Advanced Welding Processes Lab**
Subject Code : **HDWL-612**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Apply the knowledge of welding fundamentals to solve welding problems.
CO2: Select a suitable welding process for a particular application.
CO3: Prepare a WPS for a particular application.
CO4: Understand the impact of welding operations on environment and need for sustainable development
CO5: Apply the ethical principles regarding health, safety and legal issues during operations of welding machines

Conventional Welding Processes

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	3	3	2	2	2	1	1	2	3	1	1	1
CO2	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO3	2	2	3	3	3	2	2	2	1	1	2	3	2	2	2
CO4	2	2	3	3	3	2	2	2	1	1	2	3	2	3	3
CO5	2	2	3	3	3	2	2	2	1	1	2	3	1	1	2
Avg.	2	2	3	3	3	2	2	2	1	1	2	3	1.4	1.8	1.8

List of Experiments:

Experiment No	Name of Experiment
1.	To Learn the Safety and Precaution during the working on welding machine
2.	Demonstration and practice of resistance spot welding on zinc coated steel sheet
3.	To perform nugget test on specimen prepared by spot weld
4.	To perform flash butt welding on M.S round bar
5.	Demonstration and practice of underwater welding
6.	To join thin sheets by soldering using electrically operated soldering iron
7.	Demonstration and practice of friction welding
8.	Preparation of Lap joint by brazing
9.	Preparation and welding of lap joint by gas welding process
10.	Hard facing on given job by MMAW

Title of the course : **Welding Metallurgy**
Subject Code : **HDWL-613**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Learn and understand about Iron-Carbon equilibrium diagram along with different phases as well as reactions found on this diagram.

CO 2: Learn the concept of solidification of metals and alloys, epitaxial solidification. IDENTIFICATION OF Various zones of the weldment, weld zone, fusion boundary zone and HAZ

CO3: Calculate temperature at various locations

CO4: Develop welding procedures for different materials, UNDERSTAND about Welding of carbon steels, HSLA, Low alloy steels, Stainless steels and cast irons, Welding of dissimilar metals, Welding of plastics

CO5: Evaluate weldablity of different materials.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	3	3	2	2	2	1	1	2	3	1	1	1
CO2	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO3	2	2	3	3	3	2	2	2	1	1	2	3	2	2	2
CO4	2	2	3	3	3	2	2	2	1	1	2	3	2	3	3
CO5	2	2	3	3	3	2	2	2	1	1	2	3	1	1	2
Avg.	2	2	3	3	3	2	2	2	1	1	2	3	1.4	1.8	1.8

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction**	Introduction to Iron-Carbon equilibrium diagram, different phases, eutectic, eutectoid and peritectic reactions, lever rule, Overview of CCT and TTT diagrams.	**08**
	Basic metallurgy of fusion welds	Concept of solidification of metals and alloys, epitaxial solidification, Various zones of the weldment, weld zone, fusion boundary zone and HAZ (and its types), properties of HAZ, Microstructures formed in weldments, gas metal and slag metal reactions.	**08**
	Heat flow in welding	Temperature distribution in welding, Metallurgical effects of heat flow in welding	**04**
	Preheat and post weld heat treatment	Aims and methods of preheating and postweld heating, Preheating and PWHT of some specific steels	**04**
Unit-2	**Weldability of commonly used Engineering Materials**	Welding of carbon steels, HSLA, Low alloy steels, Stainless steels and cast irons, Welding of dissimilar metals, Welding of plastics.	**10**

	Weld cracking	Introduction and classification of weld cracks, factors affecting weld cracking, specific weld cracks, Fractography and Failure Analysis	**04**
	Weldability and weldability tests	Introduction, Weldability assessment, Weldability tests, Fabrication weldability tests and basic service weldability tests	**10**

Total=48

Recommended Books:

1. Welding Metallurgy by Sindo Kou (Wileyinterscience)
2. Metallurgy of Welding J. F. Lancaster Allen & Unvin
3. The Metallurgy of Welding D. Seferian Chapman and Hall
4. Welding Engineering and technology by R.S. Parmar (Khanna Publications)
5. Welding Metallurgy (Volume-1) by George E.Linnert (AWS)
6. Modern Arc Welding Technology by S.V. Nadkarni (Oxford & IBH)

Title of the course : **Welding Metallurgy Lab**
Subject Code : **HDWL-614**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Learn and understand about Iron-Carbon equilibrium diagram along with different phases as well as reactions found on this diagram.

CO2: Learn the concept of solidification of metals and alloys, epitaxial solidification. IDENTIFICATION OF Various zones of the weldment, weld zone, fusion boundary zone and HAZ

CO3: Calculate temperature at various locations

CO4: Develop welding procedures for different materials, UNDERSTAND about Welding of carbon steels, HSLA, Low alloy steels, Stainless steels and cast irons, Welding of dissimilar metals, Welding of plastics

CO5: Evaluate weldablity of different materials.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	3	3	2	2	2	1	1	2	3	1	1	1
CO2	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO3	2	2	3	3	3	2	2	2	1	1	2	3	2	2	2
CO4	2	2	3	3	3	2	2	2	1	1	2	3	2	3	3
CO5	2	2	3	3	3	2	2	2	1	1	2	3	1	1	2
Avg.	2	2	3	3	3	2	2	2	1	1	2	3	1.4	1.8	1.8

List of Experiments:

1. To study different zones of a weldment
2. To study various microstructural aspects of welded joints
3. To determine temperature distribution in welding
4. Concept of preheating and post heating in welding
5. Ferrite studies in welding of stainless steel
6. Study of weldability aspects of dissimilar welding
7. Studies on weld cracking
8. Weldability assessment of weldments
9. Study of various fabrication weldability tests

Title of the course : **Heat and Mass Transfer**

Subject Code : **PCME-621**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand fundamentals of different types of modes of Heat transfer
CO2: Apply various mode of heat transfer to actual problems
CO3: Understand various types of boiler
CO4: Application of different type of Heat exchanger
CO5: Understanding of Radiation and Mass-Transfer

NIL

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	3	2	2	2	2	2	2	2	2	2	1	1
CO2	2	3	3	3	2	2	2	2	2	2	3	2	2	3	1
CO3	2	2	2	3	2	2	2	2	3	2	2	2	1	3	2
CO4	2	3	2	2	2	2	2	2	2	2	2	2	2	1	2
CO5	3	3	3	2	2	2	3	2	3	2	2	3	1	1	1
Avg.	2.4	2.6	2.6	2.6	2	2	2.2	2	2.4	2	2.2	2.2	1.6	1.8	1.4

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction**	Different modes of heat transfer: conduction, convection, radiation.	**6**
	Conduction	Fourier's law of heat conduction, thermal Conductivity, effect of temperature and pressure on thermal conductivity of solid, liquid. Three dimensional general conduction equations in rectangular cylindrical and spherical coordinates. Electrical analogy for solving 1-D steady state conduction problem for slab, cylinder, sphere and influence of variable thermal Conductivity.	**6**
	Application of conduction	Straight and circular fins of rectangular cross-section, optimum design of rectangular fin, efficiency of fin, fin effectiveness for rectangular and circular cross section fins. Application of fins in temperature measurement of flow In tubes. Critical radius of insulation for pipes and electrical cables. Introduction to unsteady state heat transfer.	**6**
	Convection	Free and forced convection, derivation, mass, momentum and energy equations. Concept of boundary layer, boundary layer thickness. Heat transfer coefficient. Heat transfer in laminar and turbulent flow over plates, tubes using empirical relations. Dimensional analysis for forced and free convection	**6**
Unit-2	**Boiling and Condensation**	Introduction, boiling phenomena, pool boiling regimes, condensation drop-wise and film-wise.	**6**

	Heat Exchangers	Overall coefficient of heat transfer, different design criterion of heat exchangers (LMTD & NTU methods), calculation of number, diameter & length of tubes, mean temperature difference for parallel & counter flow heat exchangers.	**6**
	Radiation	Laws of radiation, definition of- emissivity, absorbitivty, reflectivity and transmissivity. Concept of black and grey bodies Planck's law monochromatic radiation, Kirchoff's law and the geometric factor. Lambert's cosine law, definition of intensity of radiation, radiation exchange between simple bodies, two parallel surfaces, concentric cylinders, furnace walls, using definition of radiosity and irradiation, radiation shields, simple	**6**
	Mass Transfer	Mass transfer process : classification, Concentrations, velocities and fluxes, Fick's law, General equation of mass diffusion, Steady state diffusion through a plain membrane,Equimolal diffusion.	**6**
			Total=48

Recommended Books

1. R. K. Rajput;Heat and Mass Transfer S. Chand Publication.
2. J.P. Holman;Heat Transfer TMH Publication.
3. R.C. Sachdeva;Heat and Mass Transfer New Age International Publication.
4. R. Yadav;Heat and Mass Transfer Central Publishing House Publication.
5. P.K.Nag;Heat Transfer TMH Publication.
6. Domkundwar;Heat Transfer Dhanpat Rai Publication.

Title of the course : **Principles of Industrial Engineering**
Subject Code : **PCME-622**

L	T	P	Credits	Weekly Load
3	1	0	4	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand and apply the basic concept of Industrial engineering.
CO2: Develop and prepare various recording techniques associated with work study/ method study.
CO3: Apply Production planning & control techniques for continuous improvement in different functionalities of an industry.
CO4: Develop and analyse the application of inventory control model in the plant.
CO5: Demonstrate the knowledge of selection of forecasting technique and compute material requirement needed in product quality management.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	3	3	2	2	3	2	3	2	3	1	1	-
CO2	2	3	3	3	2	3	3	2	3	2	3	2	2	1	2
CO3	3	2	3	3	2	3	3	3	2	3	2	3	2	1	-
CO4	3	3	2	3	3	2	3	2	3	2	3	2	2	1	1
CO5	3	2	2	2	3	2	2	3	2	3	2	3	2	1	3
Avg.	2.8	2.4	2.4	2.8	2.6	2.4	2.6	2.6	2.4	2.6	2.4	2.6	1.8	1	2

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction**	Industrial Engineering, Definition and Evolution, Understanding Industrial System Focus: Production/Service System. Performance measures of a Production System -Production, Productivity, Efficiency, Effectiveness, and Classical Industrial Engineering -Work Study: Method Study and Time Study, Human Factors, Ergonomics.	**8**
	Quality Control	Quality, TQM, SQC, Control Charts, Acceptance Quality Level (AQL), Lot Tolerance Percentage Defective (LTPD), Producer's Risk, Consumer's Risk, Operating Characteristic Curve, Simple Numerical Problems	**8**
	Value Engineering	Concept of value analysis, Aim and objectives, Phases in value analysis, Test for value analysis, Difference between V.E. and Cost Reduction Techniques, Functional Analysis System Techniques (FAST), Principles of Value Analysis.	**8**
Unit-2	**Production and Process Planning**	Objectives of PPC, Component of PPC, Phases of PPC, Process Planning, Steps in Process Planning for Flow Shop Scheduling, Types of Scheduling Systems, Master Scheduling, Order Scheduling, Comparison between Production Planning and Production Control, Sequencing.	**9**
	Sales Forecasting Techniques	Types of forecasting, importance of demand planning, Methods of Sales forecasting, Qualitative and Quantitative methods of demand planning.	**6**

	Inventory Control & Management	Introduction, Inventory, Deterministic model of EOQ, EOQ, Selective Inventory Control, Japanese Influences: Just in Time (JIT), Kanban etc., Increasing Integration in Industrial Enterprises: From MRP to ERP to Supply Chain Management.	**9**

Total=48

Recommended Books

1. A. Barnes;Motion and Time StudyJohn Wiley & sons Publication.
2. Dalela and Sourabh;Work Study and Ergonomics Standard Publishers
3. Ronald Mayer;Production Management TMH Publication.
4. MartandTelsang Industrial Engineering & Management S.Chand Publication.
5. Panneer Selvam R, Production and Operation Management, Prentice Hall India, New Delhi (2002)
6. Buffa, Modern Production/operations Management, Wiley Eastern, New York (1999)

Title of the course : **Cryogenics Engineering**
Subject Code : **OEME-621 A**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Have a comprehensive understanding of cryogenic systems.
CO2: Conduct experimentation for assessing suitability and application of different materials at cryogenic temperature.
CO3: Analyze properties of materials subjected to cryogenic temperature.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	1	1	1	2	2	2	1	1	2	1
CO2	3	3	3	3	2	1	3	1	2	2	3	2	1	2	2
CO3	3	3	3	3	2	1	1	1	2	2	2	3	1	2	1
Avg.	3	3	3	3	2	1	1.67	1	2	2	2.33	2	1	2	1.33

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Basics**	Definition of cryogenics, Physical properties of various cryogenic fluids, industrial applications of cryogenic fluids.	**4**
	Low temperature measurement	Measurement systems for low temperature: -temperature measurements, pressure measurements, flow measurements, liquidlevel measurements, fluid quality measurements	**10**
	Cryogenic insulations	Types of insulations, vacuum insulation, gas filled powders & fibrous insulation, evacuated powder & fibrous insulation multi-layer insulation, comparison of performance of various insulation.	**10**
Unit-2	**Properties of materials at low temperature:**	Mechanical properties, specific heat, thermal expansion, electrical resistance, thermal conductivity, emissivity, reflectivity and absorptivity. Properties of cryogenic fluids.	**10**
	Hazards	Physical hazards, chemical hazards, physiological hazards, combustion hazards, oxygen hazards, accidents in cryogenic plants & prevention.	**8**
	Safety	Safety in handing of cryogens, care of storage of gaseous cylinders, familiarization with regulations of department of explosives.	**6**
			Total=48

Recommended Books:

1) Randall F. Barron, “Cryogenics Systems”, Second Edition, Oxford University Press, New York (1985).
2) Timmerhaus, Flynn,”Cryogenic Process Engineering “, Plenum Press, New York (1989).
3) Pipkov, “Fundamentals of Vacuum Engineering “, Mir Publishers, Moscow.
4) Thomas M. Flynn, “Cryogenic Engineering”, second edition, CRC press, New York (2005).
5) G.M Walker. “Cryocooler- Part 1 Fundamentals” Plenum Press, New York (1983).
6) G.M Walker. “Cryocooler- Part 2” Plenum Press, New York (1983).
7) Proceedings of Advances in Cryogenic Engineering.
8) Proceedings of International Cryocooler Conference.
9) Proceedings of International Cryogenic Engineering Conference and International Cryogenic Materials Conference.

Title of the course : **Safety Engineering**
Subject Code : **OEME-621 B**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Understand various aspect of safety engineering
CO2: Gainknowledge about industrial safety and hazards
CO3: able to calculate costing of accidents and hazards
CO4: Understand basic job safety analysis

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	1	1	2	2	2	1	1	2	1	1	1	1	1
CO2	3	1	3	1	2	2	3	2	1	2	2	1	3	2	1
CO3	3	1	1	1	2	2	2	3	1	2	1	1	1	1	1
CO4	3	1	1	1	2	2	2	1	1	2	1	1	1	1	1
Avg.	3	1	1.5	1	2	2	2.25	1.75	1	2	1.25	1	1.5	1.25	1

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction**	Safety -Goals of safety engineering. Need for safety. Safety and productivity . Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. History of safety movement. Theories of accident causation	**6**
	Safety organization	objectives, types, functions, Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need , types, advantages	**6**
	Accident prevention Methods- Engineering, Education and Enforcement.	Safety Education & Training -Importance, Various training methods, Effectiveness of training, Behaviour oriented training. Communication- purpose, barrier to communication.	**6**
	House-keeping	Responsibility of management and employees. Advantages of good housekeeping. 5 s of house-keeping.	**3**
	Work permit system	objectives, hot work and cold work permits. Typical industrial models and methodology.	**3**
Unit-2	**Personal protection in the work environment**	Types of PPEs, Personal protective equipment- respiratory and non-respiratory equipment. Standards related to PPEs.	**6**
	Monitoring Safety Performance	Frequency rate, severity rate, incidence rate, activity rate.	**6**

	Cost of accidents	Computation of Costs- Utility of Cost data. Plant safety inspection, types, inspection procedure. Safety sampling techniques. Job safety analysis(JSA), Safety surveys, Safety audits. Safety Inventory Technique.	**6**
	Accident investigation	Why? When? Where? Who? & How? . Basics- Man- Environment &Systems .Process of Investigation –Tools-Data Collection-Handling witnesses- Case study.	**3**
	Accident analysis	Analytical Techniques-System Safety-Change Analysis-MORT-Multi Events Sequencing-TOR.	**3**

Total=48

Recommended Books:

1. N.V. Krishnan, Safety Management in Industry, Jaico Publishing House, 1997
2. Ronald P. Blake, Industrial Safety:, Prentice Hall, New Delhi, 1973
3. David L. Goetsch, Occupational Safety and health, Prentice Hall
4. Ted S. Ferry, Modern Accident Investigation and Analysis, John Wiley & Sons
5. Willie Hammer, Occupational Safety Management and Engineering, Prentice Hall
6. Alan Waring, Safety Management System, Chapman & Hall
7. John V. Grimaldi and Rollin H. Simonds, Safety Management, All India Traveller Book Seller, Delhi.
8. Accident Prevention Manual for Industrial Operations : National Safety Council, Chicago

Title of the course : **Supply Chain Management**
Subject Code : **OEME-621 C**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Knowledge gain about supply chain management concept
CO2: Conduct performance measurements of any supply chain.
CO3: Capable to apply the SCM philosophy in the industry.
CO4: Conduct of inventory management at inbound & outbound supply chain level
CO5: Understand the framework and scope of supply chain networks and functions.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	1	2	1	1	1	1	1	1	1	1
CO2	3	3	3	3	3	1	2	2	1	3	2	1	3	2	1
CO3	3	3	3	3	3	1	2	1	1	1	1	1	1	1	1
CO4	3	3	3	3	3	1	2	1	1	1	1	1	1	1	1
CO5	3	3	3	3	3	1	2	1	1	2	2	1	3	2	1
Avg.	3	3	3	3	3	1	2	1.2	1	1.6	1.4	1	1.8	1.4	1

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Supply Chain & Logistics Management**	Perspective of Supply Chain Logistics Management. Logistics concept, role and scope; Logistics Environment- Integrating Logistics of Supply, Logistics of Production and Logistics of Distribution. Internal and external factors for logistics strategy, Operational Resources of logistics (personnel, warehouse means of transport, warehouse transport aids, organizational aids, material stocks, and area/ spare)	**9**
	SCM Tools	Effective supply chain management, customer networking and manufacturing, Risk Pooling, Postponement, cross docking in supply chain, CPFR, IT-enabled supply chains value of Information, Coordination in SCM.	**9**
Unit-2	**Supply chain Planning**	Logistics Activity Mix. JIT and Logistics, Synchronised manufacturing. Purchasing and Materials Management. Distributional logistical systems and facilities-single stage or multistage, warehouse(s), their number, location and allocation, Automated Warehousing, Materials Handling and Packaging. Simulation aided planning of conveyor and warehousing systems.	**9**
	Supply Chain Coordination & Integration	Supply Chain Logistics Mix Management. Logistical Connectivity: Transportation modes, rate structure, legal aspects; maintenance, spares and repairs; test and support equipment, Routing of freight flows. Management and Organization of the Logistics Systems; Organization, Information and cost control; Logistical information Systems, Computer aided logistics management. Case Studies.	**9**

Total=36

Recommended Books:

1. Sunil Chopra, Peter Meindi and Kalra,Supply Chain Management , Strategy, Planning, and operation Pearson Education, 2010
2. Arvind Jayant, Industrial Engineering & Operation Management, Studium Press 2019, New Delhi
3. Srinivasan G.S;Quantitative models in Operations and Supply Chain Management, PHI, 2010.
4. James B.Ayers Handbook of Supply chain management, St.Lucle press, 2000

Title of the course : **QUALITY ENGINEERING**
Subject Code : **OEME-622 A**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to
CO1: Control the quality of processes using control charts for variables in manufacturing industries.
CO 2: Control the occurrence of defective product and the defects in manufacturing companies.
CO 3: Control the occurrence of defects in services.
CO 4: Achieve savings in rupees to the companies through quality control and improvement

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	1	2	1	1	1	1	1	1	2	1
CO2	3	3	3	3	3	1	2	2	1	3	2	1	3	2	1
CO3	3	3	3	3	3	1	2	1	1	1	1	1	1	1	1
CO4	3	3	3	3	3	1	2	1	1	1	1	1	1	2	1
Avg.	3	3	3	3	3	1	2	1.25	1	1.5	1.25	1	1.5	1.75	1

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Quality fundamentals**	Importance of quality- evolution of quality- definitions of quality- dimensions of quality- quality control- quality assurance- areas of quality- quality planning- quality objectives and policies quality costs- economics of quality- quality loss function- quality Vs productivity- Quality Vs reliability.	
	Control charts for variables	Process variation- preliminary decisions- control limits and their computation- construction and application of X bar, R and S charts- warning and modified control limits- process adjustment for trend, Comparison of process variation with specification limits- O.C. curve for X bar chart.	
Unit-2	**Statistical process control**	Process stability- process capability study using control charts- capability evaluation- Cp, Cpk and Cpm – capability analysis using histogram and normal probability plot- machine capability study- gauge capability study- setting statistical tolerances for components and assemblies individual measurement charts- X-chart, moving average and moving range chart, multi-variable chart.	
	Control charts for attributes	Limitations of variable control charts- Control charts for fraction non-conforming- p and np charts, variable sample size, operating characteristic function, run length- Control chart for nonconformities (defects)- c, u, ku charts, demerits control chart- applications.	

	Acceptance sampling	Need- economics of sampling- sampling procedure- single and double sampling- O.C. curves, Average outgoing quality- Average sample number- Average total inspection- Multiple and sequential sampling- Standard sampling plans- Military, Dodge-Roaming.	

Total=48

Recommended Books:

1. S.P.Singh, Production and Operation Management Vikas Publishers, Delhi
2. Grant & Leave worth;Statistical Quality Control McGraw Hill
3. J.R. Taylor Quality Control Systems McGraw-Hill
4. M.Mhajan, Statistical Quality Control Dhanpat Rai
5. A.V. Taylor Total Quality Control McGraw-Hill
6. Ravi Shankar, Industrial Engineering & Management McGraw-Hill

Title of the course : **Industrial Automation**
Subject Code : **OEME-622 B**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Ability to design interface of computers with the outside world
CO2: Programming for PLC
CO3: Modelling of Physical system dynamics
CO4: Linear control of Physical systems

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	1	1	1	2	2	1	3	2	2	1	1
CO2	1	1	1	2	2	1	1	1	2	1	3	1	2	1	1
CO3	3	3	1	2	1	1	1	1	2	2	2	1	2	2	1
CO4	3	1	2	1	1	2	1	2	1	2	2	2	1	2	1
Avg.	2.5	2	1.5	1.75	1.25	1.25	1	1.5	1.75	1.5	2.5	1.5	1.75	1.5	1

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction**	The Mechatronics approach: A methodology for integrated design of Mechanical, Electronics, Electrical, Control, computer and Instrumentation	**01**
	Fundamentals of Electronics and digital circuits	Number systems: Binary, Octal, Hexadecimal, Boolean Algebra, Logic Gates, Karnaugh maps and simplification of logic circuits, Operational Amplifiers, Types of Operational Amplifiers, Multiplexer and De-multiplexer.	**08**
	Application of Personal Computer in Control and Automation	Analog and Digital signal, Analog to Digital Conversion, Digital to Analog Conversion: Weighted resistor method and R-2R method, C programming for Digital Input and output, ADC and DAC	**08**
	Sensors and Actuators	Strain Gauge, Potentiometer, Optical encoders: incremental and absolute encoders, Linear variable differential transformer(LVDT), Piezoelectric, Proximity sensor, Resistance Temperature Detector(RTD), Thermistors, Thermocouple, Hall effect sensor; Permanent Magnet DC Motor, Stepper Motor	**07**
Unit-2	**Pneumatics and Hydraulics**	Hydraulics and Pneumatic power supplies, Selection of Pnuematic Pipeline Materials, Pressure drop in pipeline, FRL unit, Direction control valves: Types, Nomenclature, actuation systems, Pressure control valves: Pressure limiting, pressure relief and pressure sequence valves, Check valves: Non return valve, Shuttle valve, Non-return flow control valve, twin pressure sequence valve, Time delay valve, Basic Pneumatic Circuits, Pilot operation, Cylinder sequencing and	**09**

		process control, Movement Diagram ; Actuators: Single acting and double acting cylinders, Cushion assembly, Rotary actuators, vane motors, Jeroter.	
	Programmable Logic Controller (PLC)	Function of PLC, Architecture, Components of PLC, selection of PLC, Ladder Logic diagram, Mnemonics, Logic functions: latching, sequencing, counters, shift registers, jumpers, manipulation of data, arithmetic operations	**07**
	Fundamentals of Modelling and Linear Control	Modelling of physical systems dynamics, Laplace Transform, Transfer Functions, Block Diagrams, Response Analysis and Simulation: First order and second order systems.	**08**

Total=48

Recommended Books:

1. W. Bolten, Mechatronics, Pearson Education
2. Andrew Parr, Pneumatic Systems, TMH
3. A.P. Malvino, Digital Principles and Applications, McGraw Hill
4. Norman S. Nise, Control Systems Engineering, Wiley

Title of the course : **Optimization Techniques**
Subject Code : **OEME-622 C**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Learn the basic concepts & issues of engineering optimization and application of optimization techniques.

CO2: Formulate the general linear programming problem (LPP) using different approaches and attempt the variations of the class of problems.

CO3: Formulate the transportation and assignment model, and attempt the variations of the class of problems.

CO4: Draw the network diagrams for project management and assess the project completion time.

CO5: Learn the basic concepts of queuing theory and analyse the case studies based on (M/M/1) model.

CO/PO Mapping: Strong(3) / Medium(2) / Weak(1) indicates strength of correlation:															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2	1	1	1	2	2	1	3	2	2	1
CO2	3	3	3	1	2	2	1	1	1	2	1	3	1	2	1
CO3	3	3	3	1	2	1	1	1	1	2	2	2	1	2	2
CO4	3	3	3	2	1	1	2	1	2	1	2	2	2	1	2
CO5	3	3	3	1	2	1	1	2	1	2	3	2	1	2	3
Avg.	3	3	3	1.4	1.8	1.2	1.2	1.2	1.4	1.8	1.8	2.4	1.4	1.8	1.8

Theory:

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction**	Introduction, historical development, characteristics and application of operations research, scope of operations research, classification of optimization techniques in brief.	**04**
	Linear Programming	Introduction, formulation of linear programming problem (LPP), graphical representation and solution to LP problems, solution of LPP using simplex method, Big-M method and two-phase method, degeneracy in LPP, duality in linear programming.	**10**
	Transportation Model	Introduction, mathematical formulation, balanced and unbalanced problem, different methods of obtaining initial basic solution, Vogel's approximation, optimal solution of transportation model using MODI method, optimality test, optimal solution of minimization and maximization problems.	**10**
Unit-2	**Assignment Model**	Introduction, mathematical formulation, difference between transportation and assignment model, unbalanced (m x n matrix) assignment problem, minimization and maximization assignment problem, optimal solution of assignment model using Hungarian method, sequencing and traveling salesman problems.	**08**
	Project management (PERT& CPM)	Introduction, evolution and application of PERT & CPM technique, concept of activities and events, drawing of network diagram, Fulkurson's rule, float and slack times, time estimates, critical path, estimation of project completion time, crashing and updating problem.	**10**

	Queuing Model	Introduction, elements/ structure of queues, operating characteristics, classification of queuing model, Kendall's notation for representing queuing model, case studies on (M/M/I) model.	**06**

Total=48

Recommended Books:

1. S. S. Rao, Engineering Optimization — New Age International
2. A. H. Taha, Operations Research — Prentice Hall of India
3. P. K. Gupta & D. S. Hira, Operations Research — S. Chand & Co.
4. A. D. Belegundu, Operations Research — Prentice Hall of India

Title of the course : **AUTOMOBILE ENGINEERING**
Subject Code : **PEME-621 A**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the basic knowledge of automobile component, different systems and its performance.
CO2: Assess the basics about Automotive Engine System and fuel supply System and apply to different type of vehicles.
CO3: Understand the concept of Automobile Chassis, hydraulically operated clutch, fly wheel, and automotive brake system.
CO4: Understand about Automotive Transmission, types of gear, working of gear box and apply the knowledge to Gear selector mechanism, differentials and drive axles.
CO5: Learn the basic concepts of Automotive Electronic and Electrical Equipment and application to various parts of automobile

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	3	2	1	1	2	2	2	2	2	2	1	1
CO2	2	3	3	3	2	1	1	2	2	2	3	2	2	3	1
CO3	2	2	2	3	2	2	1	2	3	2	2	2	1	3	2
CO4	2	3	2	2	2	2	1	2	2	2	2	2	2	1	2
CO5	3	3	3	2	2	1	1	2	3	2	2	3	1	1	1
Avg.	2.4	2.6	2.6	2.6	2	1.4	1	2	2.4	2	2.2	2.2	1.6	1.8	1.4

Theory

Unit	Main Topic	Course outline	Lectures
Unit-I	**Engine fundamentals and performance**	Introduction-Engine fundamentals, engine operations, engine type and construction. Engine measurement and performance.	**6**
	Automobile Engine Components	Automobile Engine Components: connecting rods, rod bearings, piston rings, crank shaft, cylinder blocks, valves & valves train,	**6**
	Engine fuel supply System	Automotive engine fuels, fuel and exhaust system, carburetors, carburetor fuel system service, diesel fuel engines injection system, gasoline fuel injection system.	**6**
	Automotive Engine System	Engine lubricating system, engine cooling systems, emission control & tune up.	**6**
Unit-II	**Automotive Chassis**	Automotive Chassis: Spring and suspension system, steering systems, automobile clutches, hydraulically operated clutch, pressure plate, fly wheel, adjusting wheel, spacing, and automotive brake system.	**8**
	Automotive Transmission	Automotive Transmission: Gear ratio, types of gear, types of gear box, working of gear box, Gear selector mechanism, planetary type gear box, universal joints, and differentials and drive axles.	**8**
	Automotive Electronic and Electrical Equipment	Automotive Electronic and Electrical Equipment: The automotive electrical system, starting system, central point ignition, electronic ignition system, automotive battery.	**8**

Total-48

Recommended Books:

1. Nakre ;Automobile Engineering; Standard Publication.
2. Crouse;Automobile Mechanics;Tata McGraw Hill Publication.
3. Kirpal Singh;Automobile Engineering; Standard Publication.
4. Mathur & Sharma;A Text Book of IC Engine; Dhanpat Rai Publication

Title of the course : **Dynamics of Machines**
Subject Code : **PEME-621 B**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students will be able

CO1: Analyse the force analysis of CAM follower mechanism & dynamics analysis of different machines
CO2: Understand the basic concepts of flywheel and governors with their applications.
CO3: Understand the basic laws of friction and its application for studying the clutches, Power screws, brakes etc.
CO4: Understand the concepts of static and dynamic mass balancing along with concept of gyroscope
CO5: Understand the concepts of different types of vibrations and solve complex problems of vibration.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	3	2	1	1	2	2	2	2	2	2	1
CO2	3	2	3	3	3	2	1	1	2	2	2	3	2	2	3
CO3	3	2	2	2	3	2	2	1	2	3	2	2	2	1	3
CO4	3	2	3	2	2	2	2	1	2	2	2	2	2	2	1
CO5	3	3	3	3	2	2	1	1	2	3	2	2	3	1	1
Avg.	3	2.4	2.6	2.6	2.6	2	1.4	1	2	2.4	2	2.2	2.2	1.6	1.8

Theory

Unit	Main Topic	Course outline	Lectures
Unit-I	**Engine fundamentals and performance.**	Concept of free body and its equilibrium, static force analysis, friction effects, forces on gear teeth; D'Alembert's principle, dynamic force analysis, force analysis of cam-follower system, equivalent dynamical systems, dynamic analysis of reciprocating engines, practical examples from actual machines.	**04**
	Automobile Engine Components:	Introduction, an approximate analysis, Fluctuation of energy and speed, energy in flywheel, calculation of flywheel size; Flywheel in punching press, inertia force analysis of reciprocating engine.	**04**
	.Engine fuel supply System	Types of governor, function of governors, Analysis of different types of governors, controlling force diagrams, sensitivity analysis, stability of governors, isochronous governors, hunting, power and efforts of governors.	**09**
	Automotive Engine System	Introduction, laws of friction, Coulomb friction, pivot and roller friction, flat pivot and conical pivot, flat collar pivot, single and multiple clutches, cone clutch.	**03**
Unit-II	**Automotive Chassis**	Introduction, Power screws, band and block brakes.	**02**
	Automotive Transmission:	Balancing of rotating masses on one plane and in different parallel planes, balancing of slider crank mechanisms, balancing of in-line, V- and locomotive engines, principles of balancing machine.	**06**

	Automotive Electronic and Electrical Equipment:	Introduction. Principle of gyroscope. Gyroscopic couple. Direction of vector with forced precession. Analysis of precession due to forced precession of rotating disc mounted on shaft. Motion of rigid body with reference to Euler's equations. Effect of gyroscopic couple. Stability of two wheeler, four wheeler, sea vessels and aircraft with numerical problems.	**06**
		Simple harmonic motion; Conservative systems; Free vibrations of systems without damping; Equilibrium and energy methods for determining natural frequency; Rayleigh's method, free vibrations of system with viscous damping, over damped, critically and under damped systems, logarithmic decrement; Forced vibrations of systems with viscous damping, equivalent viscous damping; Impressed forces due to unbalanced masses and excitation of supports, vibration isolation, transmissibility.	**10**

Total=48

Recommended Books:

1. Vicker, J.J., Shigley, J.E., and Pennock, G.R., "Theory of Machines and Mechanisms", 3rd Ed., Oxford University Press, 2003.
2. Massie, H.H., and Reinholtz, C.F., "Mechanisms and Dynamics of Machinery", 4th Ed., John Wiley & Sons, 1987.
3. Grover, G.K., "Mechanical Vibrations", 7th Ed., Nem Chand and Brothers, 2003.
4. Thomson, W.T., "Theory of Vibration with Applications", 3rd Ed., CBS Publishers, 2003.
5. Rattan S.S., "Theory of Machines", TMH, New Delhi, 2010.
6. V.P. Singh, Theory of Machines Dhanpat Rai.
7. Mechanism and Machine Theory by J.S.Rao and R.V.Dukipatti, New Age International.
8. Theory of Mechanisms & Machines by Amitabha Ghosh, Asok Kumar Mallik, Affiliated East-West Press Pvt Ltd.
9. Theory of Machine by R.S.Khurmi. S.Chand .

Title of the course : **Power Plant Engineering**
Subject Code : **PEME-621 C**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the present scenario of energy production in India and understand the different working aspects of hydro power plant

CO2: Explain the construction detail and the working of thermodynamic cycle of the thermal as well as gas power plant

CO3: To understand the power production techniques of nuclear power plant and to apply the knowledge for power plant economics for different load situations

CO4: Explore the knowledge in the field of non-conventional power generation methods and the direct energy conversion methods

CO5: Understand the pollution effects of power generation and ways to control them for the betterment of society

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	2	2	1	2	3	2	2	2	3	1	1	2
CO2	3	3	2	2	2	1	1	2	2	3	2	3	1	1	2
CO3	3	3	3	3	2	1	1	2	2	3	3	3	2	1	2
CO4	2	2	2	2	2	1	1	3	2	2	2	3	2	1	2
CO5	2	2	2	2	2	1	1	3	2	2	2	3	1	1	2
Avg.	2.4	2.4	2.2	2.2	2	1	1.2	2.6	2	2.4	2.2	3	1.4	1	2

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Introduction**	Energy resources and their availability, Present power position and future planning in India & World, Types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants. Load estimation, load curves, various terms and factors involved in power plant calculations. Effect of variable load on power plant operation, Selection of power plant units.	**03**
	Hydroelectric power plants	Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, Advantages and comparison with other types of power plants.	**05**
	Steam power plants	Flow sheet and working of modern-thermal power plants, Classification of turbine, their working and governing, analysis of Re-heat cycle, Regenerative cycle, reheat –regenerative cycle and binary cycle Turbine problems, Condenser, cooling ponds, cooling towers, Feed water treatment, site selection, coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection mechanical dust collector and electrostatic precipitator.	**08**

	Gas & Steam turbine combined cycles	Constant pressure gas turbine power plants, Arrangements of combined plants (steam & gas turbine power plants), re-powering systems with gas production from coal, using PFBC systems with organic fluids, parameters affecting thermodynamic efficiency and performance of combined cycles..	**08**
Unit-2	**Nuclear power plants**	Principles of nuclear energy, basic nuclear reactions, nuclear reactors-PWR, BWR, CANDU, Gas-cooled reactors, liquid –metal cooled reactors, organic moderated cooled reactors, fast breeder reactor, Location of Nuclear power plants, Advantages and limitations, nuclear power station, Shielding Materials, Effect of nuclear radiation, waste disposal.	**07**
	Power plant economics	Load curve, different terminology and definitions, cost of electrical energy, tariff methods of electrical energy, performance & operating characteristics of power plants- incremental rate theory, input-output curves, efficiency, heat rate, economic load sharing.	**06**
	Non-conventional power generation	Solar radiation estimation, solar energy collectors, low, medium & high temperature power plants, OTEC, wind power plants, tidal power plants, geothermal power plants.	**07**
	Direct energy conversion systems	Fuel cell, MHD power generation-principle, open & closed cycle systems, thermoelectric power generation, and thermionic power generation	**02**
	Pollution and its control	Introduction, Air and water pollution by thermal power plants, Radioactive pollution of environment by nuclear power plants, Noise pollution, Methods for reducing the pollution.	**02**
			Total=48

Recommended Books:

1. Power Plant Engineering by P.K. Nag
2. Power Plant Engineering by P.C. Sharma
3. Power Plant Engineering by M. Wakil
4. Power Plant Engineering by ARORA.S. DOMKUNDWAR

Title of the course : **Technical Communication**
Subject Code : **HSMC-601**

L	T	P	Credits	Weekly Load
2	0	0	2	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Understand importance of Technical communication
CO2: Be able to draft different kinds of technical documents
CO3: Draft Business letters, Notices, Agenda, Minutes of Meetings and Memos
CO4: Draft Applications for Jobs
CO5: Prepare effectively for job interviews

NIL

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	1	2	2	2	1	3	2	2	2	3	2
CO2	2	3	3	3	2	1	2	1	1	1	3	1	2	2	2
CO3	3	3	2	3	2	2	1	1	2	3	2	2	3	3	3
CO4	3	3	2	3	1	2	1	2	1	3	1	2	2	2	2
CO5	3	3	2	2	1	1	1	2	2	2	2	2	3	3	3
Avg.	2.8	3	2.2	2.6	1.4	1.6	1.4	1.6	1.4	2.4	2	1.8	2.4	2.6	2.4

Theory:

Unit	Main Topics	Course Description	Lecture(s)
Unit-1	**Technical Documents: Design and Development**	• Importance of Technical communication • Different Kinds of Technical Documents: Style and Appearance • Structure of Reports, Technical Proposals, Research Papers	**08**
	Technical Writing: Grammar and Editing	• Basics of Grammar • Summarizing and Précis writing • Proof reading and Editing	**08**
Unit-2	**Business Communication**	• Business Letters-Placing, Cancelling orders, Complaints, Reply to Complaints • Notices, Agenda ,Minutes of Meetings • Writing Memorandum	**08**
	Career Oriented Communication	• Resume and Bio-data- Design and style; Applying for a job; Language and format of a job application • Job Interviews- Purpose and process; how to prepare for an interview; language and style to be used in an interview; types of interview questions and how to answer the.	**08**
			Total-32

Recommended Books:

1. Beer, David F. and David McMurrey, Guide to writing as an Engineer, Wiley. New York, 2004
2. Mishra, Sunita & C. Muralikrishna. Communication Skills forEngineers.Pearson.
3. Bhattacharya, Indrajit. An Approach to Communication Skills. Dhanpat Rai & Co.
4. Sharma, R.C. & Krishna Mohan. Business Correspondence and Report Writing. Tata McGraw-Hill.

Title of the course : **Heat and Mass Transfer Lab**
Subject Code : **PCME-623**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Ability to understand the concept of heat transfer modes
CO2: To analyze and determine the conductivity of the wall, materials etc.
CO3: Analyze the phenomena of dropwise and film wise condensation.
CO4: Design and analyze the heat exchanger design concept.
CO5: To understand the concept and application of fin with different materials.

NIL

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	1	1	1	2	2	3	2	2	3	3
CO2	3	2	3	2	2	1	2	1	1	3	2	2	2	2	3
CO3	3	3	2	3	2	2	1	1	2	2	3	2	3	2	3
CO4	3	2	3	3	2	1	1	1	1	3	2	2	2	3	2
CO5	3	3	3	3	2	1	2	1	1	2	2	2	2	2	3
Avg.	3	2.6	2.8	2.8	2	1.2	1.4	1	1.4	2.4	2.4	2	2.2	2.4	2.8

List of Experiments:

1. To determine the Thermal Conductivity of a Metal Bar.
2. To determine the total Thermal resistance and thermal conductivity or a composite wall.
3. To find out the convective heat transfer coefficient in a vertical cylinder in nature convection mode and also compare the results while using suitable empirical relation for the given configuration.
4. To find out heat transfer coefficient in forced convection mode and also compare the results while using suitable empirical relation for the given configuration. _
5. To find the thermal conductivity of insulating powder using sphere configuration.
6. To study the parallel &counter type heat exchanger &find out overall heat transfer coefficient and effectiveness of the heat exchanger for both parallel and counter type flow of heat exchanger.
7. To find out the heat transfer coefficient for film wise and drop wise condensation.
8. To verify the Stefan Boltzmann constant help or the given experimental setup.
9. To find out the emissivity of the test plate at various surface temperatures.
10. To find out rate of heat transfer on different fins materials.

Title of the course : **Technical Communication Lab**

Subject Code : **HSME-602**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Understand Concepts of Communication
CO2: Improve Communication Skills
CO3: Make oral presentations and be able to use multimedia
CO:4 Participate effectively in group discussions, debates and job interviews
CO:5 Adopt social and professional communication etiquettes

NIL

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	1	2	2	2	1	3	2	2	2	3	2
CO2	2	3	3	3	2	1	2	1	1	1	3	1	3	3	3
CO3	3	3	2	3	2	2	1	1	2	3	2	2	3	3	3
CO4	3	3	2	3	1	2	1	2	1	3	1	2	2	2	2
CO5	3	3	2	2	1	1	1	2	2	2	2	2	2	3	3
Avg.	2.8	3	2.2	2.6	1.4	1.6	1.4	1.6	1.4	2.4	2	1.8	2.4	2.8	2.6

List of Activities of Lab:

1. Reflecting upon Self and Analyzing Environment.
2. Reading and Improving upon Vocabulary with the Help of Newspapers
3. Collecting and Using Library Resources.
4. Giving Individual Oral Presentations (Will Require Multiple Sessions)
5. English Conversation Skills and Speaking Practice
6. Group Discussions/Debates/Extempores
7. Summarizing a Given Short Story
8. Summarizing Newspaper Reports and Events
9. Role Plays/Mock Events
10. Grammar Exercises
11. Finalization of Team Project Work.
12. Collecting Materials for Project Work & Finalization of Project.
13. Presentation of Project

Title of the course : **Tool Design**
Subject Code : **HDME-621**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the different types of metal cutting operations and cutting parameters used in turning, drilling and milling operations.
CO2: Identify different types of systems to represent the geometrical parameters of single point cutting tool.
CO3: Understanding of different cutting tool materials and desired properties of cutting tool materials.
CO4: Study the design considerations and development of single point cutting tool, drill, milling cutters, broach and hob.
CO5: To select the manufacturing process for a given application.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	3	3	2	2	2	1	1	2	3	1	1	1
CO2	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO3	2	2	3	3	3	2	2	2	1	1	2	3	2	2	2
CO4	2	2	3	3	3	2	2	2	1	1	2	3	2	3	3
CO5	2	2	3	3	3	2	2	2	1	1	2	3	1	1	2
Avg.	2	2	3	3	3	2	2	2	1	1	2	3	1.4	1.8	1.8

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Classification of cutting tools**	principle elements of various cutting tools; single point cutting tool geometry in ASA, ORS & NRS systems	**03**
	Tool Materials	Properties of various cutting tool materials, composition, production process and application.	**03**
	Design of Single point cutting tools	Cutting parameters, Classification of single point cutting tools: solid, carbide tipped tools, design of single point cutting tool, re-sharpening of single point cutting tools. Form Tools Purpose and types, design procedure and their sharpening.	**06**
	Drill design	Cutting parameters of drilling operations,. Types of drills, solid, carbide tipped drills, geometrical parameters of a twist drill, design of a twist drill, re-sharpening of the twist drill.	**06**
	Milling Cutter Design	Milling operations, cutting parameters, different milling tools for these operations. Types of milling cutters, solid, and carbide tipped cutter; geometrical parameters of a milling cutter, design procedure of a disc type milling cutter, re-sharpening of the cutters	**06**
Unit-2	**Broach design**	Broaching operation and cutting parameters, types of broaches, design procedure of a broach, re-sharpening of the broach.	**03**

	Hob design	Gear nomenclature, construction of involutes profile, hobbing operation and its advantages, geometrical parameters of a hob, design of a hob	**03**
	Jigs and Fixture	Definition, uses of jigs & Fixture, Principle of jigs& fixture design, location & clamping devices Drilling jigs , milling fixtures, lathe fixture, grinding fixture, assembly & welding fixture, broaching fixture. Economics of jigs & fixture, selection of particular types of jigs & fixture	**10**
	Press Tool and Die Design	Types of presses and selection, press accessories and attachments, Chutes, Magazines, Hoppers, Roll feeds, Dials, etc. Automatic stops, Hand feed and pin stops, Automatic Finger stops Development of blanks and scrap strip layouts, Die material, Selection between dies Die clearances and Allowances, Design for blanking dies, progressive, Bending dies, Forming dies, Drawing die	**8**
			Total=48

Recommended Books:

1. Donaldson ;Tool Design McGraw Hill
2. Prakash Joshi Cutting tools Wheeler Publishing
3. Arschinov&Alearoev Metal Cutting theory & practice MIR publication
4. Grant Jigs& Fixtures TMH

Title of the course : **Inspection and Testing of Welds**
Subject Code : **HDWL-621**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Identifying various weld defects and understand the nature of occurrence of these defects along with their remedial measures.

CO2: Understand the meaning of welding inspection, responsibilities in welding inspection, role and certification of welding inspectors.

CO3: Develop a WPS for particular application

CO4: Learn about various destructive and non-destructive techniques used in welding.

CO5: Apply about Statistical Quality Control Techniques for testing of welds.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	3	3	2	2	2	1	1	2	3	1	1	1
CO2	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO3	2	2	3	3	3	2	2	2	1	1	2	3	2	2	2
CO4	2	2	3	3	3	2	2	2	1	1	2	3	2	3	3
CO5	2	2	3	3	3	2	2	2	1	1	2	3	1	1	2
Avg.	2	2	3	3	3	2	2	2	1	1	2	3	1.4	1.8	1.8

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Solid State Welding Processes**	Definition of discontinuity, imperfection and defects, classification of various welding defects, causes and remedies. Concept of quality assurance in welding, weld quality-meaning, organization, requirement, procedure and program for quality assurance.	**12**
	Thermit Welding	Meaning of welding inspection, responsibilities in welding inspection, role and certification of welding inspectors. Description and important details of WPS; Essential, non-essential and supplementary variables, various steps in procedure qualification, PQR (procedure qualification record).	**08**
	Surfacing and Thermal Spraying	Welding performance qualification-requirement, qualification and re-qualification of welders, Qualification record, Essential and non-essential variables in performance qualification.	**04**

Unit-2	**Destructive Testing of Welds:**	Classification and description of destructive testing techniques like Tensile test, Bend test, Impact test, Hardness test, Fatigue test; Testing of welding consumables-All weld test, Determination of diffusible hydrogen, Deposition efficiency, Coating moisture determination.	**12**
	Non Destructive Testing:	Visual inspection, dye-penetrate inspection, magnetic particle inspection, ultrasonic testing, radiographic testing, eddy current testing.	**08**
	Statistical Quality Control Techniques applied to Weld Testing:	Basic concept about application of control charts and acceptance sampling for testing and inspection of welds	**04**
			Total=48

Recommended Books

1. R. S. Parmar Welding Engineering & Technology Khanna Publications
2. S. V. Nadkarni Modern Arc Welding Technology Oxford & IBH.
3. Leonard. P. Connor AWS Welding Handbook, Volume-1AWS
4. Juran Statistical Quality Control McGraw Hill.
5. Mahajan Quality Control Dhanpat Rai & Sons
6. Method of Testing Fusion Welded Joints and Weld Metals in Steel IS-3600 (Part-I & II) BIS, New Delhi
7. ASME Boiler and Pressure Vessel Code Section IX. ASME
8. O P Khanna Welding Technology Dhanpat Rai

Title of the course : **Inspection and Testing of Welds Lab**
Subject Code : **HDWL-622**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Identifying various weld defects and understand the nature of occurrence of these defects along with their remedial measures.

CO2: Understand the meaning of welding inspection, responsibilities in welding inspection, role and certification of welding inspectors.

CO3: Develop a WPS for particular application

CO4: Learn about various destructive and non-destructive techniques used in welding.

CO5: Apply about Statistical Quality Control Techniques for testing of welds.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	3	3	2	2	2	1	1	2	3	1	1	1
CO2	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO3	2	2	3	3	3	2	2	2	1	1	2	3	2	2	2
CO4	2	2	3	3	3	2	2	2	1	1	2	3	2	3	3
CO5	2	2	3	3	3	2	2	2	1	1	2	3	1	1	2
Avg.	2	2	3	3	3	2	2	2	1	1	2	3	1.4	1.8	1.8

List of Experiments:

1. Introduction to destructive testing facilities in the lab.
2. Introduction to non-destructive testing facilities in the lab.
3. Demonstration for the working of muffle furnace.
4. Study and demonstration of tensile test.
5. Study and demonstration of compressive test.
6. Study and demonstration of impact strength (Charpy V-notch) test.
7. Study and demonstration of impact strength (Izod) test.
8. Study and demonstration of U-bend test.
9. To perform visual inspection of a given weld specimen.
10. To perform magnetic particle inspection of a given weld specimen.
11. To perform die penetrant test on a given weld specimen
12. To perform ultrasonic test on a given weld specimen
13. Hardness test.

Title of the course : **CAD/CAM**
Subject Code : **PCME-711**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Identify the application of computers in designing.
CO2: Understand the hardware in a CAD/CAM system.
CO3: Designing and analysis ability in field of modeling the parts.
CO4: Understand the knowledge related to the use of computers in manufacturing.
CO5: Apply CAD software to produce 2D and 3D designs.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	2	1	1	2	2	3	1	2	1	1	2
CO2	3	2	2	1	1	1	2	3	2	3	1	1	1	2	3
CO3	3	3	2	1	1	1	1	3	3	3	2	2	1	1	3
CO4	3	2	2	1	1	1	2	2	2	3	2	1	1	2	2
CO5	3	1	2	1	1	1	2	3	2	3	1	1	1	2	3
Avg.	3	2	2	1	1.2	1	1.6	2.6	2.2	3	1.4	1.4	1	1.6	2.6

Theory:

Unit	Main Topics	Course Outline	Lecture(s)
Unit-1	**Fundamentals of CAD/CAM**	Introduction to CAD and CAM. Definition of CAD and CAM tools. Applications of CAD/CAM. Design process and application of computers in design. Creating Manufacturing database. Benefits of CAD/CAM.	**04**
	CAD Hardware and Software	Input devices: Keyboard, Touch panel, Light pens, Graphic tablets, Joysticks, Trackball, Mouse, Voice systems. Output devices: Storage, Printers. Display devices: Tube graphics display, Raster refresh graphics display, Plasma panel displays, Liquid crystal displays. Central Processing Unit (CPU). Graphic Standards: GKS, IGES, PHIGS. Data Structure and Database Management of a Graphics System. Coordinate Systems: WCS, MCS, SCS. Software modules: Operating System, Graphics, Application, Programming and Communication.	**06**
	Curves, Surfaces and Solids	Analytical curves: parametric and non-parametric equations; Bezier Curves; Introduction to free form curves: B-spline and NURBS; Surfaces: plane, cylindrical, spherical, ruled, coons patch, swept, revolved, Bezier, B-spline. Ferguson and Bilinear	**07**

		patch. Introduction to solid models; Solid representation, B-rep. CSG, Sweep representation; CAD/CAM data exchange.	
	Geometric Transformations	Formulation, translation, rotation, scaling, reflection, mapping of geometric models, projections. Basic concepts of hidden surface removal and shading.	**04**
Unit-2	**Fundamentals of Computer Numerical Control**	Principles of NC, Classification of NC: Motion control, control loops, positioning systems, NC, CNC, DNC, Combined CNC/DNC systems. Constructional details of CNC machines; Components of CNC machines: MCU, drives, transducers, lead screw, control loops and interpolation, guide-ways. Tooling for NC machines: automatic tool changes, multiple pallets.	**06**
	Numerical Control Programming	Manual part programming; Format and codes; Tool length and radius compensation; Tool path simulation of lathe and milling; Computer assisted part programming; APT, post processor and auxiliary statements.	**07**
	Adaptive Control Systems	Types, advantages, adaptive control for proper cutting speed, feed in turning operation.	**03**
	Computer Integrated Manufacturing System	Role of computers in QC, Contact and Non-contact inspection methods, Computer aided testing, CMM, 3D scanners, Material requirement planning (MRP)- concepts, inputs, output, Benefits. Manufacturing Resource Planning (MRP-II). Entrepreneur Resource Planning (ERP). Introduction group technology, Part families, Coding and classification, production flow analysis, benefits of group technology, Computer aided process planning (CAPP)-variant and generative approach	**07**
	Recent Trends in CAD/CAM	Concurrent Engineering: concept, enabling technologies. Reverse Engineering. Rapid Prototyping (RP), flexible manufacturing systems (FMS).	**04**

Total = 48

Recommended Books:

1. Zeid, Ibraham, CAD/CAM – Theory and Practice, Tata Mc Graw Hill
2. Mortenson, Geometric Modeling, John Wiley& Sons
3. Groover & Zimmer, Automation, Production Systems and CIM, PHI
4. Chang, Wysk and Wang, Computer aided manufacturing, PHI
5. Kundra, Rao, Tiwari, Numerical Control and Computer Aided Manufacture, Tata Mc Graw Hill

Title of the course : **Machine Design-II**
Subject Code : **PCME-712**

L	T	P	Credits	Weekly Load
3	1	0	4	4

COURSE OUTCOMES:

After successful completion, of the course, students should be able to

CO1: Analyse and apply the theories of failure in design of machine elements.

CO2: Analyse complex Mechanical Engineering problems and apply appropriate engineering techniques and design processes.

CO3: Design machine elements to perform functions to obtain desired objectives under various operating conditions.

CO4: Conduct a failure analysis for the design of mechanical components to select suitable materials and manufacturing considerations.

CO5: Develop creative solutions to problems and conceive innovative approaches of design Mechanical systems.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO 1	PSO 2	PSO3
CO1	3	3	2	2	1	1	2	1	1	1	2	1	3	-	1
CO2	3	3	3	3	2	2	2	1	1	1	2	1	3	1	2
CO3	3	3	3	3	3	2	2	2	1	1	2	1	2	1	2
CO4	3	3	3	3	3	2	2	2	1	1	2	2	3	2	2
CO5	3	2	3	3	3	2	2	1	2	2	2	3	2	2	2
Avg.	3	2.8	2.8	2.8	2.4	1.8	2	1.4	1.2	1.2	2	1.6	2.6	1.5	1.8

Theory

Unit	Main Topics	Course Outlines	Lecture(s)

Unit-1	**Keys and Couplings**	Definition of term "key" & its various types, Splines. Deign of keys for various load cases. Shaft couplings and its various types. Design of various shaft couplings; sleeve or muff, clamp or compression, flange-protected and unprotected; flexible; Oldham's and universal couplings,	**09**
	Clutches	Design procedure for positive, friction and centrifugal clutch.	**07**
	Brakes	Introduction, heat generation equation, design of shoe, band-brake and combination of shoe and band brake, design of caliper type and disc brake and other variants of brakes.	**08**
Unit-2	**Springs**	Design of Helical Springs, Buckling, Surge, Stress and Deflection in non-circular springs, Helical Springs Subjected to Fatigue Loading. Springs in Series. Springs in Parallel. Concentric or Composite Springs. Helical Torsion Springs, Spiral Springs. Design of leaf spring; Material and Construction, equalized stresses, length of leaves, standard sizes of Automobile suspension springs.	**09**
	Gears	Design of spur gear; Design Considerations for a Gear Drive Beam Strength of Gear Teeth-Lewis Equation, Permissible Working Stress for Gear Teeth in Lewis Equation. Dynamic Tooth Load. Static Tooth Load. Wear Tooth Load. Causes of Gear Tooth Failure. Design Procedure for Spur Gears. Spur Gear Construction. Design of Arms for Spur Gears. Helical gear Terms used in Helical Gears. Face Width of Helical Gears. Formative or Equivalent Number of Teeth for Helical Gears. Proportions for Helical Gears. Strength of Helical Gears. Bevel gear; Determination of Pitch; Angle for Bevel Gears. Proportions for Bevel Gears. Formative or Equivalent Number of Teeth for Bevel Gear. Strength of Bevel Gears. Forces Acting on a Bevel Gear. Worm gear; Types of Worms, Types of Worm Gears.	**07**
	I.C. Engine parts	Principal Parts of an I. C. Engine., Cylinder and Cylinder Liner, Design of a Cylinder, Piston; Design considerations for a Piston, Material for Pistons, Piston Head or Crown, Piston Rings, Piston Skirt, Piston Pin. Connecting Rod; Forces Acting on the Connecting Rod, Design of Connecting Rod. Crankshaft; Material and Manufacture of Crankshafts, Bearing Pressure and Stresses in Crankshafts, Design Procedure for Crankshaft, Design for Centre Crankshaft, Side or Overhung Crankshaft. Valve Gear Mechanism, Valves. Rocker Arm.	**07**
			Total=48

Recommended Books:

1. Shigley, J.E., and Mischke, C.R., "Mechanical Engineering Design (in S.I. Units)", 6th Ed., Tata McGraw-Hill, 2006.
2. Juvinall, R.C., and Marshek, K.M., "Fundamentals of Machine Component Design", 4th Ed., John Wiley & Sons, 2006.
3. M.F. Spotts , Mechanical Design Analysis –Prentice Hall.
4. A.M. Wahl, Mechanical Springs –first edition; Cleveland: Penton Pub. Co.
5. Sharma & Aggarwal, "A Text book of Machine Design", Katson.
6. Machine Design-An Integrated Approach, Norton, Pearson Education.
7. D W Dudley, Handbook of Practical Gear Design, McGraw-Hill Companies
8. Mahadevan, K., and B., Reddy, "Design Data Hand Book", CBS Publishers, 2003.
9. P. S. G, "Design data handbook", P. S. G., Coimbatore.

Title of the course : **Non-Conventional Energy Resources**
Subject Code : **OEME-711 A**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the operation of various non conventional energy resources.
CO2: Analyze the various non conventional energy resources.
CO3: Familiarize the components of non conventional energy resources.
CO4: Design of solar energy system and wind energy system.
CO5: Identify the application of various non conventional energy resources.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	1	1	1	1	2	1	2	1	1	1	2
CO2	3	3	1	3	1	1	1	1	2	1	3	1	1	1	2
CO3	3	2	1	1	2	1	2	1	2	1	2	1	2	1	2
CO4	3	3	1	1	1	1	1	1	2	1	3	1	1	1	2
CO5	3	3	1	3	1	1	1	1	2	1	3	1	1	1	2
Avg.	3	2.6	1	1.8	1.2	1	1.2	1	2	1	2.6	1	1.2	1	2

Theory

Unit	Main Topics	Course Description	Lecture(s)
Unit-1	**Introduction**	Renewable and non-renewable energy sources, their availability and growth in India: energy consumption as a measure of Nations Development: strategy for meeting the future energy requirements.	12
	Solar Energy	Solar radiations-beam and diffusion radiations; earth sun angles, attenuation and measurement of solar radiation; Optical properties of materials and selective surfaces.	
	Solar Energy Equipments	Principles, introduction of different types of collectors, flat plate, cylindrical, and parabolic collectors; Solar energy storage system-their types, characteristics and capacity; solar ponds. Application of solar energy in water, space and process heating, solar refrigerant and air conditioning; water desalination and water pumping; Solar thermal power generation; solar cells and batteries.	12
	Wind Energy	Principle of wind energy conservation; basic components of wind energy conversion systems; wind mill components, various types and their construction features; wind data and site selection considerations.	
Unit-2	**Direct Energy Conversion Systems**	i)Magnetic Thermodynamic(MHD) Generators; Operating principle, types and working of different MHD system-their relative merits; MHD materials and production of magnetic fields. ii) Thermo-Electric Generators; Thermo-electric effects and materials; thermoelectric devices and types of thermo-electric generators; thermo-electric	12

		refrigeration. iii) Thermionic Generators; Thermionic emission and materials; working principle of thermionic convertors. iv) Fuel Cell; Thermodynamic aspect; types, components and working of fuel cell. Performance, applications and economic aspects of above mentioned direct energy conversion systems.	
	Miscellaneous Non-Conventional Energy System	i) Bio-Mass; Concept of bio-mass conversion, photo-synthesis and bio-gasification; bio gas generators and plants, their types constructional features and functioning; fuel properties of bio gas and community bio gas plants ii) Geothermal; Sources of geothermal energy types, constructional features and associated prime movers iii) Tidal and wave energy plants; single basin and double basin tidal power plants; conversion devices, Advantages/disadvantages and applications of above mentioned energy system.	12

Total = 48

Recommended Books:

1. Jai Prakash, H.P. Garg, Solar Energy: Fundamental And Application, Tata McGraw-Hill.
2. S.P. Sukhatme, Solar energy: Principles of Thermal collection & storage, Tata McGraw-Hill.
3. DuffieBeckman , Solar Engineering of Thermal Process, John Willey Duffie.
4. Chang, Energy conversion, Publishers prentice Hall.

Title of the course : **Robotics**
Subject Code : **OEME-711 B**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: To develop the ability to analyze and design the motion for articulated systems.

CO2: To acquire the knowledge on advanced algebraic tools for the description of motion.

CO3: Obtain knowledge and understand the basic concepts of industrial robotics, namely in terms of classification, kinematics, sensors, and typical applications

CO4: Program industrial (manipulator) robots.

CO5: Describe current status of robotics technology and new development. Understand the context and importance of robotics in the different society sectors.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	1	1	1	2	1	2	2	2	2	1	1	1
CO2	3	3	1	1	1	1	2	1	2	2	2	3	1	1	1
CO3	3	1	2	1	2	1	2	1	2	3	2	2	2	1	2
CO4	3	1	2	1	2	1	2	1	2	2	2	2	2	1	2
CO5	1	1	1	1	1	1	2	1	2	3	2	2	1	1	1
Avg.	2.6	1.8	1.4	1	1.4	1	2	1	2	2.4	2	2.2	1.4	1	1.4

Theory:

Unit	Main Topics	Course Description	Lecture(s)
Unit-1	**Introduction**	Evolution of robot and robotics, laws of robotics, robot anatomy: Links, joints, Degrees of freedom (DOF), Precision movement, robot specifications and work volume, Types of Robot drives-Basic robot motions, Arm configuration, wrist configuration.	**05**
	End Effectors	End effectors classification-Mechanical, magnetic, vacuum and adhesive gripper, Robot control-unit control system concept-servo and non servo control of robot joints, adaptive and optimal control.	**07**
	Sensors	Sensor devices Types of sensors- contact, position and displacement sensors, Force and torque sensors-proximity and range sensors-acoustic sensors- Robot vision systems, sensing and digitizing- Image processing and analysis.	**08**
Unit-2	**Coordinate Frame,**	Coordinate frames, description of objects in space, transformation of vectors, funamental rotation matrices.	**05**

	Mapping and Transforms		
	Kinematics	Denavit- Hartenberg Notation, kinematic relationship between adjacent links, Manipulator transformation matrix, Inverse kinematics, Concept of manipulator jacobian.	**09**
	Robot Programming	Robot language classification-programing methods off and on line programming, Lead through method, Teach pendent method, Language, simple program.	**08**
	Industrial Applications	Application of robots- Material handling- machine loading and unloading, Assembly, Inspection, Welding, spray painting, Recent developments ion robots-safety considerations.	**06**

Total = 48

Recommended Books:

1. Mittal and Nagrath, Robotics and Control, TMH.
2. J.J. Craig, Introduction to Robotics, Pearson Education.
3. S.R.Deb& S. Deb, Robotics Technology and Flexible Automation, Tata McGraw-Hill

Title of the course : **Energy Auditing**
Subject Code : **OEME-711 C**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: To explain the importance of Energy audit.
CO2: To calculate the materials balance and energy balance.
CO3: To apply the different energy saving principles in thermal systems.
CO4: To use the energy saving practice in electrical systems.
CO5: To discuss a case study of energy saving in industry.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	2	1	1	1	1	1	1	2	1	1	1
CO2	1	1	1	1	2	2	1	3	2	1	3	2	1	3	2
CO3	2	1	2	1	2	1	1	1	1	1	1	1	1	1	1
CO4	2	1	2	1	2	1	1	1	1	1	1	2	1	1	1
CO5	1	1	1	1	3	2	1	3	2	1	3	2	1	3	2
Avg.	1.4	1	1.4	1	2.2	1.4	1	1.8	1.4	1	1.8	1.8	1	1.8	1.4

Theory

Unit	Main Topics	Course Description	Lecture(s)
Unit-1	**Energy Management & Audit**	Definition, need and types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, energy audit instruments.	**03**
	Material and Energy balance	Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.	**02**
	Fuels and Combustion	Introduction to fuels, principles of combustion, combustion of oil, coal and gas.	**02**
	Boilers	Types, combustion in boilers, performances evaluation, analysis of losses, feed water treatment, blow down, energy conservation opportunities	**03**
	Steam System	Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings.	**03**
	Furnaces	Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery.	**02**

	FBC boilers	Introduction, mechanism of fluidized bed combustion, advantages, types of FBC boilers, operational features, retrofitting FBC system to conventional boilers, saving potential.	**03**
	Cogeneration	Definition, need, application, advantages, classification and saving potentials.	**02**
	Waste Heat Recovery	Classification, advantages and applications, commercially viable waste heat recovery devices, saving potential.	**02**
Unit-2	**Electrical system**	Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses.	**03**
	Electric motors	Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.	**03**
	Compressed Air System	Types of air compressors, compressor efficiency, capacity assessment, leakage test, factors affecting the performance and savings opportunities	**03**
	HVAC and Refrigeration System	Vapour compression refrigeration cycle, refrigerants, coefficient of performance, capacity, and factors affecting Refrigeration and Air conditioning system performance and savings opportunities.	**03**
	Vapour absorption refrigeration system	Working principle, types and comparison with vapour compression system, saving potential.	**02**
	Fans and blowers	Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.	**02**
	Pumps and Pumping System	Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.	**03**
	Cooling Tower	Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities assessment of cooling towers.	**02**
	Lighting System	Light source, choice of lighting, luminance requirements, and energy conservation avenues.	**02**
	Energy Efficient Technologies in Electrical Systems	automatic power factor controllers, energy efficient motors, variable speed drives, energy efficient transformers, energy efficient lighting controls.	**03**
			Total=48

Recommended Books:

1. W.R.Murphy and G.McKAY, Energy Management, Btterworth-Heinemann
2. P.Balasubramanian, Energy Auditing made simple, R.NR.Printers(P)Ltd

Title of the course : **Refrigeration and Air Conditioning**
Subject Code : **PEME-711 A**

L	T	P	Credits	Weekly Load
3	1	0	4	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the operation of vapour comperation and vapur absorption system.
CO2: Analyze the refrigeration cycles and methods of improving performance.
CO3: Familiarize the components of refrigeration systems**.**
CO4: Design air-conditioning system using cooling load calculations.
CO5: Identify the applications of refrigeration and air-conditioning systems.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2	1	1	1	2	2	1	3	2	2	2
CO2	3	3	3	1	2	2	1	1	1	2	1	3	1	2	1
CO3	3	3	3	1	2	1	1	1	1	2	2	2	1	2	1
CO4	3	3	3	2	1	1	2	1	2	1	2	2	2	1	2
CO5	3	3	3	1	2	1	1	2	1	2	3	2	1	2	1
Avg.	3	3	3	1.4	1.8	1.2	1.2	1.2	1.4	1.8	1.8	2.4	1.4	1.8	1.4

Theory

Unit	Main Topics	Course Description	Lecture(s)
Unit-1	**Air Refrigeration Systems**	Introduction, types of air refrigeration systems, reversed control cycle, Bell Coleman air refrigerator, Necessity of air-craft refrigeration, regenerative and reduced ambient type cycles, compression and bootstrap cycle.	**12**
	Refrigeration Systems	Vapor compression refrigeration system,T-S,H-S,P-H diagram for VCR, COP. Performance of VCR, advantages and disadvantages, Methods for improving COP, Multiload system, Single and multi compressions. Introduction, actual aqua ammonia absorption system, electrolux refrigerator, COP Compression between VCR and absorption refrigeration system.	**12**
Unit-2	**Refrigerants and Refrigeration Equipment's**	Classifications of refrigerants, properties of ideal refrigerants, anti-freeze solutions, selection of refrigerants, nomenclature of refrigerants. Ozone layer depletion, eco-friendly refrigerants. Construction details of different types of compressors, condensers, evaporator, expansion devices, dehydrators	**12**
	Air Conditioning Systems	Types of air-conditioning systems, central AC, unitary AC load circulation load calculation based on various parameters, like solar radiations, transmission through building, fresh air ventilation occupancy load, internal heat gain such as lights, appliances, machine etc, state and quantity of supply air for different type of air-conditioning system.	**12**

Total-48

Recommended Books:

1. C. P. Arora, Refrigeration and Air conditioning, TMH.
2. Domkondwar, Refrigeration and Air conditioning, Khanna.
3. Balleney , Refrigeration and Air conditioning, Khanna.
4. Gupta & Prakash, Ref and Air Conditioning, New Chand

Title of the course : **Optimization Techniques**
Subject Code : **PEME-711 B**

L	T	P	Credits	Weekly Load
3	1	0	4	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the basic concepts & issues of engineering optimization and application of optimization techniques.

CO2: Formulate the linear programming problem (LPP) using different approaches and attempt the variations of the class of problems.

CO3: Formulate the transportation and assignment model, and attempt the variations of the class of problems.

CO4: Draw the network diagrams for project management and assess the project completion time.

CO5: Understand the basic concepts of queuing theory and analyze the case studies based on (M/M/1) model.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2	1	1	1	2	2	1	3	2	1	3
CO2	3	3	3	1	2	2	1	1	1	2	1	3	1	1	3
CO3	3	3	3	1	2	1	1	1	1	2	2	2	1	2	2
CO4	3	3	3	2	1	1	2	1	2	1	2	2	2	2	2
CO5	3	3	3	1	2	1	1	2	1	2	3	2	1	3	2
Avg.	3	3	3	1.4	1.8	1.2	1.2	1.2	1.4	1.8	1.8	2.4	1.4	1.8	2.4

Theory

Unit	Main Topics	Course Description	Lecture(s)
Unit-1	**Introduction**	Meaning of optimization, operations research (OR), historical development, characteristics and application of operations research, scope of operations research, Classification of optimization techniques in brief.	**04**
	Linear Programming	Introduction, formulation of linear programming problem (LPP), graphical representation and solution to LP problems, solution of LPP using simplex method, Big-M method and two phase method, degeneracy in LPP, duality in linear programming.	**10**
	Transportation Model	Definition, mathematical formulation, balanced and unbalanced problem, different methods of obtaining initial basic solution, Vogel's approximation, optimal solution of transportation model using MODI method, optimality test, optimal solution of minimization and maximization problems.	**10**
Unit-2	**Assignment Model**	Introduction, mathematical formulation, difference between transportation and assignment model, unbalanced (m x n matrix) assignment problem, minimization and maximization assignment problem, optimal solution of assignment model using Hungarian method, sequencing and traveling salesman problems.	**08**

	Network Analysis In Project Planning (PERT & CPM)	Introduction, evolution and application of PERT & CPM technique, concept of activities and events, drawing of network diagram, Fulkurson's rule, float and slack times, time estimates, critical path, estimation of project completion time, crashing and updating problem.	**10**
	Queuing Model	Introduction, elements/structure of queues, operating characteristics, classification of queuing model, Kendall's notation for representing Queuing Model, Case studies on (M/M/I) Model.	**06**
			Total=48

Recommended Books:

1. S. S. Rao, Engineering Optimization, New Age International
2. A. H. Taha, Operations Research, Prentice Hall of India.
3. P. K. Gupta & D. S. Hira, Operations Research, S. Chand & Co.
4. A. D. Belegundu, Operations Research, Prentice Hall of India.
5. C. K. Mustafi, Operations Research, New Age International.

Title of the course : **Finite Element Methods**
Subject Code : **PEME-711 C**

L	T	P	Credits	Weekly Load
3	1	0	4	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Analyse strain-displacement and stress-strain relations with and without the temperature effect.
CO2: Design a finite element mesh using different finite elements for a continuum domain.
CO3: Analyse the implementation of FEM to solve static, scalar field and dynamic problems.
CO4: Solve a simple mechanical problem using appropriate finite element software.
CO5: Create a computer program for the finite element method.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	2	1	1	1	2	2	1	3	2	1	3
CO2	1	1	1	1	2	2	1	1	1	2	1	3	1	1	3
CO3	2	1	2	1	2	1	1	1	1	2	2	2	1	2	2
CO4	1	1	1	1	2	1	2	1	2	1	2	2	2	2	2
CO5	1	1	1	1	2	1	1	2	1	2	3	2	1	3	2
Avg.	1.2	1	1.2	1	2	1.2	1.2	1.2	1.4	1.8	1.8	2.4	1.4	1.8	2.4

Theory

Unit	Main Topics	Course Description	Lecture(s)
Unit-1	**Introduction**	Historical Background, Stresses and equilibrium, Boundary Conditions, Strain-Displacement Relations, Stress-Strain Relations, Temperature Effects, Vectors and Matrices.	**06**
	Introduction & Fundamental Concepts	Rayleigh-Ritz Method, Galerkin's Method, Point Collocation Method, Least Square Method, Weighted Residual Method.	**06**
	1-D FE Modelling	Finite Element Modelling, Coordinates and Shape Functions, The Potential Energy Approach, The Galerkin's Approach, Assembly of Global Stiffness matrix and Load vector, Properties of Stiffness Matrix, Treatment of Boundary Conditions and Temperature Effects.	**08**
	2-D FE Modelling	Finite Element Modelling, Constant Strain Triangle (CST).	**04**
Unit-2	**2-D FE Modelling**	The Four Node Quadrilateral, Numerical Integration, Higher Order Elements; Nine Node Quadrilateral, Eight Node Quadrilaterals, Six Node Triangle.	**05**
	Truss	Introduction, Plane Trusses, Assembly of Global Stiffness Matrix and Load Vector. (For 1D and 2D problems only)	**08**
	Scalar Field Problems	Introduction, Steady-state heat transfer, Potential Flow, Fluid Flow in ducts.	**04**

	Dynamic Considerations	Element Mass Matrices, Evaluation of Eigen Values and Eigen Vectors. (Introduction only)	**04**
	Computer Implementation	Introduction; Computer Program Organization for Calculation of System Matrices.	**03**

Total=48

Recommended Books:

1. Chandrupatla and Belegundu, Introduction to Finite Elements in Engineering, PHI.
2. K.J. Bathe, Finite Element Procedures, PHI.
3. J. N. Reddy, An Introduction to Finite Element Method, TMH.
4. Huebner, The Finite Element Methods for Engineers, John Wiley.
5. O.C. Zienkiewicz, The Finite Element Method, TMH.
6. Buchanan, Finite Element Analysis, McGraw Hill.

Title of the course : **Non Conventional Energy Resources**
Subject Code : **PEME-712 A**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the operation of various non conventional energy resources.
CO2: Analyze the various non conventional energy resources.
CO3: Familiarize the components of non conventional energy resources.
CO4: Design of solar energy system and wind energy system.
CO5: Identify the application of various non conventional energy resources.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	1	1	1	1	2	1	2	1	1	1	2
CO2	3	3	1	3	1	1	1	1	2	1	3	1	1	1	2
CO3	3	2	1	1	2	1	2	1	2	1	2	1	2	1	2
CO4	3	3	1	1	1	1	1	1	2	1	3	1	1	1	2
CO5	3	3	1	3	1	1	1	1	2	1	3	1	1	1	2
Avg.	3	2.6	1	1.8	1.2	1	1.2	1	2	1	2.6	1	1.2	1	2

Theory

Unit	Main Topics	Course Description	Lecture(s)
Unit-1	**Introduction**	Renewable and non-renewable energy sources, their availability and growth in India: energy consumption as a measure of Nations Development: strategy for meeting the future energy requirements.	12
	Solar Energy	Solar radiations-beam and diffusion radiations; earth sun angles, attenuation and measurement of solar radiation; Optical properties of materials and selective surfaces.	
	Solar Energy Equipment's	Principles, introduction of different types of collectors, flat plate, cylindrical, and parabolic collectors; Solar energy storage system-their types, characteristics and capacity; solar ponds. Application of solar energy in water, space and process heating, solar refrigerant and air conditioning; water desalination and water pumping; Solar thermal power generation; solar cells and batteries.	12
	Wind Energy	Principle of wind energy conservation; basic components of wind energy conversion systems; wind mill components, various types and their construction features; wind data and site selection considerations.	
Unit-2	**Direct Energy Conversion Systems**	i)Magnetic Thermodynamic(MHD) Generators; Operating principle, types and working of different MHD system-their relative merits; MHD materials and production of magnetic fields. ii) Thermo-Electric Generators; Thermo-electric effects and materials; thermoelectric devices and types of thermo-electric generators; thermo-electric	12

		refrigeration. iii) Thermionic Generators; Thermionic emission and materials; working principle of thermionic convertors. iv) Fuel Cell; Thermodynamic aspect; types, components and working of fuel cell. Performance, applications and economic aspects of above mentioned direct energy conversion systems.	
	Miscellaneous Non-Conventional Energy System	i) Bio-Mass; Concept of bio-mass conversion, photo-synthesis and bio-gasification; bio gas generators and plants, their types constructional features and functioning; fuel properties of bio gas and community bio gas plants ii) Geothermal; Sources of geothermal energy types, constructional features and associated prime movers iii) Tidal and wave energy plants; single basin and double basin tidal power plants; conversion devices, Advantages/disadvantages and applications of above mentioned energy system.	12

Total = 48

Recommended Books:

5. Jai Prakash, H.P. Garg, Solar Energy: Fundamental And Application, Tata McGraw-Hill.
6. S.P. Sukhatme, Solar energy: Principles of Thermal collection & storage, Tata McGraw-Hill.
7. DuffieBeckman , Solar Engineering of Thermal Process, John Willey Duffie.
8. Chang, Energy conversion, Publishers prentice Hall.

Title of the course : **Flexible Manufacturing System**
Subject Code : **PEME-712 B**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the operation of various study about Group Technology
CO2: Analyze the various study about CAPP
CO3: Familiarize about FMS Components and Interfaces
CO4: Design about Automated Material Handling Systems
CO5: Identify the application CAPP, FMS and Group technology

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	1	1	1	1	1	2	1	2	1	1	1
CO2	3	3	3	1	3	1	1	1	1	2	1	2	1	1	1
CO3	3	3	2	1	1	2	1	2	1	2	1	2	2	1	2
CO4	3	3	3	1	1	1	1	1	1	2	1	2	1	1	1
CO5	3	3	3	1	3	1	1	1	1	2	1	2	1	1	1
Avg.	3	3	2.6	1	1.8	1.2	1	1.2	1	2	1	2	1.2	1	1.2

Theory:

Unit	Main Topics	Course Description	Lecture(s)
Unit-1	**Group Technology**	Introduction, objectives, part families, algorithms and models for G.T. – Rank order clustering, Bond energy, mathematical model for machine – component cell formation. Design and manufacturing attributes. Parts classification and coding, concept of composite job machine group, cell group tooling, design rationalization.	**6**
	Computer Aided Process Planning	Generative and variant types, backward and forward approach, feature based and CAD based CAPP	**4**
	Introduction to FMS	concepts, advantages, components of FMS and their integration in the data processing systems, FMS scheduling - examples of FMS installations.	**5**
Unit-2	**Distributed data processing in FMS**	DBMS and their applications in CAD/CAM and FMS – distributed systems in FMS -Integration of CAD and CAM - Part programming in FMS, tool data base - Clamping devices and fixtures data base.	**6**
	Material Handling systems	conveyors - AGVs – industrial robots in material handling - AS/RS.	**5**
	Interfacing of computers - machine tool controllers and handling systems	communications standards - programmable Logic Controllers (PLC's) – Interfacing - Computer aided Project planning dynamic part scheduling.	**6**

Total:32

Recommended Books:

1. Groover Englewood, Automation, Production System & Computer Integrated Manufacturing
2. Rankey, Design and Operation of SMS, IFS
3. Wernecks, Flexible Manufacturing System, Spring Verlag.
4. BoncttoNorthox, FMS in Practice, Ford
5. W.W. Luggen, Flexible Manufacturing Cells and systems, Prentice Hall India.
6. Vishwanathan&Narahari, Performance Modelling of Automated Manufacturing Systems, Prentice Hall India

Title of the course : **Supply Chain Management**
Subject Code : **PEME-712 C**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Knowledge gain about supply chain management concept
CO2: Conduct performance measurements of any supply chain.
CO3: Capable to apply the SCM philosophy in the industry.
CO4: Conduct ofinventory management at inbound & outbound supply chain level
CO5: Understand the framework and scope of supply chain networks and functions.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	1	1	1	1	1	1	2	1	2	1
CO2	3	3	3	3	3	1	3	1	1	1	1	2	1	2	1
CO3	3	3	3	3	3	1	1	2	1	2	1	2	1	2	2
CO4	3	3	3	3	3	1	1	1	1	1	1	2	1	2	1
CO5	3	3	3	3	3	1	3	1	1	1	1	2	1	2	1
Avg.	3	3	3	3	3	1	1.8	1.2	1	1.2	1	2	1	2	1.2

Theory:

Unit	Main Topics	Course Description	Lecture(s)
Unit-1	**Supply Chain & Logistics Management**	Perspective of Supply Chain Logistics Management. Logistics concept, role and scope; Logistics Environment- Integrating Logistics of Supply, Logistics of Production and Logistics of Distribution. Internal and external factors for logistics strategy, Operational Resources of logistics (personnel, warehouse means of transport, warehouse transport aids, organizational aids, material stocks, and area/ spare)	**09**
	SCM Tools	Effective supply chain management, customer networking and manufacturing, Risk Pooling, Postponement, cross docking in supply chain, CPFR, IT-enabled supply chains value of Information, Coordination in SCM.	**09**
Unit-2	**Supply chain Planning**	Logistics Activity Mix. JIT and Logistics, Synchronised manufacturing. Purchasing and Materials Management. Distributional logistical systems and facilities-single stage or multistage, warehouse(s), their number, location and allocation, Automated Warehousing, Materials Handling and Packaging. Simulation aided planning of conveyor and warehousing systems.	**09**
	Supply Chain Coordination & Integration	Supply Chain Logistics Mix Management. Logistical Connectivity: Transportation modes, rate structure, legal aspects; maintenance, spares and repairs; test and support equipment, Routing of freight flows. Management and Organization of the Logistics Systems; Organization, Information and cost control; Logistical information Systems, Computer aided logistics management. Case Studies.	**09**

Total = 36

Recommended Books:

1. Sunil Chopra, Peter Meindi and Kalra,Supply Chain Management , Strategy, Planning, and operation Pearson Education, 2010
2. Arvind Jayant, Industrial Engineering & Operation Management, Studium Press 2019, New Delhi
3. Srinivasan G.S;Quantitative models in Operations and Supply Chain Management, PHI, 2010.
4. James B.Ayers Handbook of Supply chain management, St.Lucle press, 2000

Title of the course : **CAD/CAM Lab**
Subject Code : **PCME-713**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Enhance the knowledge of application of computers in designing.
CO2: Know about the hardware**.**
CO3: Designing and analysis ability in field of modeling the parts.
CO4: Understand the knowledge related to the use of computers in manufacturing.
CO5: Use CAD software to produce 2d and 3D designs.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	2	1	1	2	2	3	1	2	1	1	2
CO2	3	2	2	1	1	1	2	3	2	3	1	1	1	2	3
CO3	3	3	2	1	1	1	1	3	3	3	2	2	1	1	3
CO4	3	2	2	1	1	1	2	2	2	3	2	1	1	2	2
CO5	3	1	2	1	1	1	2	3	2	3	1	1	1	2	3
Avg.	3	2	2	1	1.2	1	1.6	2.6	2.2	3	1.4	1.4	1	1.6	2.6

List of Experiments:

S. No.	Title
1.	Introduction to AutoCAD and drawing and drafting of a 2D component
2.	Draw orthographic projections of given 2D components using AutoCAD
3.	Introduction to CNC Star Lathe and Part Programming for a given component using Fanuc controller
4.	Part Programming for a given component for CNC lathe using Fanuc controller, simulation and machining the component.
5.	Introductions to CNC Star Mill and Part programming for a given prismatic component using Fanuc controller
6.	Part programming for a given prismatic component using Fanuc controller, Simulation and machining the component.
7.	Make a program for transformations like scaling, rotation, translation etc. of Line/Rectangle/Triangle in C or MATLAB

8.	Make a program to find points of intersection between two lines, line and a circle, line and rectangle using C or MATLAB
9.	Make a program for drawing analytical or parametric curves like line, circle, parabola, hyperbola and Bezier.
10.	To make 3D model of the given component and generate its drawing using ProE/CATIA
11.	To make 3D model of given components and make assembly using ProE/ CATIA
12.	Introduction to stress analysis through software and performing for a given structure

Title of the course : **Non-Conventional Machining**
Subject Code : **HDME-711**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Understand advantages and applications of non-conventional machining processes in comparison to the conventional machining processes.

CO2: Identify different energy sources like mechanical, chemical, electrochemical, and thermal interaction

CO3: To study the various process parameters and their effect on the component machined on various unconventional machining processes

CO4: To analyse the concept, mechanism, parameters associated with the processes.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	3	3	2	2	2	1	1	2	3	1	1	1
CO2	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO3	2	2	3	3	3	2	2	2	1	1	2	3	2	2	2
CO4	2	2	3	3	3	2	2	2	1	1	2	3	2	3	3
Avg.	2	2	3	3	3	2	2	2	1	1	2	3	1.5	2	1.75

Theory:

Unit	Main Topics	Course Description	Lecture(s)
Unit - 1	**Introduction**	Classification, Advantages & limitations of non-conventional machining. Principle, mechanism of material removal, advantages, limitations, and applications of Ultrasonic Machining (USM)	**12**
	Abrasive and Water Jet Machining	Principle, mechanism of material removal, advantages, limitations, and applications of Abrasive Jet Machining (AJM), Water Jet Machining (WJM), Abrasive Water Jet Machining (AWJM).	**12**
Unit - 2	**Chemical Machining (CM)**	Principle, mechanism of material removal, process characteristics, procedures, advantages, disadvantages, and applications of Chemical Machining (CM).	**06**

	Electrochemical Processes	Principle, mechanism of material removal, process characteristics, procedures, advantages, disadvantages, and applications of Electro Chemical Machining (ECM). Variants of ECM like ECG, Electrochemical deburring, Electrochemical jet drilling.	**06**
	Thermal Metal Removal Processes	Principle, mechanism of material removal, process characteristics, advantages, disadvantages, and applications of processes like Electric Discharge Machining (EDM), Electron Beam Machining (EBM), Ion Beam Machining (IBM), Laser Beam Machining (LBM) and Plasma Arc Machining (PAM).	**12**
			Total - 48

Recommended Books:

1. McGeough JA, Advanced Methods of Machining, Chapman and Hall
2. Pandey & Shan, Modern Machining Process, TMT
3. P.K. Mishra, Non- Conventional Machining, Narosa Publishing House.
4. HMT, Production Technology, TATA McGraw Hill
5. G F Benedict, Non-Traditional Manufacturing Process, Marcel Dekker.
6. B G Ranganath, Thermal Metal cutting processes, I K International Publishing House

Title of the course : **Non-Conventional Machining Lab**
Subject Code : **HDME-712**

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Understand advantages and applications of non-conventional machining processes in comparison to the conventional machining processes.

CO2: Identify different energy sources like mechanical, chemical, electrochemical, and thermal interaction

CO3: To study the various process parameters and their effect on the component machined on various unconventional machining processes

CO4: To analyse the concept, mechanism, parameters associated with the processes.

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CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	3	3	2	2	2	1	1	2	3	1	1	1
CO2	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO3	2	2	3	3	3	2	2	2	1	1	2	3	2	2	2
CO4	2	2	3	3	3	2	2	2	1	1	2	3	2	3	3
Avg.	2	2	3	3	3	2	2	2	1	1	2	3	1.5	2	1.75

List of Experiments:

1. To study and perform the experiment on EDM
2. To study and perform the experiment on ECM
3. To perform the experiment on USM and observe what change in magnitude of impact force of a particle as the temperature of workpiece increased
4. To study and perform the experiment on AJM
5. To study and perform the experiment on WJM
6. To study and perform the experiment on PAM
7. To study and perform the experiment on EBM

Title of the course : **Design of Welds**
Subject Code : **HDWL-711**

L	T	P	Credits	Weekly Load
3	1	0	4	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understandings of the theories of fracture mechanics, types of fractures.

CO2: Understand the mechanical properties and the behavior of the welded components operating at varying temperatures are given to students which in turn enlighten them to understand and interpret the materials and its properties in a better perspective.

CO3: To identify, construct and examine the types of welded joints their significance and applications.

CO4: The safety measures against the setting up and means of controlling residual stresses help students to design and fabricate the weld components with enhanced service life.

CO5: To control distortion and the prevention of distortion.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	3	3	2	2	2	1	1	2	3	1	1	1
CO2	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO3	2	2	3	3	3	2	2	2	1	1	2	3	2	2	2
CO4	2	2	3	3	3	2	2	2	1	1	2	3	2	3	3
CO5	2	2	3	3	3	2	2	2	1	1	2	3	1	1	2
Avg.	2	2	3	3	3	2	2	2	1	1	2	3	1.4	1.8	1.8

Theory

Unit	Main Topics	Course Description	Lecture(s)
Unit-1	**Fracture in Metals**	Types of fracture mainly: Ductile fracture, Brittle fracture, Intergranular fracture, Various factors/conditions affecting type of fracture	**05**
	Fracture Mechanics	Assessment of fracture toughness, Griffith's theory of fracture mechanics, Brittle fracture test parameters, Procedure for evaluating propensity for brittle fracture, Fracture mechanics testing of ductile metals, Crack arrest-principles and methods of crack arrest	**10**
	Mechanical Properties at Low Temperature	Strength at low temperature, Impact toughness at low temperature, Energy absorption in Impact testing, Test methods for toughness evaluation.	**04**
	Fatigue	Definition and meaning of fatigue of metals, Mechanism of fatigue failure, S-N diagram, Factors affecting fatigue life	**05**

Unit-2	**Weld Joints**	Types of welds and welded joints, Different types of edge preparation and factors affecting their selection.	**04**
	Welding Symbols	Primary and secondary weld symbols, location of welding symbols on drawings.	**05**
	Weld design for static loading	Fundamental formulas for design under different types of loading like tension, compression, bending, torsion and impact loading	**08**
	Residual Stresses in Weldments	Definition, causes of development of residual stresses, Residual stresses in specific materials and joints, Methods of controlling residual stresses in Weldments	**03**
	Distortion in Weldments	Definition, and types of distortion in weldments, Various causes and control of distortion, in weldments	**04**
			Total=48

Recommended Books:

1. Welding Engineering & Technology by R.S. Parmar (Khanna Publications)
2. Welding Metallurgy (Volume-1) by George E.Linnert (AWS)
3. Design of Welded Structures by Blodgett, (Lincoln Electric Co.)
4. Modern Arc Welding Technology by S.V. Nadkarni (Oxford & IBH)
5. Design of Welded Structures by Pellini, W.S ISBN: 0-85300-166-9 (The Welding Institute, UK)
6. AWS Welding Handbook Volume-1 Leonard. P. Connor AWS
7. Standard Methods for Mechanical Testing of Welds ANSI/AWS B4.0-92

Title of the course : **Cryogenics Engineering**
Subject Code : **PEME-721 A**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Have a comprehensive understanding of cryogenic systems.
CO2: Conduct experimentation for assessing suitability and application of different materials at cryogenic temperature.
CO3: Analyze properties of materials subjected to cryogenic temperature.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	1	1	1	2	2	2	1	1	2	1
CO2	3	3	3	3	2	1	3	1	2	2	3	2	1	2	2
CO3	3	3	3	3	2	1	1	1	2	2	2	3	1	2	1
Avg.	3	3	3	3	2	1	1.67	1	2	2	2.33	2	1	2	1.33

Theory:

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	**Basics**	Definition of cryogenics, Physical properties of various cryogenic fluids, industrial applications of cryogenic fluids.	**4**
	Low temperature measurement	Measurement systems for low temperature: -temperature measurements, pressure measurements, flow measurements, liquidlevel measurements, fluid quality measurements	**10**
	Cryogenic insulations	Types of insulations, vacuum insulation, gas filled powders & fibrous insulation, evacuated powder & fibrous insulation multi-layer insulation, comparison of performance of various insulation.	**10**
Unit-2	**Properties of materials at low temperature:**	Mechanical properties, specific heat, thermal expansion, electrical resistance, thermal conductivity, emissivity, reflectivity and absorptivity. Properties of cryogenic fluids.	**10**
	Hazards	Physical hazards, chemical hazards, physiological hazards, combustion hazards, oxygen hazards, accidents in cryogenic plants & prevention.	**8**
	Safety	Safety in handing of cryogens, care of storage of gaseous cylinders, familiarization with regulations of department of explosives.	**6**
			Total=48

Recommended Books:

1) Randall F. Barron, “Cryogenics Systems”, Second Edition, Oxford University Press, New York (1985).
2) Timmerhaus, Flynn,”Cryogenic Process Engineering “, Plenum Press, New York (1989).
3) Pipkov, “Fundamentals of Vacuum Engineering “, Mir Publishers, Moscow.

4) Thomas M. Flynn, “Cryogenic Engineering”, second edition, CRC press, New York (2005).
5) G.M Walker. “Cryocooler- Part 1 Fundamentals” Plenum Press, New York (1983).
6) G.M Walker. “Cryocooler- Part 2” Plenum Press, New York (1983).
7) Proceedings of Advances in Cryogenic Engineering.
8) Proceedings of International Cryocooler Conference.
9) Proceedings of International Cryogenic Engineering Conference and International Cryogenic Materials Conference.

Title of the course : **Industrial Automation**

Subject Code : **PEME-721 B**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Ability to design interface of computers with the outside world.

CO2: Programming for PLC.

CO3: Modelling of Physical system dynamics.

CO4: Linear control of Physical systems.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	1	1	1	2	1	2	2	2	2	1	1	1
CO2	3	3	1	1	1	1	2	1	2	2	2	3	1	1	1
CO3	3	3	2	1	2	1	2	1	2	3	2	2	2	1	2
CO4	3	3	2	1	2	1	2	1	2	2	2	2	2	1	2
Avg.	3	3	1.5	1	1.5	1	2	1	2	2.25	2	2.25	1.5	1	1.5

Theory:

Unit	Main Topics	Course Description	Lecture(s)
Unit-1	**Introduction**	The Mechatronics approach: A methodology for integrated design of Mechanical, Electronics, Electrical, Control, computer and Instrumentation	**1**
	Fundamentals of Electronics and digital circuits	Number systems: Binary, Octal, Hexadecimal, Boolean Algebra, Logic Gates, Karnaugh maps and simplification of logic circuits, Operational Amplifiers, Types of Operational Amplifiers, Multiplexer and De-multiplexer.	**8**
	Application of Personal Computer in Control and Automation	Analog and Digital signal, Analog to Digital Conversion, Digital to Analog Conversion: Weighted resistor method and R-2R method, C programming for Digital Input and output, ADC and DAC	**8**
	Sensorsand Actuators	Strain Gauge, Potentiometer, Optical encoders: incremental and absolute encoders, Linear variable differential transformer(LVDT), Piezoelectric, Proximity sensor, Resistance Temperature Detector(RTD), Thermistors, Thermocouple, Hall effect sensor Permanent Magnet DC Motor, Stepper Motor	**7**
Unit-2	**Pneumatics and Hydraulics**	Hydraulics and Pneumatic power supplies, Selection of Pnuematic Pipeline Materials, Pressure drop in pipeline, FRL unit, Direction control valves: Types, Nomenclature, actuation systems, Pressure control valves: Pressure limiting, pressure relief and pressure sequence valves, Check valves: Non return valve,	**9**

		Shuttle valve, Non-return flow control valve, twin pressure sequence valve, Time delay valve, Basic Pneumatic Circuits, Pilot operation, Cylinder sequencing and process control, Movement Diagram Actuators: Single acting and double acting cylinders, Cushion assembly, Rotary actuators, vane motors, Jeroter.	
	Programmable Logic Controller (PLC)	Function of PLC, Architecture, Components of PLC, selection of PLC, Ladder Logic diagram, Mnemonics, Logic functions: latching, sequencing, counters, shift registers, jumpers, manipulation of data, arithmetic operations	**7**
	Fundamentals of Modelling and Linear Control	Modelling of physical systems dynamics, Laplace Transform, Transfer Functions, Block Diagrams, Response Analysis and Simulation: First order and second order systems.	**8**

Total=48

Recommended Books:

1. W. Bolten, Mechatronics, Pearson Education
2. Andrew Parr, Pneumatic Systems, TMH
3. A.P. Malvino, Digital Principles and Applications, McGraw Hill
4. Norman S. Nise, Control Systems Engineering, Wiley

Title of the course : **Quality Engineering**
Subject Code : **PEME-721 C**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Control the quality of processes using control charts for variables in manufacturing industries.

CO 2: Control the occurrence of defective product and the defects in manufacturing companies.

CO 3: Control the occurrence of defects in services.

CO 4: Achieve savings in rupees to the companies through quality control and improvement

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	1	2	1	1	1	1	1	1	2	1
CO2	3	3	3	3	3	1	2	2	1	3	2	1	3	2	1
CO3	3	3	3	3	3	1	2	1	1	1	1	1	1	1	1
CO4	3	3	3	3	3	1	2	1	1	1	1	1	1	2	1
Avg.	3	3	3	3	3	1	2	1.25	1	1.5	1.25	1	1.5	1.75	1

Theory:

Unit	Main Topics	Course Description	Lecture(s)
Unit-1	**Quality Fundamentals**	Importance of quality- evolution of quality- definitions of quality- dimensions of quality- quality control- quality assurance- areas of quality- quality planning- quality objectives and policies quality costs- economics of quality- quality loss function- quality Vs productivity- Quality Vs reliability.	**12**
	Control Charts For Variables	Process variation- preliminary decisions- control limits and their computation- construction and application of X bar, R and S charts- warning and modified control limits- process adjustment for trend, Comparison of process variation with specification limits- O.C. curve for X bar chart.	**12**
Unit-2	**Statistical Process Control**	Process stability- process capability study using control charts- capability evaluation- Cp, Cpk and Cpm – capability analysis using histogram and normal probability plot- machine capability study- gauge capability study- setting statistical tolerances for components and assemblies individual measurement charts- X-chart, moving average and moving range chart, multi-vari chart.	**06**
	Control Charts For Attributes	Limitations of variable control charts- Control charts for fraction non-conforming- p and np charts, variable sample size, operating characteristic function, run length- Control chart for nonconformities (defects)- c, u, ku charts, demerits control chart- applications.	**06**
	Acceptance Sampling	Need- economics of sampling- sampling procedure- single and double sampling- O.C. curves, Average outgoing quality- Average sample number- Average total inspection- Multiple and sequential sampling- Standard sampling plans- Military, Dodge-Roaming.	**12**

Total = 48

Recommended Books:

1. S.P.Singh, Production and Operation Management , Vikas Publishers, Delhi.
2. Grant & Leave worth, Statistical Quality Control, McGraw Hill.
3. J.R. Taylor, Quality Control Systems, McGraw-Hill.
4. M.Mhajan, Statistical Quality Control, Dhanpat Rai.
5. A.V. Taylor, Total Quality Control, McGraw-Hill.
6. Ravi Shankar, Industrial Engineering & Management, McGraw-Hill.

Title of the course : **Robotics**
Subject Code : **PEME-722 A**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: To develop the ability to analyze and design the motion for articulated systems.
CO2: To acquire the knowledge on advanced algebraic tools for the description of motion.
CO3: Obtain knowledge and understand the basic concepts of industrial robotics, namely in terms of classification, kinematics, sensors, and typical applications.
CO4: Program industrial (manipulator) robots.
CO5: Describe current status of robotics technology and new development. Understand the context and importance of robotics in the different society sectors.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	2	1	1	1	2	1	1	1	2	2	1	3	2
CO2	3	1	2	1	1	1	2	2	1	1	1	2	1	3	1
CO3	3	1	2	1	2	1	2	1	1	1	1	2	2	2	1
CO4	3	1	2	1	1	1	2	1	2	1	2	1	2	2	2
CO5	2	1	2	1	1	1	2	1	1	2	1	2	3	2	1
Avg.	3	3	3	3	3	1	1.25	1	2	1.25	1.25	1	1.5	1.75	1.5

Theory:

Unit	Main Topics	Course Description	Lecture(s)
Unit-1	**Introduction**	Evolution of robot and robotics, laws of robotics, robot anatomy: Links, joints, Degrees of freedom (DOF), Precision movement, robot specifications and work volume, Types of Robot drives-Basic robot motions, Arm configuration, wrist configuration.	**05**
	End Effectors	End effectors classification-Mechanical, magnetic, vacuum and adhesive gripper, Robot control-unit control system concept-servo and non servo control of robot joints, adaptive and optimal control.	**07**
	Sensors	Sensor devices Types of sensors- contact, position and displacement sensors, Force and torque sensors-proximity and range sensors-acoustic sensors- Robot vision systems, sensing and digitizing- Image processing and analysis.	**08**
Unit-II	**Coordinate Frame, Mapping and Transforms**	Coordinate frames, description of objects in space, transformation of vectors, fundamental rotation matrices.	**05**

	Kinematics	Denavit- Hartenberg Notation, kinematic relationship between adjacent links, Manipulator transformation matrix, Inverse kinematics, Concept of manipulator jacobian.	**09**
	Robot Programming	Robot language classification-programing methods off and on line programming, Lead through method, Teach pendent method, Language, simple program.	**08**
	Industrial Applications	Application of robots- Material handling- machine loading and unloading, Assembly, Inspection, Welding, spray painting, Recent developments ion robots-safety considerations.	**06**
			Total = 48

Recommended Books:

1. Mittal and Nagrath, Robotics and Control, TMH.
2. J.J. Craig, Introduction to Robotics, Pearson Education.
3. S.R.Deb& S. Deb, Robotics Technology and Flexible Automation, Tata McGraw-Hill

Title of the course : **Energy Auditing**
Subject Code : **PEME-722 B**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: To explain the importance of Energy audit.
CO2: To calculate the materials balance and energy balance.
CO3: To apply the different energy saving principles in thermal systems.
CO4: To use the energy saving practice in electrical systems.
CO5: To discuss a case study of energy saving in industry.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	2	1	1	1	1	1	1	2	1	1	1
CO2	1	1	1	1	2	2	1	3	2	1	3	2	1	3	2
CO3	2	1	2	1	2	1	1	1	1	1	1	1	1	1	1
CO4	2	1	2	1	2	1	1	1	1	1	1	2	1	1	1
CO5	1	1	1	1	3	2	1	3	2	1	3	2	1	3	2
Avg.	1.4	1	1.4	1	2.2	1.4	1	1.8	1.4	1	1.8	1.8	1	1.8	1.4

Theory:

Unit	Main Topics	Course Description	Lecture(s)
Unit -1	**Energy Management & Audit**	Definition, need and types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, energy audit instruments.	**03**
	Material and Energy balance	Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.	**02**
	Fuels and Combustion	Introduction to fuels, principles of combustion, combustion of oil, coal and gas.	**02**
	Boilers	Types, combustion in boilers, performances evaluation, analysis of losses, feed water treatment, blow down, energy conservation opportunities	**03**
	Steam System	Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings.	**03**
	Furnaces	Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery.	**02**

	FBC boilers	Introduction, mechanism of fluidized bed combustion, advantages, types of FBC boilers, operational features, retrofitting FBC system to conventional boilers, saving potential.	**03**
	Cogeneration	Definition, need, application, advantages, classification and saving potentials.	**02**
	Waste Heat Recovery	Classification, advantages and applications, commercially viable waste heat recovery devices, saving potential.	**02**
Unit - 2	**Electrical system**	Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses.	**03**
	Electric motors	Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.	**03**
	Compressed Air System	Types of air compressors, compressor efficiency, capacity assessment, leakage test, factors affecting the performance and savings opportunities	**03**
	HVAC and Refrigeration System	Vapour compression refrigeration cycle, refrigerants, coefficient of performance, capacity, and factors affecting Refrigeration and Air conditioning system performance and savings opportunities.	**03**
	Vapour absorption refrigeration system	Working principle, types and comparison with vapour compression system, saving potential.	**02**
	Fans and blowers	Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.	**02**
	Pumps and Pumping System	Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.	**03**
	Cooling Tower	Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities assessment of cooling towers.	**02**
	Lighting System	Light source, choice of lighting, luminance requirements, and energy conservation avenues.	**02**
	Energy Efficient Technologies in Electrical Systems	automatic power factor controllers, energy efficient motors, variable speed drives, energy efficient transformers, energy efficient lighting controls.	**03**
			Total=48

Recommended Books:

1. W.R.Murphy and G.McKAY, Energy Management, Btterworth-Heinemann.
2. P.Balasubramanian, Energy Auditing made simple, R.NR.Printers(P)Ltd.

Title of the course : **Safety Engineering**
Subject Code : **PEME-722** C

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to:

CO1: Understand various aspect of safety engineering
CO2: Gainknowledge about industrial safety and hazards
CO3: able to calculate costing of accidents and hazards
CO4: Understand basic job safety analysis

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	1	1	2	2	2	1	1	2	1	1	1	1	1
CO2	3	1	3	1	2	2	3	2	1	2	2	1	3	2	1
CO3	3	1	1	1	2	2	2	3	1	2	1	1	1	1	1
CO4	3	1	1	1	2	2	2	1	1	2	1	1	1	1	1
Avg.	3	1	1.5	1	2	2	2.25	1.75	1	2	1.25	1	1.5	1.25	1

Theory:

Unit	Main Topics	Course Description	Lecture(s)
Unit -1	**Introduction**	Safety -Goals of safety engineering. Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. History of safety movement.Theories of accident causation.	**06**
	Safety organization	objectives, types, functions, Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages	**06**
	Accident prevention Methods	Engineering, Education and Enforcement, Safety Education & Training - Importance, Various training methods, Effectiveness of training, Behaviour oriented training. Communication- purpose, barrier to communication.	**06**
	House-keeping	Responsibility of management and employees. Advantages of good house ke-ping. 5 s of house-keeping	**03**
	Work permit system	objectives, hot work and cold work permits. Typical industrial models and methodology	**03**
Unit - 2	**Personal protection in the work environment**	Types of PPEs, Personal protective equipment- respiratory and non-respiratory equipment. Standards related to PPEs.	**06**

	Monitoring Safety Performance	Frequency rate, severity rate, incidence rate, activity rate	**06**
	Cost of accidents	Computation of Costs- Utility of Cost data. Plant safety inspection, types, inspection procedure. Safety sampling techniques. Job safety analysis (JSA), Safety surveys, Safety audits. Safety Inventory Technique.	**06**
	Accident investigation	Why? When? Where? Who? & How? Basics- Man- Environment & Systems, Process of Investigation –Tools-Data Collection-Handling witnesses- Case study.	**03**
	Accident analysis	Analytical Techniques-System Safety-Change Analysis-MORT-Multi Events Sequencing-TOR.	**03**

Total = 48

Reference Books:

1. N.V. Krishnan, Safety Management in Industry, Jaico Publishing House, 1997
2. Ronald P. Blake, Industrial Safety:, Prentice Hall, New Delhi, 1973
3. David L. Goetsch, Occupational Safety and health, Prentice Hall
4. Ted S. Ferry, Modern Accident Investigation and Analysis, John Wiley & Sons
5. Willie Hammer, Occupational Safety Management and Engineering, Prentice Hall
6. Alan Waring, Safety Management System, Chapman & Hall
7. John V. Grimaldi and Rollin H.Simonds, Safety Management, All India Traveller Book Seller, Delhi.
8. Accident Prevention Manual for Industrial Operations : National Safety Council, Chicago

Title of the course : **Work Study and Ergonomics**
Subject Code : **PEME-722 D**

L	T	P	Credits	Weekly Load
3	1	0	4	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Critical examination of existing engineering methods.
CO2: Develop and improved method of any engineering operation/process/ system.
CO3: Identify the standard time for an operation/ activity.
CO4: Describe ergonomically designed engineering system.
CO5: Able to design and development of product/systems with applications of Ergonomics

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	3	3	2	2	3	2	3	2	3	1	1	-
CO2	2	3	3	3	2	3	3	2	3	2	3	2	2	1	2
CO3	1	3	2	1	3	2	1	3	2	3	2	3	2	1	-
CO4	3	3	2	3	3	2	3	2	3	2	3	2	2	1	1
CO5	3	2	2	2	3	2	2	3	2	3	2	3	2	1	3
Avg.	2.4	2.6	2.2	2.4	2.8	2.2	2.2	2.6	2.4	2.6	2.4	2.6	1.8	1	2

Theory

Unit	Main Topics	Course Description	Lecture(s)
Unit - 1	**Productivity**	Introduction, Types of productivity, Measurement of productivity, Productivity Index, Importance of productivity, Means of productivity improvement, Effect of productivity on society	**04**
	Method Study	Introduction to Work Study: Time study and method study, Objectives of work study, Method Study Procedure, factors for selection of Job for method study, Recording techniques: Charts, and Diagrams, Critical Examination, Principle of motion economy, Concept of Normal and maximum working area, Therbligs, Simo Chart, Micro motion study, Memo Motion Study, Cyclegraph and Chronocyclegraphs.	**16**
Unit-2	**Time Study**	Introduction to various work measurement techniques, Stop watch Time study: definition, equipments, Types of stop watches, stop watch time study procedure: Computation of number of cycles, types of work elements, guidelines for breaking the job into various work elements, Confidence levels and permissible error. Work sampling: definition, procedure, design of work sampling plans. PMTS: various methods, MTM-1, MTM-2, work factor Rating: Definition, Types of rating Techniques, Standard Performance, Normal Time, Observed Time and Standard Time, Uses of Standard Time, Allowances.	**16**

	Ergonomics	Definition, Components of Ergonomics: Anthropology, Physiology, Psychology and Machines, Design principles, Anthropometry: Definition, Structural Body Dimensions and Functional Body Dimensions, Seat Design, Design recommendations for seat design, Displays and controls: Types, design recommendations, design of control panels Environment: Light, ventilation, Vibration, Sound, House keeping	**12**

Total=48

Recommended Books:

1. NPC, A Manual of Method Study
2. ILO, Work Study
3. Dalela and Sharma, Work Study and Ergonomics, Standard
4. Barnes, Motion and Time Study, John Wiley