Cluster –I: Common with B.Tech in (a) Mechanical Engineering, (b) Aeronautical Engineering (c) Automobile Engineering (d) Civil Engineering (e) Mechatronics Engg. (f) Textile Engineering (g) Chemical Engg.

Bachelor of Technology in Civil Engineering(Credit Based)

KURUKSHETRA UNIVERSITY, KURUKSHETRA

Scheme of Studies/Examination

Semester I (w.e.f. session 2018-2019)

S.No.	CourseNo./ Code	Subject	L:T:P	Hours/ Week	Credits	ExaminationSchedule(Marks)				Duration of exam(Hours)
						Major Test	MinorTest	Practical	Total	
1A	BS-119A	IntroductiontoElectromagneticTheory	3:1:0	4	4	75	25	0	100	3
1B	BS-101A	Chemistry	3:1:0	4	4	75	25	0	100	3
2A	ES-105A	ProgrammingforProblemSolving	3:0:0	3	3	75	25	0	100	3
2B	HM-101A	English	2:0:0	2	2	75	25	0	100	3
3	BS-135A	Multi-variableCalculus&LinearAlgebra	3:1:0	4	4	75	25	0	100	3
4A	ES-109A	EngineeringGraphics&Design	1:2:0	3	3	75	25	0	100	3
4B	ES-111LA	ManufacturingProcessesWorkshop	0:0:3	3	1.5	-	40	60	100	3
5A	BS-141A	Biology	2:1:0	3	3	75	25	0	100	3
5B	ES-101A	BasicElectricalEngineering	4:1:0	5	5	75	25	0	100	3
6A	BS-121LA	ElectromagneticsLab	0:0:3	3	1.5	--	20	30	50	3
6B	BS-103LA	ChemistryLab	0:0:3	3	1.5	--	20	30	50	3
7A	ES-107LA	ProgrammingforProblemSolvingLab	0:0:2	2	1	--	20	30	50	3
7B	ES-103LA	BasicElectricalEngineeringLab	0:0:2	2	1	--	20	30	50	3
8A	ES-113LA	EngineeringGraphics&DesignPractice	0:0:3	3	1.5	--	20	30	50	3
8B	HM-103LA	LanguageLab	0:0:2	2	1	--	20	30	50	3
		Total	12:5:8/ 12:3:10	25/25	21.0/ 20.0	375/ 300	185/ 200	90/ 150	650A/ 650B	

Note: A branch will study either the subjects corresponding to Sr. No. Marked A or corresponding to Sr. No. marked B in one particular semester.
Induction Program (Three weeks duration) is a part of scheme of first year in 1st semester for all branches.

Cluster –I: Common with B.Tech in (a) Mechanical Engineering, (b) Aeronautical Engineering (c) Automobile Engineering (d) Civil Engineering (e) Mechatronics Engg. (f) Textile Engineering (g) Chemical Engg.

Bachelor of TechnologyCivil Engineering(Credit Based)
KURUKSHETRA UNIVERSITY, KURUKSHETRA
Scheme of Studies/Examination
Semester II (w.e.f. session 2018-2019)

S.No.	CourseNo./ Code	Subject	L:T:P	Hours/ Week	Credits	ExaminationSchedule(Marks)				Duration of exam(Hours)
						Major Test	MinorTest	Practical	Total	
1A	BS-119A	IntroductiontoElectromagnetictheory	3:1:0	4	4	75	25	0	100	3
1B	BS-101A	Chemistry	3:1:0	4	4	75	25	0	100	3
2A	ES-105A	ProgrammingforProblemSolving	3:0:0	3	3	75	25	0	100	3
2B	HM-101A	English	2:0:0	2	2	75	25	0	100	3
3	BS-136A	Calculus&OrdinaryDifferentialEquations	3:1:0	4	4	75	25	0	100	3
4A	ES-109A	EngineeringGraphics&Design	1:2:0	3	3	75	25	0	100	3
4B	ES-111LA	ManufacturingProcessesWorkshop	0:0:3	3	1.5	-	40	60	100	3
5A	BS-141A	Biology	2:1:0	3	3	75	25	0	100	3
5B	ES-101A	BasicElectricalEngineering	4:1:0	5	5	75	25	0	100	3
6A	BS-121LA	ElectromagneticsLab	0:0:3	3	1.5	--	20	30	50	3
6B	BS-103LA	ChemistryLab	0:0:3	3	1.5	--	20	30	50	3
7A	ES-107LA	ProgrammingforProblemSolvingLab	0:0:2	2	1	--	20	30	50	3
7B	ES-103LA	BasicElectricalEngineeringLab	0:0:2	2	1	--	20	30	50	3
8A	ES-113LA	EngineeringGraphics&DesignPractice	0:0:3	3	1.5	--	20	30	50	3
8B	HM-103LA	Language Lab	0:0:2	2	1	--	20	30	50	3
		Total	12:5:8/ 12:3:10	25/ 25	21.0/ 20.0	375/ 300	185/200	90/150	650A/ 650B	

Note: A branch will study either the subjects corresponding to Sr. No. Marked A or corresponding to Sr. No. marked B in one particular semester.

BS-119A	Introduction to Electromagnetic Theory						
L	T	P	Credit	Major Test	Minor Test	Total	Time
3	1	-	4	75	25	100	3h

Purpose	To introduce the fundamentals of electromagnetic theory to the students for applications in Engineering field.
Course Outcomes	
CO 1	Introduce the basic concepts of Electrostatics in vacuum.
CO 2	Introduce the basic concepts of Magnetostatics in vacuum.
CO 3	Discuss electrostatics and magnetostatics in linear dielectric medium.
CO 4	Basics of Maxwell's equations and electromagnetic waves.

Unit - I

Electrostatics in Vacuum: Calculation of Electric Field: Coulomb's law, Continuous charge distribution; Divergence and Curl of Electrostatic Fields: Field lines, flux, Gauss's law, Applications of Gauss's law; Electrostatic Potential: Comments on potential, Poisson's and Laplace's Equation, the potential of a localized charge distribution; Electrostatic Boundary Conditions; Work and Energy in Electrostatics: the work done to move a charge, the energy of a point and continuous charge distribution.

Unit - II

Electrostatics in a Linear Dielectric Medium: Polarization:dielectrics, induced dipoles, alignments of polar molecules; The field of a Polarized Object: bound charges and its physical interpretation; The Filed Inside a Dielectric; The Electric Displacement: Gauss's law in the presence of dielectrics, A deceptive parallel, Boundary conditions; Linear Dielectrics: Susceptibility, Permittivity, dielectric constant, Boundary value problems with linear dielectrics, Energy in dielectric systems, Forces in dielectrics.

Unit - III

Magnetostatics: The Lorentz Force Law: magnetic fields, magnetic forces, currents; Biot- Savart law, Divergence and Curl of magnetic field, Magnetic Vector Potential: vector potential, magnetostatic boundary conditions, multiple expansion of vector potential.

Magnetostatics in a linear magnetic: Magnetization: Effect of magnetic field on atomic orbits; The Field of a Magnetized Object: Bound currents, Physical interpretation of bound currents; The Auxiliary Magnetic Field: Ampere's law in magnetized materials, A deceptive parallel, Boundary conditions; Linear and Nonlinear Media: magnetic susceptibility and permeability, ferromagnetism.

Unit - IV

Faraday's law: Electromotive Force: Ohm's law, Motional emf; Electromagnetic Induction: Faraday's law, The induced electric field, inductance, energy in magnetic fields.

Maxwell's Equations: Electrodynamics before Maxwell, How Maxwell fixed Ampere's law, Maxwell's equations, Maxwell's equations in matter.

Electromagnetic Waves: Electromagnetic Waves in Vacuum: the wave equation for electric and magnetic field; Electromagnetic Waves in Matter: propagation in linear media.

Suggested Books:

1. David J. Griffiths, Introduction to Electrodynamics, Pearson Education.
2. Halliday and Resnick, Physics
3. W. Saslow, Electricity, Magnetism and Light

Note: The paper setter will set the paper as per the question paper templates provided.

BS-121LA	Electromagnetics Lab						
L	**T**	**P**	**Credit**	**Practical**	**Minor Test**	**Total**	**Time**
-	**-**	**3**	**1.5**	**30**	**20**	**50**	**3h**
Purpose	**To give the practical knowledge of handling the instruments.**						
Course Outcomes							
CO	**To make the students familiar with the experiments related with Electromagnetic Theory.**						

Note: Student will be required to perform at least 10 experiments out of the following list.

1. To study the variation of magnetic field with distance and to find the radius of coil by Stewart and Gee's apparatus.
2. To study induced e.m.f. as a function of velocity of magnet.
3. To study the growth and decay of current in a LR circuit using magnetic core inductor.
4. To find the coefficient of self-inductance by Rayleigh's method.
5. To find the coefficient of mutual inductance of two coils.
6. To determine the magnetic induction field between the pole pieces of an electromagnet.
7. To study Bio-Savart's law.
8. To study the dependency of magnetic field on coil diameter and number of turns.
9. To investigate the equipotential liens of electric fields.
10. To draw the equipotential lines of bar electrode.
11. To draw the equipotential lines for ring electrode.
12. Verification of Farady and Lenz's law of induction by measuring the induced voltage as function of time.
13. Measurement of induced voltage impulse as a function of the velocity of magnet.
14. To determine the dielectric constant of different dielectric materials.
15. To measure the spatial distribution of the magnetic field between a pair of identical coils in Helmholtz arrangement.
16. To investigate the spacing between coils at which magnetic field is uniform and to measure its spatial distribution.

Suggested Books:

1. C.L.Arora, B. Sc. Practical Physics, S. Chand.
2. B.L. Worshnop and H, T, Flint, Advanced Practical Physics, KPH.
3. S.L. Gupta & V. Kumar, Practical Physics, PragatiPrakashan.

BS-101A	Chemistry						
L	T	P	Credit	Major Test	Minor Test	Total	Time
3	1	-	4	75	25	100	3h

Purpose	**To familiarize the students with basic and applied concept in chemistry**
CO1	**An insight into the atomic and molecular structure**
CO2	**Analytical techniques used in identification of molecules**
CO3	**To understand Periodic properties**
CO4	**To understand the spatial arrangement of molecules**

UNIT - I

Atomic and molecular structure (10 lectures)

Molecular orbitals of diatomic molecules (N_2, O_2, CO) Equations for atomic and molecular orbitals. Energy level diagrams of diatomics. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and energy level diagrams of $[Co(NH_3)_6]$, $[Ni(CO)_4]$, $[PtCl_2(NH_3)_2]$ and magnetic properties of metal complexes. Band structure of solids and the role of doping on band structures.

UNIT - II

Spectroscopic techniques and applications (8 lectures)

Principles of spectroscopy and selection rules. Electronic spectroscopy(basic concept). Fluorescence and its applications in medicine.Vibrational and rotational spectroscopy of diatomic molecules.Applications.Basic concepts of Nuclear magnetic resonance and magnetic resonance imaging, Diffraction and scattering.

UNIT - III

Use of free energy in chemical equilibria (4 lectures)

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies.Free energy and emf.Cell potentials, the Nernst equation and applications.

Periodic properties (4 Lectures)

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries (H_2O, NH_3, PCl_5, SF_6, CCl4, $Pt(NH_3)_2Cl_2$

UNIT - IV

Stereochemistry (6 lectures)

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis.

Organic reactions and synthesis of a drug molecule (4 lectures)

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule(paracetamol and Aspirin)

Suggested Books:

1) University chemistry, by B. M. Mahan, Pearson Education
2) Chemistry: Principles and Applications, byM. J. SienkoandR. A. Plane
3) Fundamentals of Molecular Spectroscopy, by C. N. Banwell
4) Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S.Krishnan
5) Physical Chemistry, by P. W. Atkins
6)Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore,5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp

Note: The paper setter will set the paper as per the question paper templates provided.

BS-103LA	Chemistry Lab						
L	T	P	Credit	Practical	Minor Test	Total	Time
-	-	3	1.5	30	20	50	3h

LIST OF EXPERIMENTS

1. To Determine the surface tension of a given liquid
2. To determine the relative viscosity of a given liquid using Ostwald's viscometer
3. To identify the number of components present in a given organic mixture by thin layer chromatography
4. To determine the alkalinity of a given water sample
5. Determination of the strength of a given HCl solution by titrating it with standard NaOH solution using conductometer
6. Synthesis of a drug (paracetamol/Aspirin)
7. Determination of chloride content of a given water sample
8. To determine the calcium & magnesium or temporary & permanent hardness of a given water sample by EDTA method
9. To determine the total iron content present in a given iron ore solution by redox titration
10. Determination of the partition coefficient of a substance between two immiscible liquids
11. To find out the content of sodium, potassium in a given salt solution by Flame Photometer
12. To find out the λmax and concentration of unknown solution by a spectrophotometer
13. To find out the flash point and fire point of the given oil sample by Pensky Martin apparatus
14. To determine the amount of dissolved oxygen present in a given water sample
15. To find out the pour point and cloud point of a lubricating oil
16. Determination of the strength of a given HCl solution by titrating it with standard NaOH solution using pH meter
17. Using Redwood Viscometer find out the viscosity of an oil sample

Note: Atleast 9 experiments to be performed from the list.

ES-105A	Programming for Problem Solving						
L	T	P	Credit	Major Test	Minor Test	Total	Time
3	-	-	3	75	25	100	3h
Purpose	To familiarize the students with the basics of Computer System and C Programming						
Course Outcomes							
CO 1	Describe the overview of Computer System and Levels of Programming Languages.						
CO 2	Learn to translate the algorithms to programs (in C language).						
CO 3	Learn description and applications of conditional branching, iteration and recursion.						
CO 4	To use arrays, pointers and structures to formulate algorithms and programs.						

UNIT – I

Overview of Computers: Block diagram and its description, Number systems, Arithmetic of number systems, Computer Hardware: Printers, Keyboard and Mouse, Storage Devices.
Introduction to programming language: Different levels of PL: High Level language, Assembly language, Machine language; Introduction to Compiler, Interpreter, Debugger, Linker, Loader, Assembler.
Problem Analysis: Problem solving techniques, Algorithms and Flowchart representation.

UNIT – II

Overview of C: Elements of C, Data types; Storage classes in C; Operators: Arithmetic, relational, logical, bitwise, unary, assignment and conditional operators, precedence & associativity of operators.
Input/output: Unformatted & formatted I/O function in C.
Control statements: if statement, switch statement; Repetition: for, while, and do-while loop; break, continue, goto statements.

UNIT – III

Arrays: Definition, types, initialization, processing an array, String handling.
Functions: Definition, prototype, parameters passing techniques, recursion, built-in functions, passing arrays to functions, returning arrays from functions.

UNIT – IV

Pointers: Declaration, operations on pointers, pointers and arrays, dynamic memory allocation, pointers and functions, pointers and strings.
Structure & Union: Definition, processing, passing structures to functions, use of union.
Data files: Opening and closing a file, I/O operations on files.

Suggested Books:

1. Brian W. Kernighan Dennis Ritchie, "C Programming Language" Pearson Education India.
2. SubrataSaha,Subhodip Mukherjee:Basic Computation & Programming with 'C'-Cambridge University Press.
3. Ajay Mittal, "Programming in C - A Practical Approach", Pearson.
4. E Balagurusamy :Programming in ANSI C,TMH Education.
5. PradipDey and ManasGhose, "Computer Fundamental and Programming in C", Oxford Pub.
6. ForouzanBehrouz, "Computer Science: A Structured Programming Approach Using C", Cengage Learning.
7. Ashok Kamthane, "Programming in C, 3e", Pearson Education India..
8. YashwantKanetker, "Let us C", BPB Publications.
9. A K Sharma, " Fundamentals of Computers & Programming" DhanpatRai Publications
10. Rajaraman V., "Computer Basic and C Programming", Prentice Hall of India Learning.

Note: The paper setter will set the paper as per the question paper templates provided.

ES-107LA	Programming for Problem Solving Lab						
L	**T**	**P**	**Credit**	**Practical**	**Minor Test**	**Total**	**Time**
-	**-**	**2**	**1**	**30**	**20**	**50**	**3h**
Purpose	**To Introduce students with problem solving using C Programming language**						
Course Outcomes							
CO 1	**To formulate the algorithms for simple problems**						
CO 2	**Implementation of arrays and functions.**						
CO 3	**Implementation of pointers and user defined data types.**						
CO 4	**Write individual and group reports: present objectives, describe test procedures and results.**						

LIST OF PROGRAMS

1. Write a program to find the sum of individual digits of a positive integer.
2. Write a program to generate the first n terms of the Fibonacci sequence.
3. Write a program to generate all the prime numbers between 1 and n, where n is the input value given by the user.
4. Write a program to find the roots of a quadratic equation.
5. Write a function to generate Pascal's triangle.
6. Write a program for addition of Two Matrices
7. Write a program for calculating transpose of a matrix.
8. Write a program for Matrix multiplication by checking compatibility
9. Write programs to find the factorial of a given integer by using both recursive and non-recursive functions.
10. Write a function that uses functions to perform the count the lines, words and characters in a given text.
11. Write a program to explores the use of structures, union and other user defined variables
12. Write a program to print the element of array using pointers
13. Write a program to implement call by reference
14. Write a program to print the elements of a structure using pointers
15. Write a program to read a string and write it in reverse order
16. Write a program to concatenate two strings
17. Write a program to check that the input string is a palindrome or not.
18. Write a program which copies one file to another.
19. Write a program to reverse the first n characters in a file.

Note: At least 10 programs are to be performed & executed from the above list.

HM-101 A	English						
L	T	P	Credit	Major Test	Minor Test	Total	Time
2	-	-	2	75	25	100	3h

Course Outcomes	
CO 1	Building up the vocabulary
CO 2	Students will acquire basic proficiency in English including writing skills

UNIT- 1

Vocabulary Building

1.1 The concept of Word Formation
1.2 Root words from foreign languages and their use in English
1.3 Acquaintance with prefixes and suffixes from foreign languages in English to formderivatives.
1.4 Synonyms, antonyms, and standard abbreviations.

UNIT- 2

Basic Writing Skills

2.1 Sentence Structures
2.2 Use of phrases and clauses in sentences
2.3 Importance of proper punctuation
2.4 Creating coherence
2.5 Organizing principles of paragraphs in documents
2.6 Techniques for writing precisely

UNIT- 3

Identifying Common Errors in Writing

3.1 Subject-verb agreement
3.2 Noun-pronoun agreement
3.3 Misplaced modifiers
3.4 Articles
3.5 Prepositions
3.6 Redundancies
3.7 Clichés

UNIT- 4

Nature and Style of sensible Writing

4.1 Describing
4.2 Defining
4.3 Classifying
4.4 Providing examples or evidence
4.5 Writing introduction and conclusion
4.6 Comprehension
4.7 Précis Writing
4.8 Essay Writing

Suggested Books:

(i) Practical English Usage. Michael Swan. OUP. 1995.
(ii) Remedial English Grammar. F.T. Wood. Macmillan.2007
(iii)On Writing Well. William Zinsser. Harper Resource Book. 2001
(iv) Study Writing. Liz Hamp-Lyons and Ben Heasly.Cambridge University Press. 2006.
(v) Communication Skills. Sanjay Kumar and PushpLata.Oxford University Press. 2011.
(vi) Exercises in Spoken English. Parts.I-III. CIEFL, Hyderabad. Oxford University Press

Note: The paper setter will set the paper as per the question paper templates provided.

HM-103LA	Language Lab						
L	**T**	**P**	**Credit**	**Practical**	**Minor Test**	**Total**	**Time**
-	**-**	**2**	**1**	**30**	**20**	**50**	**3h**

OBJECTIVES

1. Listening Comprehension
2. Pronunciation, Intonation, Stress and Rhythm
3. Common Everyday Situations: Conversations and Dialogues
4. Communication at Workplace
5. Interviews
6. Formal Presentations

BS-135A	Multivariable Calculus and Linear Algebra						
L	T	P	Credit	Major Test	Minor Test	Total	Time
3	1	-	4	75	25	100	3 h
Purpose	To familiarize the prospective engineers with techniques in calculus, sequence & series, multivariable calculus, and linear algebra.						
Course Outcomes							
CO1	To introduce the idea of applying differential and integral calculus to notions of improper integrals. Apart from some applications it gives a basic introduction on Beta and Gamma functions.						
CO 2	To introduce the fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.						
CO 3	To develop the tool of power series and Fourier series for learning advanced Engineering Mathematics.						
CO 4	To familiarize the student with functions of several variables that is essential in most branches of engineering.						
CO 5	To develop the essential tool of matrices and linear algebra in a comprehensive manner.						

UNIT-I (12 hrs)

Calculus: Evaluation of definite and improper integrals: Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions. Rolle's Theorem, Mean value theorems, Indeterminate forms and L'Hospital's rule.

UNIT-II **(**12 hrs)

Sequence and Series: Convergence of sequence and series, tests for convergence (Comparison test, D'Alembert's Ratio test, Logarithmic test, Cauchy root test, Raabe's test); Power series.

Fourier series: Introduction, Fourier-Euler Formula, Dirichlet's conditions, Change of intervals, Fourier series for even and odd functions, Half range sine and cosine series.

UNIT-III (09 hrs)

Multivariable Calculus (differentiation): Taylor's series (for one and more variables), series for exponential, trigonometric and logarithm functions.

Partial derivatives, Total differential, Chain rule for differentiation, Homogeneous functions, Euler's theorem, Jacobian, Maxima, minima and saddle points; Method of Lagrange multipliers.

UNIT-IV (07 hrs)

Matrices: Rank of a matrix, elementary transformations, elementary matrices, Gauss Jordon method to find inverse using elementary transformations, normal form of a matrix, linear dependence and independence of vectors, consistency of linear system of equations, linear and orthogonal transformations, eigenvalues and eigenvectors, properties of eigenvalues, Cayley – Hamilton theorem and its applications.

Suggested Books:

1.ErwinKreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Erwin Kreyszig and SanjeevAhuja, Applied Mathematics- I, Wiley India Publication, Reprint 2015.
3. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
4. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
5. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
6. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
7. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
8. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Note: The paper setter will set the paper as per the question paper templates provided.

BS-136A	Calculus and Ordinary Differential Equations						
L	T	P	Credit	Major Test	Minor Test	Total	Time
3	1	-	4	75	25	100	3 h
Purpose	To familiarize the prospective engineers with techniques inmultivariate integration, ordinary and partial differential equations and complex variables.						
Course Outcomes							
CO1	To introduce effective mathematical tools for the solutions of differential equations that model physical processes.						
CO 2	To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.						
CO 3	To introduce the tools of differentiation and integration of functions of complex variable thatare used in various techniques dealing engineering problems.						

UNIT-I (10 hrs)

First order ordinary differential equations: Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree:equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Ordinary differential equations of higher orders:

Second order linear differential equations with constant coefficients, method of variation of parameters, Cauchy and Legendre's linear differential equations.

UNIT-II **(**10 hrs)

Multivariable Calculus (Integration): Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar)

Applications: areas and volumes; Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds.

UNIT-III (10hrs)

Vector Calculus: Introduction, Scalar and Vector point functions, Gradient, divergence & Curl and their properties, Directional derivative.

Line integrals, surface integrals, volume integrals, Theorems of Green, Gauss and Stokes (without proof).

UNIT-IV (10 hrs)

Complex Variable – Differentiation: Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, findingharmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) andtheir properties;

Complex Variable – Integration: Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (withoutproof), Taylor's series,zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof).

Suggested 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. Erwin kreyszig and SanjeevAhuja, Applied Mathematics- II, Wiley India Publication, 2015.
4. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary ValueProblems, 9th Edn., Wiley India, 2009.
5. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
6. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice HallIndia, 1995.
7. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
8. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc-Graw Hill,2004.
9. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
10. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Note: The paper setter will set the paper as per the question paper templates provided.

Course code	ES-109A							
Coursetitle	EngineeringGraphics&Design							
Scheme and Credits	L	T	P	Credits	Major Test	Minor Test	Total	Time
	1	2	0	3	75	25	100	3h

Course Outcomes

Objective- To expose students to the basics of Engineering Drawing, graphics and Projections.	
CO-1	To learn about construction of various types of curves and scales.
CO-2	To learn about orthographic projections of points, lines and planes.
CO-3	To Learn about the sectional views and development of Right regular solids
CO-4	To Learn about the construction of Isometric Projections and conversion of Isometric views to Orthographic views and vice-versa.

UNIT - I

IntroductiontoEngineeringDrawing:

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales;

UNIT - II

Orthographic Projections:

PrinciplesofOrthographicProjections-Conventions-Projections ofPointsandlinesinclined tobothplanes;Projectionsofplanesinclined to one principalPlane.

ProjectionsofRegular Solids:

Solid with axis inclinedtobothePlanes;

UNIT - III

Sections andSectionalViewsofRightRegular Solids:

Sectional views of simple right regular solids like prism, pyramid, Cylinder and Cone. Development ofsurfacesofRightRegularSolids-Prism,Pyramid,CylinderandCone;

UNIT - IV

Isometric Projections:

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of IsometricViews to Orthographic Views and Vice-versa, Conventions;

Suggested Books:

1. Engineering Graphics using AUTOCAD 2000: T. Jeyapoovan, Vikas Publishing House.
2. Engineering Drawing: Plane and Solid Geometry: N.D. Bhatt and V.M.Panchal, Charotar Publishing House.
3. Engineering Drawing: Amar Pathak, Dreamtech Press, New Delhi.
4. Thomas E.French, Charles J.Vierck, Robert J.Foster, "Engineering drawing and graphic technology", McGraw Hill International Editions.
5. Engineering Graphics and Drafting: P.S. Gill, Millennium Edition, S.K. Katariaand Sons.
6. A Primer on Computer aided Engineering Drawing-2006, published by VTU, Belgaum.
7. A.Yarwood, Introduction to AutoCAD 2017, Published by CRC Press.
8. O. Ostrowsky, Engineering Drawing with CAD applications, Butterworth Heinemann,1999.
9. BSI, Technical production documentation (TPD) – specification for defining, specifying and graphically reporting products, BS8888, 2002.
10. Corresponding'stoCADSoftwareTheoryandUserManuals.

Note: The paper setter will set the paper as per the question paper templates provided.

Course code	ES-113LA							
Coursetitle	EngineeringGraphics&Design Practice							
Scheme and Credits	L	T	P	Credits	Practical	Minor Test	Total	Time
	-	-	3	1.5	30	20	50	3h
Pre-requisites(if any)	-							

Aim: To make student practice on engineering graphics and designsoftwaresand provide exposuretothevisualaspectsofengineeringdesign.	
CO-1	To give an overview of the user interface and toolboxes in a CAD software.
CO-2	To understand to customize settings of CAD software and produce CAD drawing.
CO-3	To practice performing various functions in CAD softwares.
CO-4	To Learn about solid modelling and demonstration of a simple team design project.

Module 1:OverviewofComputerGraphics:
Listingthecomputertechnologiesthatimpactongraphicalcommunication,Demonstrating Knowledgeofthetheory ofCADsoftware[suchas:TheMenuSystem,Toolbars(Standard, ObjectProperties,Draw,Modify andDimension),DrawingArea(Background,Crosshairs, CoordinateSystem),Dialogboxes andwindows,Shortcutmenus(Button Bars),The CommandLine(whereapplicable),TheStatusBar,Differentmethodsofzoom asusedin CAD,Selectanderaseobjects.; IsometricViewsoflines,Planes, Simpleandcompound Solids];
Module2:Customization &CAD Drawing:
Setupofthedrawingpageandtheprinter,includingscalesettings,Settingup ofunitsanddrawing limits;ISOand ANSIstandardsforcoordinatedimensioningandtolerancing; Orthographic constraints, Snap to objects manually and automatically; Producingdrawingsbyusingvariouscoordinateinputentrymethodstodrawstraightlines,Applyingvari ouswaysofdrawingcircles;
Module3:Annotations,layering&other functions:
Applyingdimensionstoobjects,applyingannotationstodrawings;Settingupanduseof Layers,layerstocreatedrawings,Create,editandusecustomizedlayers; Changingline lengthsthroughmodifyingexisting lines(extend/lengthen);Printingdocumentstopaper usingtheprintcommand;orthographicprojection techniques;Drawingsectionalviewsof compositerightregulargeometricsolids andprojectthetrueshapeof thesectionedsurface; Drawing annotation,Computer-aideddesign(CAD)softwaremodelingof partsand assemblies.Parametricandnon-parametricsolid,surface,and wireframemodels.Partediting andtwo-dimensionaldocumentationofmodels.Planarprojectiontheory,includingsketching of perspective,isometric,multiview,auxiliary,andsectionviews.Spatialvisualization exercises.Dimensioning guidelines,tolerancingtechniques; dimensioningandscalemulti viewsofdwelling;
Module4:Demonstration ofasimpleteamdesign project:
Geometryandtopologyofengineeredcomponents:creation ofengineeringmodelsandtheir presentationinstandard2Dblueprintform andas3Dwire-frameandshadedsolids;meshed topologiesforengineeringanalysisandtool-path generationforcomponentmanufacture; geometricdimensioningandtolerancing;Useof solid-modelingsoftwareforcreating associativemodels atthecomponentand assemblylevels;floorplans thatinclude: windows,doors,andfixturessuchasWC,bath,sink,shower,etc.Applying colourcodingaccordingto buildingdrawingpractice;Drawingsectionalelevation showingfoundation toceiling; IntroductiontoBuildingInformationModeling (BIM).
Suggested Books(ES-113L):

1. Chris McMahon and Jimmie Browne, CAD/CAM – Principle Practice and Manufacturing Management, Addison Wesley England, Second Edition, 2000.
2. Chougule N.K.; CAD/CAM /CAE, Scitech Publications India Pvt. Ltd.
3. Vikram Sharma; Computer Aided Design and Manufacturing, S.K. Kataria and Sons.
4. Rogers, D.F. and Adams, A., Mathematical Elements for Computer Graphics, McGraw Hill Inc, NY, 1989
5. Ibrahim Zeid, CAD/CAM theory and Practice, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1992.
6. M.P. Groover, Automation, Productions systems and Computer-Integrated Manufacturing by Prentice – Hall.
7. A Primer on Computer aided Engineering Drawing-2006, published by VTU, Belgaum.
8. A.Yarwood, Introduction to AutoCAD 2017, Published by CRC Press.
9. O. Ostrowsky, Engineering Drawing with CAD applications, Butterworth Heinemann,1999.
10. BSI, Technical production documentation (TPD) – specification for defining, specifying and graphically reporting products, BS8888, 2002.
11. (Correspondingsetof)CADSoftwareTheoryandUserManuals
12. Ibrahim Zeid, Mastering CAD/CAM, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
13. P. Radhakrishnan, S. Subramanayan and V.Raju, CAD/CAM/CIM, New Age International (P) Ltd., New Delhi.
14. Groover M.P. and Zimmers E. W., CAD/CAM: Computer Aided Design and Manufacturing, Prentice Hall International, New Delhi, 1992.
15. Dr. Sadhu Singh, Computer Aided Design and Manufacturing, Khanna Publishers, New Delhi, Second Edition, 2000.
16. Thomas E.French, Charles J.Vierck, Robert J.Foster, “Engineering drawing and graphic technology”, McGraw Hill International Editions.

Course code	ES-111LA							
Coursetitle	ManufacturingProcessesWorkshop							
Scheme and Credits	L	T	P	Credits	Practical	Minor Test	Total	Time
	0	0	3	1.5	60	40	100	3h
Pre-requisites (if any)								

Aim: To make student gain a hands on work experience in a typical manufacturing industry environment.	
CO-1	To familiarize with different manufacturing methods in industries and work on CNC machine.
CO-2	To learn working in Fitting shop and Electrical and Electronics shops,
CO-3	To practice working on Carpentry and Plastic moulding/glass cutting jobs.
CO-4	To gain hands on practice experience on Metal casting and Welding jobs.

ManufacturingProcessesWorkshop

Contents

1.ManufacturingMethods-casting,forming,machining,joining, advancedmanufacturing methods
2. CNCmachining, Additivemanufacturing
3. Fittingoperations&powertools
4. Electrical&Electronics
5. Carpentry
6. Plasticmoulding,glasscutting
7. Metalcasting
8. Welding(arc welding&gas welding), brazing

Suggested Books:

1. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology" , 7th edition, Pearson Education India Edition.
2. HajraChoudhury S.K., HajraChoudhury A.K. and Nirjhar Roy S.K., " Elements of Workshop Technology" , Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
3. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education, 2008.
4. Roy A. Lindberg, " Processes and Materials of Manufacture" , 4th edition, Prentice Hall India, 1998
5. Rao P.N., " Manufacturing Technology" , Vol. I and Vol. II, Tata McGraw-Hill House, 2017.

BS-141A	Biology						
L	T	P	Credit	Major Test	Minor Test	Total	Time
2	1	-	3	75	25	100	3h
Purpose	To familiarize the students with the basics of Biotechnology						

Course Outcomes	
CO1	Introduction to essentials of life and macromolecules essential for growth and Development
CO2	Defining the basic concepts of cell division, genes and Immune system
CO3	Introduction of basic Concept of ThermoGenetic Engg. & Biochemistry
CO4	Introduction of basic Concept of Microbiology & Role of Biology in Different Fields

Unit – I

Introduction to living world: Concept and definition of Biology; Importance of biology in major discoveries of life Characteristic features of living organisms; Cell ultra-structure and functions of cell organelles like nucleus, mitochondria,chloroplast, ribosomes and endoplasmic reticulum; Difference between prokaryotic and eukaryotic cell; Difference between animal and plant cell.

Classification of organisms: Classify the organisms on the basis of (a) Cellularity;- Unicellular and Multicellular organisms. (b) Energy and Carbon Utilization:- Autotrophs, Hetrotrophs and Lithotrops (c) Habitat (d) Ammonia excretion:- ammonotelic, 17ricotelic and ureotelic. (e) Habitat- acquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life

Unit-II

Introduction to Biomolecules: Definition, general classification and important functions of carbohydrates, lipids, proteins, nucleic acids (DNA& RNA: Structure and forms). Hierarch in protein structure: Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.

Enzymes as biocatalysts: General characteristics, nomenclature and classification of Enzymes. Effect of temperature, Ph, enzyme and substrate concentrations on the activity of enzymes. Elementary concept of and coenzymes. Mechanism of enzyme action. Enzyme kinetics and kinetic parameters (Km and Vmax)

Unit-III

Genetics:-Mendel's laws of inheritance. Variation and speciation.Concepts of recessiveness and dominance. Genetic Disorders: Single gene disorders in human. **Human traits**: Genetics of blood groups, diabetes type I & II.

Cell Division:- Mitosis and its utility to living systems. Meiosis and its genetic significance.Evidence of nucleic acids as a genetic material. Central Dogma of molecular biology

4. Role of immune system in health and disease: Brief introduction to morphology and pathogenicity of bacteria, fungi, virus, protozoa beneficial and harmful for human beings.

Unit-IV

Metabolism:-Concept of Exothermic and endothermic reactions. Concept of standard free energy and Spontaneity in biological reactions. Catabolism (Glycolysis and Krebs cycle) and synthesis of glucose (Photosynthesis:- Light and Dark Reaction) of glucose. ATP as Energy Currency of the cell

Microbiology: Concept of species and strains, sterilization and media compositions, growth kinetics.

Role of Biology : Role of Biology in Agriculture, Medicine, Forensic science, Bioinformatics, Nanotechnology, Micro-electromechanical systems (Bio-MEMS) and Sensors (Biosensors).

Text Book:

1. Introduction to Biotechnology, By Deswal&Deswal, DhanpatRai Publications N.A
2.Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, "Biology: A global approach", Pearson Education Ltd, 2014.
3. E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, "Outlines of Biochemistry", John Wiley and Sons, 2009.
D. L. Nelson and M. M. Cox, "Principles of Biochemistry", W.H. Freeman and Company, 2012.
4.G. S. Stent and R. Calendar, "Molecular Genetics", Freeman and company, 1978.

Note: The paper setter will set the paper as per the question paper templates provided

Suggested Books:

1. Molecular Biology of cell, 4th ed. Alberts, Bruce et al. Garland Science Publishing, New York.
2. Microbiology. Pelczar Jr., M.J.; Chan, E.C.S. and Krieg, N.R. Tata McGraw Hill, New Delhi.
3. Lehninger: Principles of Biochemistry, 3rd edition, by David L. Nelson and M.M. Cox. Maxmillan/ Worth publishers.
4. Genetics by Snusted& Simmons.
5. Molecular Biotechnology: Principles Application of Recombinant DNA. Glick, B. R. and Pasternak, J. J. ASM press WashingtonDC.
6. Kuby's Immunology, Goldsby, R A,.Kindt, T.J, Osborne, B.A.(2003) W. H. Freeman and company, New York.
7. Recombinant DNA 2nd Edition. Watson, James D. and Gilman, M. (2001) W.H Freeman and Company, NewYork.
8. Essentials of Molecular Biology 4thed, Malacinski, G. M. (2003) Jones &Bartlet Publishers, Boston.

ES-101A	BASIC ELECTRICAL ENGINEERING						
L	T	P	Credit	Major Test	Minor Test	Total	Time(Hrs)
4	1	-	5	75	25	100	3
Purpose	To familiarize the students with the basics of Electrical Engineering						
Course Outcomes							
CO1	Deals with steady state circuit analysis subject to DC.						
CO 2	Deals with AC fundamentals & steady state circuit response subject to AC.						
CO 3	Deals with introductory Balanced Three Phase System analysis and Single Phase Transformer.						
CO 4	Explains the Basics of Electrical Machines & Electrical installations						

Unit-I

D.C. circuits: Ohm's Law, junction, node, circuit elements classification: Linear & nonlinear, active & passive, lumped & distributed, unilateral & bilateral with examples. KVL, KCL, Loop and node-voltage analysis of resistive circuit.Star-Delta transformation for resistors.

Network Theorems: Superposition, Thevenin's, Norton's and Maximum power transfer theorems in a resistive network.

Unit-II

AC Fundamentals: Mathematical representation of various wave functions. Sinusoidal periodicsignal, instantaneous and peak values, polar & rectangular form of representation of impedances and phasor quantities. Addition & subtraction of two or more phasor sinusoidal quantities using component resolution method.RMS and average values of various waveforms.

A.C. Circuits: Behavior of various components fed by A.C. source (steady state response of pureR, pure L, pure C, RL, RC, RLC series with waveforms of instantaneous voltage, current & power on simultaneous time axis scale and corresponding phasor diagrams), power factor, active, reactive & apparent power. Frequency response of Series & Parallel RLC ckts.including resonance, Q factor, cut-off frequency & bandwidth. Generation of alternating emf.

Unit-III

Balanced Three Phase Systems: Generation of alternating 3- phaseemf). 3-phase balanced circuits, voltage and current relations in star and delta connections. Measurement of 3-phase power by two wattmeter method for various types of star & delta connected balanced loads.

Single Phase Transformer (qualitative analysis only): Concept of magnetic circuits.Relation between MMF & Reluctance.Hysteresis & Eddy current phenomenon.Principle, construction &emf equationPhasor diagram at ideal, no load and on load conditions. Losses & Efficiency, regulation. OC & SC test, equivalent circuit, concept of auto transformer.

Unit-IV

Electrical Machines (qualitative analysis only)**:** Construction and working of dc machine with commutator action, speed control of dc shunt motor. Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Basics of Single-phase induction motor, capacitor start capacitor run Single-phase induction motor working. Basic construction and working of synchronous generator and motor.

Electrical Installations (LT Switchgear): Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing.

Suggested Books:

1. Basic Electrical Engg: A complete Solution by Vijay Kumar Garg, Wiley India Ltd.
2. Electrical Engg. Fundamentals by Rajendra Prasad, PHI Pub.
3. Basic Electrical Engg.by S.K. Sahdev, Pearson Education
4. Electrical Engg. Fundamentals:byBobrow, Oxford Univ.Press
5. Basic Electrical Engg. By Del Toro.
6. Saxena&Dasgupta: Fundamentals of Electrical Engg (Cambridge University Press).

Note: The paper setter will set the paper as per the question paper templates provided.

ES-103LA	BASIC ELECTRICAL ENGINEERING LAB						
L	T	Practical	Credit	Minor Test	(Practical)	Total	Time (Hrs)
-	-	2	1	20	30	50	3

Purpose	To familiarize the students with the Electrical TechnologyPracticals

Course Outcomes	
CO1	Understand basic concepts of Network theorems
CO 2	Deals with steady state frequency response of RLC circuit parameters solution techniques
CO 3	Deals with introductory Single Phase Transformer practicals
CO 4	Explains the constructional features and practicals of various types of Electrical Machines

LIST OF EXPERIMENTS

1. To verify KVL and KCL.
2. To verify Superposition theorem on a linear circuit with at least one voltage & one current source.
3. To verify Thevenin's Theorem on a linear circuit with at least one voltage & one current source.
4. To verify Norton's Theorem on a linear circuit with at least one voltage & one current source.
5. To study frequency response of a series R-L-C circuit on CRO and determine resonant frequency& Q- factor for various Values of R, L, and C.
6. To study frequency response of a parallel R-L-C circuit on CRO and determine resonant frequency& Q -Factor for various values of R, L, and C.
7. To perform O.C. and S.C. tests on a single phase transformer.
8. To perform direct load test on a single phase transformer and plot efficiency v/s load characteristic.
9. To perform speed control of DC shunt motor.
10. To perform starting & reversal of direction of a three phase induction motor.
11. Measurement of power in a 3 phase balanced system by two watt meter method.
12. Study of Cut sections of DC Machines, Induction Motor
13. To study components of various LT Switchgears

Note: At least 9 out of the listed experiments to be performed during the semester.

BACHELOR OF TECHNOLOGY (MECHANICAL ENGINEERING) CREDIT BASED
KURUKSHETRA UNIVERSITY KURUKSHETRA
SCHEME OF STUDIES/EXAMINATION(Modified)
SEMESTER III (w.e.f. session 2019-2020)

S. No.	Course No.	Course Name	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of Exam (Hrs.)
						Major Test	Minor Test	Practical	Total	
1	BS-201A	Optics & Waves	3:0:0	3	3	75	25	0	100	3
2	BS-204A	Higher Engineering Mathematics	3:0:0	3	3	75	25	0	100	3
3	ES-203A	Basic Electronics Engineering	3:0:0	3	3	75	25	0	100	3
4	MEC-201A	Theory of Machines	3:1:0	4	4	75	25	0	100	3
5	MEC-203A	Mechanics of Solids-I	3:1:0	4	4	75	25	0	100	3
6	MEC-205A	Thermodynamics	3:1:0	4	4	75	25	0	100	3
7	MEC-207LA	Theory of Machines Lab	0:0:2	2	1	0	40	60	100	3
8	MEC-209LA	Mechanics of Solids Lab	0:0:2	2	1	0	40	60	100	3
9	*MEC-211A	Industrial Training-I	2:0:0	2	-	-	100	-	100	
10	**MC-901A	Environmental Sciences	3:0:0	3	-	75	25	0	100	3
			Total	**30**	**23**	**450**	**230**	**120**	**800**	

*MEC-211A is a mandatory non-credit course in which the students will be evaluated for the industrial training undergone after 2nd semester and students will be required to get passing marks to qualify.

**MC-901A is a mandatory credit-less course in which the students will be required to get passing marks in the major test.

BACHELOR OF TECHNOLOGY (MECHANICAL ENGINEERING) CREDIT BASED

KURUKSHETRA UNIVERSITY KURUKSHETRA

SCHEME OF STUDIES/EXAMINATION(Modified)

SEMESTER IV (w.e.f. session 2019-2020)

S. No.	Course No.	Course Name	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of Exam (Hrs.)
						Major Test	Minor Test	Practical	Total	
1	ES-204A	Materials Engineering	3:0:0	3	3	75	25	0	100	3
2	MEC-202A	Applied Thermodynamics	3:0:0	3	3	75	25	0	100	3
3	MEC-204A	Fluid Mechanics & Fluid Machines	3:1:0	4	4	75	25	0	100	3
4	MEC-206A	Mechanics of Solids-II	3:1:0	4	4	75	25	0	100	3
5	MEC-208A	Instrumentation& Control	3:0:0	3	3	75	25	0	100	3
6	ES-206LA	Materials Engineering Lab	0:0:2	2	1	0	40	60	100	3
7	MEC-210LA	Fluid Mechanics & Fluid Machines Lab	0:0:2	2	1	0	40	60	100	3
8	*MC-902A	Constitution of India	3:0:0	3	-	75	25	-	100	3
			Total	**24**	**19**	**375**	**205**	**120**	**700**	

*MC-902A is a mandatory credit-less course in which the students will be required to get passing marks in the major test.

Note: All the students have to undergo 4 to 6 weeks Industrial Training after 4th semester which will be evaluated in 5th semester.

B. Tech (3rd Semester) Mechanical Engineering							
BS – 201A	**Optics and Waves**						
L	**T**	**P**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**-**	**-**	**3**	**75**	**25**	**100**	**3h**
Purpose	To introduce the fundamentals of wave and optics for the applications in Engineering field.						
Course Outcomes							
CO 1	Familiarize with basic phenomenon used in propagation of waves.						
CO 2	Introduce the fundamentals of interference, diffraction, polarization and their applications.						
CO 3	To make the students aware to the importance of Laser in technology.						

Unit - I

Waves: Travelling waves, Characteristics of waves, Mathematical representation of travelling waves, General wave equation, Phase velocity, Light source emit wave packets, Wave packet and Bandwidth, Group velocity and real light waves.

Propagation of light waves: Maxwell's equations, Electromagnetic waves and constitutive relations, Wave equation for free-space, Uniform plane waves, Wave polarization, Energy density, the pointing vector and intensity, Radiation pressure and momentum, Light waves at boundaries, Wave incident normally on boundary, Wave incident obliquely on boundary: law of reflection, Snell's law and reflection coefficients.

Unit - II

Interference: Principle of Superposition, Conditions for Sustained interference, Young's double slit experiment, Division of wave-front: Fresnel's Biprism and its applications, Division of amplitude: Interference due to reflected and transmitted light, Wedge-shaped thin film, Newton's rings and its applications, Michelson Interferometer and its applications.

Unit – III

Diffraction: Types of diffraction, Fraunhofer diffraction at a single slit, Plane transmission diffraction grating: theory, secondary maxima and secondary minima, width of principal maxima, absent spectra, overlapping of spectral lines, determination of wavelength; Dispersive power and resolving power of diffraction grating.

Polarization: Polarization of transverse waves, Plane of polarization, Polarization by reflection, Double refraction, Nicol Prism, Quarter and half wave plate, Specific Rotation, Laurent 's half shade polarimeter, Biquartzpolarimeter.

Unit – IV

Laser: Stimulated Absorption, Spontaneous and Stimulated Emission; Einstein's Coefficients and its derivation, Population Inversion, Direct and Indirect pumping, Pumping schemes, Main components of Laser, Gas lasers (He-Ne, CO_2), Solid state lasers (Ruby, Neodymium, semiconductor), Dye laser, Characteristics of Laser, Applications of Laser.

Text/Reference Books:

1. P.K. Diwan, Applied Physics for Engineers, *Wiley India Pvt. Ltd*., *India*
2. N. Subrahmanyam, B. Lal, M.N. Avadhanulu, A Textbook of Optics, *S. Chand & Company Ltd*., *India.*
3. A. Ghatak, Optics, *McGraw Hill Education(India) Pvt. Ltd., India*.
4. E. Hecht, A.R. Ganesan, Optics, *Pearson India Education Services Pvt. Lt., India.*

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BS-204A	HIGHER ENGINEERING MATHEMATICS						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	-	-	3	75	25	100	3 h
Purpose	The objective of this course is to familiarize the prospective Engineers with Laplace Transform, partial differential equations which allow deterministic mathematical formulations of phenomena in engineering processes and to study numerical methods for the approximation of their solution. More precisely, the objectives are as under:						

Course Outcomes	
CO 1	Introduction about the concept of Laplace transform and how it is useful in solving the definite integrals and initial value problems.
CO 2	To introduce the Partial Differential Equations, its formation and solutions for multivariable differential equations originated from real world problems.
CO 3	To introduce the tools of numerical methods in a comprehensive manner those are used in approximating the solutions of various engineering problems.
CO 4	To familiar with essential tool of Numerical differentiation and Integration needed in approximate solutions for the ordinary differential equations.

UNIT-1

Laplace Transform

Laplace Transform, Laplace Transform of Elementary Functions, Basic properties of Laplace Transform, Laplace transform of periodic functions, finding inverse Laplace transform by different methods, Convolution theorem, solving ODEs by Laplace Transform method.

UNIT-2

Partial Differential Equations

Formation of Partial Differential Equations, Solutions of first order linear and non-linear PDEs, Charpit's method, Solution to homogenous linear partial differential equations (with constant coefficients) by complimentary function and particular integral method.

UNIT-3

Numerical Methods-1

Solution of polynomial and transcendental equations: Bisection method, Newton-Raphson method and Regula-Falsi method, Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formulae. Interpolation with unequal intervals: Newton's divided difference and Lagrange's formulae.

UNIT-4

Numerical Methods-2

Numerical Differentiation using Newton's forward and backward difference formulae, Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules, Ordinary differential equations: Taylor's series, Euler and modified Euler's methods. Runge-Kutta method of fourth order for solving first and second order equations.

Textbooks/References:

1. S. J. Farlow, Partial Differential Equations for Scientists and Engineers, Dover Publications, 1993. AICTE Model Curriculum in Mathematics.
2. R. Haberman, Elementary Applied Partial Differential equations with Fourier Series and Boundary Value Problem, 4th Ed., Prentice Hall, 1998.
3. Ian Sneddon, Elements of Partial Differential Equations, McGraw Hill, 1964.
4. Manish Goyal and N.P. Bali, Transforms and Partial Differential Equations, University Science Press, Second Edition, 2010.
5. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
7. Veerarajan T., Engineering Mathematics, Tata McGraw-Hill, New Delhi, 2008.
8. P. Kandasamy, K. Thilagavathy, K. Gunavathi, Numerical Methods, S. Chand & Company, 2nd Edition, Reprint 2012.
9. S.S. Sastry, Introductory methods of numerical analysis, PHI, 4th Edition, 2005.
10. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
11. Erwin Kreyszig and Sanjeev Ahuja, Applied Mathematics-II, Wiley India Publication, Reprint, 2015.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

B. Tech (3rd Semester) Mechanical Engineering							
ES-203A	**Basic Electronics Engineering**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose :	To provide an overview of electronic devices and components to Mechanical engineering students.						
Course Outcomes							
CO 1	To introduce the basic electronics devices along with their applications.						
CO 2	To become familiar with basic operational amplifier circuits with applications and oscillators.						
CO 3	To understand the fundamentals of digital electronics.						
CO 4	To become familiar with basic electroniccommunication system.						

UNIT-I

Semiconductor Devices and Applications: Introduction to P-N junction Diode and V-Icharacteristics, Half wave and Full-wave rectifiers, capacitor filter. Zener diode and its characteristics, Zener diode as voltage regulator. BJT structure, its input-output and transfer characteristics, BJT as a Common Emitter amplifier, frequency response and bandwidth.

UNIT-II

Operational amplifier and its applications: Introduction to operational amplifiers, inverting, non-inverting and differential modes, basic parameters of Op-amp, Op-amp in open loop configuration, study of practical op-amp IC 741, Op-amp applications: adder, subtractor, scale changer, averaging amplifer,comparator, integrator and differentiator.

Timing Circuits and Oscillators: IC 555 timer pin diagram: Astableand mono-stable operation, Barkhausen's criteria for oscillations, R-C phase shift and Wein bridge oscillators using BJT and Op-Amp and their frequency of oscillation.

UNIT-III

Digital Electronics Fundamentals : Difference between analog and digital signals, Booleanalgebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K- maps, Logic ICs, half and full adder, multiplexers, de-multiplexers, flip-flops, basic counters.

UNIT-IV

Electronic Communication Systems: The elements ofcommunication system,
Transmission media: wired and wireless, need of modulation, AM and FM modulation schemes, Mobile communication systems: cellular concept and block diagram of GSM system.

Text Books:

1. Integrated Electronics, Millman&Halkias (Mc-Graw Hill)
2. Electronics Devices & Circuit Theory, RL Boylestead& L Nashelsky (PHI)

Reference Books:

1. Modern Digital Electronics, R P Jain, Tata McGraw Hill.
2. Electronic Communication Systems, G. Kennedy, McGraw Hill, 4th Edition

Note: The paper setter will set the paper as per the question paper templates provided.

B. Tech (3rd Semester) Mechanical Engineering							
MEC-201A	**THEORY OF MACHINES**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs)**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose:	To familiarize the students with design of various types of linkage mechanisms for obtaining specific motion, their analysisand applicability for optimal functioning.						
Course Outcomes							
CO 1	To understand the kinematics of simple mechanisms and methods of determining the link velocities.						
CO 2	To understand the acceleration of different mechanisms and profilegeneration of cams and followers.						
CO 3	To understand the concepts of static and dynamic force analysis of different mechanisms and balancing of different components.						
CO 4	To familiarize with gear, gear trains, belts and chain drives.						

UNIT-I

Simple Mechanisms: Introduction to mechanism and machine, Kinematic links, pairs and chains, Mobility of mechanisms, Equivalent mechanisms,Four bar chain, Inversion of four bar chain, slider crank chain and inversions.

Velocity Analysis: Determination of link velocities, Relative velocity method, Velocities in four bar mechanism, Slider crank mechanism, crank and slotted lever mechanism and quick return motion mechanism, Instantaneous center method: Types & location of instantaneous centers, Arnold Kennedy theorem, methods of locating instantaneous centers, steering gear mechanisms. Problems.

UNIT-II

Acceleration Analysis: Acceleration of a point on a link, four bar mechanism and slider crank mechanism, Coriolis component of acceleration, Klein's construction, Problems.

Cams and Followers: Classification & terminology, Cam profile by graphical methods with knife edge and radial roller follower for uniform velocity, simple harmonic, constant acceleration and deceleration and cycloidal motion of followers, Problems.

UNIT-III

Static and Dynamic Force Analysis:constraints and applied forces, static equilibrium, equilibrium of two and three-force member, equilibrium of four-forces and torque, free body diagrams. Dynamic Force Analysis:D'Alembert'sprinciple, equivalent offset interia force, Dynamic analysis of four-link,Dynamic analysis of slider-crank mechanisms, velocity and acceleration of piston, angular velocity and angular acceleration of connecting rod, turning moment on crank shaft, turning moment diagrams, fluctuation of energy, flywheels, Problems.

Balancing:rotating masses: Static and Dynamic Balancing, Single Rotating mass, Many Masses rotating in same plane and in different planes. Analytical method for balancing of rotating masses.Reciprocating masses: Balancing of reciprocating engine, Balancing of Multi-cylinder in line engines, balancing machines.

UNIT-IV

Belts and Chain Drives:classifications of belt, law of belting, Length of open and cross flat belt, Ratio of tensions,Centrifugal tension, power transmission, condition for maximum power transmission, creep of belt, V-belt drives: driving tensions, Chain drives: classifications, terminology of chains, kinematics of chains, Problems.

Gears and Gear Trains: Classification & terminology, Law of gearing, Tooth forms & comparisons, Length of path of contact, Contact ratio, Interference & undercutting in involute gear teeth, Minimum number of teeth on gear and pinion to avoid interference. Gear Trains**:**simple, compound, reverted andplanetary gear trains, Problems.

Text Books:

1. Theory of Mechanisms and Machines: Amitabha Ghosh and Ashok Kumar Mallik, Third Edition Affiliated East-West Press.
2. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
3. Cleghorn W.L., Mechanisms of Machines, Oxford University Press, 2005. 3. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGrawHill, 2009.
4. Theory of Machines and Mechanisms: Joseph Edward Shigley and John Joseph Uicker, Jr. Second Edition, MGH, New York.

Reference Books:

1. Mechanism and Machine Theory: J.S. Rao and R.V. Dukkipati Second Edition New age International.
2. Theory and Machines: S.S. Rattan, Tata McGraw Hill.
3. Kinematics of Machines-Dr. Sadhu Singh, Pearson Education

Note: The paper setter will set the paper as per the question paper templates provided.

	B. Tech. (3rd Semester) Mechanical Engineering						
MEC-203A	**MECHANICS OF SOLIDS-I**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose	The objective of this course is to make the students aware of Stress, Strain and deformation of solids with the applications to beams, shafts and column and struts. The course will help the students to build the fundamental concepts in order to solve engineering problems.						
Course Outcomes							
CO1	Apply fundamental principles of mechanics & principles of equilibrium to simple and practical problems of engineering, determine centroid and moment of inertia of a different geometrical shapes and able to understand its importance. Explain the basic concepts of stress and strain and solve the problems						
CO 2	Determine and calculate the values of principal stresses. Express the concept of shear force and bending moment of beams. Construct shear force and bending moment diagram for beams.						
CO 3	Express the concept of torsion of circular shaft and able to solve the problems on torsion of circular shaft. Illustrate and solve the problems on bending and shear stresses on beams						
CO 4	Solve the problems on column and strut and Derive the derivations and solve the problems on slope and deflection.						

Unit-I

Introduction: Force, types of forces, Characteristics of a force, System of forces, Composition and resolution of forces, forces in equilibrium, principle and laws of equilibrium, Free body diagrams, Lami's Theorem, equations of equilibrium, Concept of center of gravity and centroid, centroid of various shapes: Triangle, circle, semicircle and trapezium, theorem of parallel and perpendicular axes, moment of inertia of simple geometrical figures, polar moment of inertia. Numerical Problems

Simple Stresses & Strains: Concept & types of Stresses and strains, Poisson's ratio, stresses and strain in simple and compound bars under axial loading, stress strain diagrams, Hook's law, elastic constants & their relationships, temperature stress & strain in simple & compound bars under axial loading, Numerical problems.

Unit-II

Principle Stresses: Two dimensional systems, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stresses, Numerical Problems.

Shear Force & Bending Moments: Definitions, SF & BM diagrams for cantilevers, simply supported beams with or without over-hang and calculation of maximum BM & SF and the point of contraflexture under (i) concentrated loads, (ii) uniformly distributed loads over whole span or a part of it, (iii)combination of concentrated loads and uniformly distributed loads, (iv) uniformly varying loads and (v) application of moments, relation between the rate of loading, the shear force and the bending moments, Numerical Problems.

. **Unit-III**

Torsion of Circular Members: Derivation of equation of torsion, Solid and hollow circular shafts, tapered shaft, stepped shaft & composite circular shafts, Numerical problems.

Flexural and Shear Stresses – Theory of simple bending, Assumptions, derivation of equation of bending, neutral axis, determination of bending stresses, section modulus of rectangular & circular (solid & hollow), I,T, Angle, channel sections, composite beams, shear stresses in beams with derivation, shear stress distribution across various beam sections like rectangular, circular, triangular, I, T, angle sections. combined bending and torsion, equivalent torque,. Numerical problems.

Unit-IV

Columns & Struts: Column under axial load, concept of instability and buckling, slenderness ratio, derivation of Euler's formula for crippling load for columns of different ends, concept of equivalent length, eccentric loading, Rankine formulae and other empirical relaions, Numerical problems.

Slope & Deflection : Relationship between bending moment, slope & deflection, moment area method, method of integration, Macaulay's method, calculations for slope and deflection of (i) cantilevers and (ii) simply supported beams with or without overhang under concentrated load, Uniformly distributed loads or combination of concentrated and uniformly distributed loads, Numerical problems.

Text Books:

1. Strength of Materials – R.K. Rajput, Dhanpat Rai & Sons.
2. Strength of Materials – Sadhu Singh, Khanna Publications.
3. Strength of Materials – R.K. Bansal, Laxmi Publications.

Reference Books:

1. Strength of Materials – Popov, PHI, New Delhi.
2. Strength of Materials – Robert l. Mott, Pearson, New Delhi
3. Strength of Material – Shaums Outline Series – McGraw Hill
4. Strength of Material – Rider – ELBS

Note: The paper setter will set the paper as per the question paper templates provided.

	B. Tech. (3rd semester) Mechanical Engineering						
MEC-205A	**THERMODYNAMICS**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose	The objective of this course is to make the students aware of Energy, Entropy, and Equilibrium, various laws of thermodynamics, concepts and principles. The course will help the students to build the fundamental concepts to apply in various applications like IC engines and Air conditioning systems.						
Course Outcomes							
CO 1	Analyze the work and heat interactions associated with a prescribed process path and to perform an analysis of a flow system.						
CO 2	Define the fundamentals of the first and second laws of thermodynamics and explain their application to a wide range of systems.						
CO 3	Evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations.						
CO 4	Solve the problems related to Steam and plot the processes on H-S and T-S diagram. Understand thermodynamics relations.						

Unit-I

Basic Concepts: Thermodynamics: Macroscopic and Microscopic Approach, Thermodynamic Systems, Surrounding and Boundary, Thermodynamic Property – Intensive and Extensive, Thermodynamic Equilibrium, State, Path, Process and Cycle, Quasi-static, Reversible and Irreversible Processes, Working Substance. Concept of Thermodynamic Work and Heat, Zeroth Law of Thermodynamic and its utility.

First Law of Thermodynamics: Energy and its Forms, Energy and 1st law of Thermodynamics, Internal Energy and Enthalpy, 1st Law Applied to Non-Flow Process, Steady Flow Process and Transient Flow Process, Throttling Process and Free Expansion Process.

Unit-II

Second Law of Thermodynamics: Limitations of First Law, Thermal Reservoir Heat Source and Heat Sink, Heat Engine, Refrigerator and Heat Pump, Kelvin- Planck and Clausius Statements and Their Equivalence, Perpetual Motion Machine of Second Kind. Carnot Cycle, Carnot Heat Engine and Carnot Heat Pump, Carnot's Theorem and its Corollaries, Thermodynamic Temperature Scale, Numericals

Entropy: Clausius Inequality and Entropy, Principle of Entropy Increase, Temperature-Entropy Plot, Entropy Change in Different Processes, Introduction to Third Law of thermodynamics.

Unit -III

Availability, Irreversibility and Equilibrium: High and Low Grade Energy, Available Energy and Unavailable Energy, Loss of Available Energy Due to Heat Transfer Through a Finite Temperature Difference, Availability of a Non-Flow or Closed System, Availability of a Steady Flow System, Helmholtz and Gibb's Functions, Effectiveness and Irreversibility.

Pure Substance: Pure Substance and its Properties, Phase and Phase Transformation, Vaporization, Evaporation and Boiling , Saturated and Superheated Steam, Solid – Liquid – Vapour Equilibrium, T-V, P-V and P-T Plots During Steam Formation, Properties of Dry, Wet and Superheated Steam, Property Changes During Steam Processes, Temperature – Entropy (T-S) and Enthalpy – Entropy (H-S) Diagrams, Throttling and Measurement of Dryness Fraction of Steam.

Unit-IV

Thermodynamic Relations: TDS Relations, Enthalpy and Internal Energy as a Function of Independent Variables, Specific Heat Capacity Relations, Clapeyron Equation, Maxwell Relations.

Gas Power Cycles: Air standard efficiency, Otto cycle, Diesel cycle, Dual cycle, Atkinson cycle, Stirling and Ericsson cycles, Brayton or Joule cycle, Lenoir cycle

Text Books:

1. Engineering Thermodynamics – C P Arora, Tata McGraw Hill
2. Engineering Thermodynamics – P K Nag, Tata McGraw Hill
3. Thermodynamics – An Engineering Approach; Y. A. Cengel, M. A. Boles; Tata McGraw Hill

Reference Books:

1. Thermal Science and Engineering – D S Kumar, S K Kataria and Sons
2. Engineering Thermodynamics -Work and Heat transfer – G F C Rogers and Maghew
Y R Longman

Note: The paper setter will set the paper as per the question paper templates provided.

	B.Tech (3rd Semester) Mechanical Engineering							
MEC-207LA	**THEORY OF MACHINES LAB**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time (Hrs)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose :	To familiarize and practice the students with various kinds of mechanisms andmachines.							
	Course Outcomes							
CO 1	To learn about various types of basic mechanism & their applications in different machines.							
CO 2	To study the effect of static and dynamic force on the components of single slider crank mechanism.							
CO 3	To find gyroscopic couple of a motorized gyroscope experimentally.							
CO 4	To study the design and working of various gear, gear trains, steering systems, belt drives, brakes and dynamometers.							

List of experiments

1. To study inversions of 4 bar mechanisms, single and double slider crank mechanisms.
2. To determine the ratio of times and tool velocities of Whitworth quick-return mechanism.
3. To plot slider displacement, velocity and acceleration against crank rotation for single slider crank mechanism.
4. To find out experimentally the Coriolis component of acceleration and compare with theoretical value.
5. To determine the moment of inertia of a flywheel.
6. To plot follower displacement v/s cam rotation for various cam follower systems.
7. To find gyroscopic couple on motorized gyroscope and compare with applied couple.
8. To calculate the torque on planet carrier and torque on internal gear using epicycle gear train and holding torque apparatus.
9. To determine the coefficient of friction between belt and pulley and plot a graph between $\log_{10} T_1/T_2$ v/s θ
10. To study the different types of centrifugal and inertia governor with demonstration.
11. To study different types of brakes and dynamometers with demonstration.
12. To study various types of steering mechanisms.

Note: At least eight experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.

	B.Tech. (3rd semester) Mechanical Engineering							
MEC-209LA	**MECHANICS OF SOLIDS LAB**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time (Hrs.)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose	To make the students aware of different properties of material using different experiments.							
Course Outcomes								
CO1	Ability to design and conduct experiments, acquire data, analyze and interpret data							
CO 2	Ability to determine the behavior of ferrous metals subjected to normal and shear stresses by means of experiments.							
CO 3	Ability to determine the behavior of structural elements, such as bars subjected to tension, compression, shear, bending, and torsion by means of experiments.							
CO 4	Physical insight into the behavior materials and structural elements, including distribution of stresses and strains, deformations and failure modes.							
CO5	Write individual and group reports: present objectives, describe test procedures and results, synthesize and discuss the test results.							

List of Experiments:

1. To study the Brinell hardness testing machine & perform the Brinell hardness test.
2. To study the Rockwell hardness testing machine & perform the Rockwell hardness test.
3. To study the Vickers hardness testing machine & perform the Vickers hardness test.
4. To study the Erichsen sheet metal testing machine & perform the Erichsen sheet metal test.
5. To study the Impact testing machine and perform the Impact tests (Izod&Charpy).
6. To study the Universal testing machine and perform the tensile, compression & bending tests.
7. To perform the shear test on UTM.
8. To study the torsion testing machine and perform the torsion test.
9. To draw shear Force, Bending Moment Diagrams for a simply Supported Beam under point and distributed Loads.
10. To prepare the composite specimen using hot compression molding machine and test for different mechanical properties.

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Note: At least eight experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.

	B.Tech. (3rd semester) Mechanical Engineering							
MEC-211A	**INDUSTRIAL TRAINING-I**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time (Hrs.)**
2	**0**	**0**	**--**	**--**	**100**	**--**	**100**	
Purpose	To provide comprehensive learning platform to students where they can enhance their employ ability skills and exposure to the industrial environment.							
Course Outcomes								
CO1	Capability to acquire and apply fundamental principles of engineering.							
CO 2	Become updated with all the latest changes in technological world.							
CO 3	Capability and enthusiasm for self-improvement through continuous professional development and life-long learning							
CO 4	Awareness of the social, cultural, global and environmental responsibility as an engineer.							

Note: MEC-211 is a mandatory non-credit course in which the students will be evaluated for the industrial training undergone after 2nd semester and students will be required to get passing marks to qualify.

The candidate has to submit a training report of his/her work/project/assignment completed in the industry during the training period. The evaluation will be made on the basis of submitted training report and viva-voce/presentation.

MC-901A	Environmental Sciences						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**0**	**0**	**0**	**75**	**25**	**100**	**3 Hrs.**
Purpose	To learn the multidisciplinary nature, scope and importance of Environmental sciences.						
Course Outcomes (CO)							
CO1	The students will be able to learn the importance of natural resources.						
CO2	To learn the theoretical and practical aspects of eco system.						
CO3	Will be able to learn the basic concepts of conservation of biodiversity.						
CO4	The students will be able to understand the basic concept of sustainable development.						

UNIT 1

The multidisciplinary nature of environmental studies, Definition, Scope and Importance, Need for public awareness, Natural Resources: Renewable and Non-Renewable Resources: Natural resources and associated problems.

(a) Forest Resources: Use and over-exploitation, deforestation, case studies. Timber eztraction, mining, dams and their effects on forests and tribal people.
(b) Water Resources: Use & over-utilization of surface & ground water, floods, drought, conflicts over water, dams-benefits and problems.
(c) Mineral Resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
(d) Food Resources: World Food Problems, changes caused by agriculture and overgazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
(e) Energy Resources: Growing energy needs, renewable & non-renewable energy sources, use of alternate energy sources. Case studies.
(f) Land Resources: Land as a resource, land, degradation, man induced landslides, soil erosion and desertification.

Role of an individual in conservation of natural resources, Equitable use of resources for sustainable lifestyle.

UNIT II

Ecosystem-Concept of an ecosystem. Sturcture and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological Succession, Food Chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: (a) Forest Ecosystem, (b) Grassland Ecosystem, (c) Desert Ecosystem and (d) Aquatic Ecosystems (ponds, streams, lakes, rivers, oceans, esturaries

Field Work: Visit to a local area to document Environment assets-river/forest/grassland/hill/mountain, Visit to a local polluted site-Urban /Rural Industrial/Agricultural, Study of common plants, insects and birds, Study of simple ecosystems-pond, river, hill, slopes etc. (Field work equal to 5 lecture hours).

UNIT III

Biodiversity and its conservation: Introduction, Definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversityof global, National and local levels. India as a mega-diversity nation Hot spots of Biodiversity, Threats to biodiversity: Habitat loss, poaching of wild life, man-wildlife conflicts, Endangered and endemic species of India, Conservation of Biodiversity- In situ and Ex-Situ conservation of biodiversity.

Environmental Pollution Definition: Cause, effects and control measures of (a) Air Pollution (b) Water Pollution (c) Soil Pollution (d) Marine Pollution (e) Noise Pollution (f) Thermal Pollution (g) Nuclear Hazards

Solid waste management- cause, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, Pollution case studies, Disaster management: floods, earthquake, cyclone and landslides

UNIT IV

Social Issues and the Environment. From unsustainable to sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people: Its problems and concerns, Case Studies: Environmental ethics-issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies: Wasteland Reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation, Public Awareness, Human population and the Environment, Population growth, variation among nations, Population explosion-Family Welfare Programme, Environment and human health. Human rights, Value Education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environment and Human Health, Case Studies, Drugs and their effects; Useful and harmful drugs, Use and abuse of drugs, Stimulant and depressan drugs, Concept of drug de-addiction, Legal position on drugs and laws related to drugs.

Suggested Books

- Environmental Studies- Deswal and Deswal. Dhanpat Rai and Co.
- Environmental Science and Engineering Anandan, P. and Kumaravelan, R. 2009. Scitech Publications (India) Pvt. Ltd., India.
- Environmental Studies. Daniels Ranjit R. J. and Krishnaswamy. 2013. Wiley India.
- Environmental Science- Botkin and Keller. 2012. Wiley , India

Note: The Examiner will be given the question paper template to set the question paper.

	B.Tech. (4th Semester) Mechanical Engineering						
ES-204	MATERIALS ENGINEERING						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	0	0	3	75	25	100	3
Purpose:	To understand internal structure- properties relationship of different types of materials and learn about Metallographic analysis and Characterization.						
Course Outcomes							
CO 1	To understand the Crystal structures and deformation mechanism in various materials.						
CO 2	To study various types of phase diagrams, TTT curve and Iron carbon diagram. To learn about different heat treatment processes.						
CO 3	To learn about the failure mechanisms like Creep and Fatigue and designation of materials.						
CO 4	To study Basics of Metallography and Basic Principle involved in the working of various types of Material characterization techniques.						

UNITI

Crystallography: Review of Crystal Structure, Space Lattice, Co-ordination Number ,Number of Atomsper Unit Cell, Atomic Packing Factor; Numerical Problems Related to Crystallography.

Imperfection in Metal Crystals: Crystal Imperfections and their Classifications, Point Defects, Line Defects, Edge & Screw Dislocations, Surface Defects, Volume Defects.

Introduction to Engineering materials and Standard Materials Designation: Introduction to Engineering materials, Steel Terminology, Standard Designation System for Steels, Indian Standard specifications for steels as per BIS: Based on Ultimate Tensile Strength and based on Composition, AISI-SAE standard designation for Steels and Aluminium Alloys

UNIT II

Phase Diagrams: Alloy Systems, Solid solutions, Hume Rothery's Rules, Intermediate phases, Phase Diagrams, Gibbs Phase Rule, Cooling curves, The Lever Rule, binary phase diagrams, Applications of Phase Diagrams, Phase Transformation, Micro constituents of Fe-C system, Allotropic Forms of Iron ,Iron-iron carbide phase diagram, Modified Iron Carbon Phase Diagrams, Isothermal Transformation, TTT Curve,

Heat Treatment: Heat treatment of steels, Annealing, Normalising, Hardening, Tempering, Case Hardening, Ageing, Aus tempering and Mar tempering, Surface Hardening, Mass Effect, Equipments for Heat Treatment, Major Defects in Metals or Alloys due to faulty Heat treatment.

UNIT III

Deformation of Metal: Elastic and Plastic Deformation, Mechanism of Plastic Deformation, Slip; Critical Resolved Shear Stress, Twinning, Conventional and True Stress Strain Curves for Polycrystalline Materials, Yield Point Phenomena, Bauschinger Effect, Work Hardening.

Failure of Materials: Fatigue, Fatigue fracture, fatigue failure, Mechanismof Fatigue Failure, Fatigue Life calculations ,Fatigue Tests, Theories of Fatigue.

Creep: Creep Curve , Types of Creep, Factors affecting Creep, Mechanism of Creep, Creep Resistant Material, Creep Fracture, Cre ep Test, Stress Rupture test.

UNITIV

Introduction to Metallography: Metallography, Phase analysis, Dendritic growth, Cracks and other defects Corrosion analysis, Intergranular attack (IGA), Coating thickness and integrity, Inclusion size, shape and distribution, Weld and heat-affected zones (HAZ), Distribution and orientation of composite fillers, Graphite nodularity, Intergranular fracturing

Materials Characterization Techniques: Characterization techniques suchas X-Ray Diffraction (XRD), Scanning Electron Microscopy, transmission electron microscopy, atomic force microscopy, scanning tunneling microscopy, Atomic absorption spectroscopy.

Text Books:

1. Material Science by S.L.Kakani, New Age Publishers.
2. The Science and Engineering of Materials, Donald R. Askeland , Chapman & Hall.
3. Fundamentals of Material Science and Engineering by W. D. Callister, Wiley.
4. FundamentalofLightMicroscopyandElectronicImagingbyDouglasB.Murphy, Kindle Edition 2001
5. Materials Science and Engineering, V. Raghvan
6. Phase Transformation in Metals and Alloys,D. A.Porter &K.E. Easterling

Reference Books:

7. Material Science by Narula, TMH
8. Metallographic Handbook by Donald C. Zipperian, Pace Technologies, USA.
9. Robert Cahn Concise Encyclopedia of Materials Characterization, SecondEdition:2nd Edition (Advances in Materials Science and Engineering) Elsevier Publication 2005.
10. Smart Materials and Structures by Gandhi and Thompson, Chapman and Hall.

Note: The paper setter will set the paper as per the question paper templates provided.

	B. Tech. (4th Semester) Mechanical Engineering						
MEC-202A	**APPLIED THERMODYNAMICS**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose:	This course aims to provide a platform to students to understand, model and analyze concept of dynamics involved in thermal energy transformation. To prepare them to carry out experimental investigation and analysis of problems related to applied thermodynamics.						
Course Outcomes							
CO1	Understand the working of boilers, types of boilers, accessories and mountings used on boilers.						
CO 2	Learn about simple and modified Rankine cycles.						
CO 3	Understand the design and analysis of steam flow through steam nozzles. To learn about the working of different types of condensers.						
CO 4	Analyze the working and design of the steam turbine and apply the knowledge in solving the engineering problems of turbines.						

UNITI

Steam Generators: Introduction; classification of boilers; comparison of fire tube and water tube boiler; their advantages; description of boiler; Lancashire; locomotive; Babcock; Wilcox etc.; boiler mountings; stop valve; safety valve; blow off valve; feed check etc.; water level indicator; fusible plug; pressure gauge; boiler accessories; feed pump; feed water heater; preheater; super heater; economizer; natural draught chimney design; artificial draught; stream jet draught; mechanical draught; calculation of boiler efficiency and equivalent evaporation.

UNIT II

Vapour Power Cycles: Simple and modified Rankine cycle; effect of operating parameters on Rankine cycle performance; effect of superheating; effect of maximum pressure; effect of exhaust pressure; reheating and regenerative Rankine cycle; types of feed water heater; reheat factor; binary vapour cycle. Simple steam engine, compound engine; function of various components.

UNIT III

Steam Nozzle: Function of steam nozzle; shape of nozzle for subsonic and supersonics flow of stream; variation of velocity; area of specific volume; steady state energy equation; continuity equation; nozzle efficiency; critical pressure ratio for maximum discharge; physical explanation of critical pressure; super saturated flow of steam; design of steam nozzle. Advantage of steam condensation; component of steam condensing plant; types of condensers; air leakage in condensers; Dalton's law of partial pressure; vacuum efficiency; calculation of cooling water requirement; air expansion pump.

UNIT IV

Steam Turbines: Introduction; classification of steam turbine; impulse turbine; working principle; compounding of impulse turbine; velocity diagram; calculation of power output and efficiency; maximum efficiency of a single stage impulse turbine; design of impulse turbine blade section; impulse, reaction turbine; working principle; degree of reaction; parsons turbine; velocity diagram; calculation of power output; efficiency of blade height; condition of maximum efficiency; internal losses in steam turbine; governing of steam turbine.

Text Books:

1. Thermal Engineering – P L Ballaney, Khanna Publishers.
2. Thermodynamics and Heat Engines vol II – R Yadav, Central Publishing House
3. Engineering Thermodynamics Work and Heat Transfer - G. F. C Rogers and Y. R. Mayhew, Pearson.
4. Applied Thermodynamics for Engineering Technologists - T. D. Eastop and A. McConkey, Pearson.

Reference Books:

1. Applied Thermodynamics for Engineering Technologists – T D Eastop and A. McConkey, Pearson Education
2. Heat Engineering – V P Vasandani and D S Kumar, Metropolitan Book Co Pvt Ltd.

Note: The paper setter will set the paper as per the question paper templates provided.

	B. Tech. (4th Semester) Mechanical Engineering						
MEC-204A	**FLUID MECHANICS&FLUID MACHINES**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**

Purpose: To build a fundamental understanding of concepts of Fluid Mechanics and their application in rotodynamic machines.

Course Outcomes	
CO1	Upon completion of this course, students will be able to apply mass and momentum conservation laws to mathematically analyze simple flow situations.
CO2	The students will be able to obtain solution for boundary layer flows using exact or approximate methods.
CO3	The students will be able to estimate the major and minor losses through pipes and learn to draw the hydraulic gradient and total energy lines.
CO4	The students will be able to obtain the velocity and pressure variations in various types of simple flows.
CO5	They will be able to analyze the flow and evaluate the performance of pumps and turbines.

Unit I

Fluid Properties: Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, weight density, specific volume, specific gravity, viscosity, compressibility, surface tension and capillarity.

Fluid Kinematics: Types of fluid flows, stream, streak and path lines; flow rate and continuity equation, differential equation of continuity in cartesian and polar coordinates, rotation and vorticity, circulation, stream and potential functions, flow net. Problems.

Fluid Dynamics: Concept of system and control volume, Euler's equation, Navier-Stokes equation, Bernoulli's equation and its practical applications, Impulse momentum equation. Problems.

Unit II

Viscous Flow: Flow regimes and Reynold's number, relationship between shear stress and pressure gradient. Exact flow solutions, Couette and Poisuielle flow, laminar flow through circular conduits. Problems.

Turbulent Flow Through Pipes: Darcy Weisbach equation, friction factor, Moody's diagram, minor losses in pipes, hydraulic gradient and total energy lines, series and parallel connection of pipes, branched pipes; equivalent pipe, power transmission through pipes. Problems.

Boundary Layer Flow: Concept of boundary layer, measures of boundary layer thickness, Blasius solution, von-Karman momentum integral equation, laminar and turbulent boundary layer flows, separation of boundary layer and its control. Problems.

Unit III

Dimensional Analysis: Need for dimensional analysis – methods of dimension analysis – Dimensionless parameters – application of dimensionless parameters. Problems.

Hydraulic Pumps: Introduction, theory of Rotodynamic machines, Classification, various efficiencies, velocity components at entry and exit of the rotor, velocity triangles; Centrifugal pumps, working principle, work done by the impeller, minimum starting speed, performance curves, Cavitation in pumps, Reciprocating pumps, working principle, Indicator diagram, Effect of friction and acceleration, air vessels, Problems.

Unit IV

Hydraulic Turbines: Introduction, Classification of water turbines, heads and efficiencies, velocity triangles, Axial, radial and mixed flow turbines, Pelton wheel, Francis turbine and Kaplan turbines, working principles, work done, design of turbines, draft tube and types, Specific speed, unit quantities, performance curves for turbines, governing of turbines. Problems.

Text Books:

1. Introduction to Fluid Mechanics – R.W. Fox, Alan T. McDonald, P.J. Pritchard, Wiley Publications.
2. Fluid Mechanics – Frank M. White, McGraw Hill
3. Fluid Mechanics and Fluid Power Engineering – D.S. Kumar, S.K. Kataria and Sons
4. Fluid Mechanics – Streeter V L and Wylie E B, Mc Graw Hill
5. Introduction to Fluid Mechanics and Fluid Machines – S.K. Som and G. Biswas, Tata McGraw Hill.

Reference Books:

1. Mechanics of Fluids – I H Shames, Mc Graw Hill
2. Fluid Mechanics: Fundamentals and Applications - YunusCengel and John Cimbala, McGraw Hill.
3. Fluid Mechanics: Pijush K. Kundu, Ira M. Cohen and David R. Rowling, Academic Press.

Note: The paper setter will set the paper as per the question paper templates provided.

	B. Tech. (4th Semester) Mechanical Engineering						
MEC-206A	**MECHANICS OF SOLIDS-II**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose	The objective of this course is to show the development of strain energy and stresses in springs, pressure vessel, rings, links, curved bars under different loads. The course will help the students to build the fundamental concepts in order to solve engineering problems						
Course Outcomes							
CO1	Identify the basics concepts of strain energy and various theories of failures and solve the problems						
CO 2	Differentiate different types of stresses induced in thin pressure vessel and solve the problems. Use of Lame's equation to calculate the stresses induced in thick pressure vessel.						
CO 3	Able to compute stresses in ring, disk and cylinder due to rotation. Classify the different types of spring and analyze the stresses produced due to loading						
CO 4	Determine the stresses in crane hook, rings, chain link for different cross section and also the deflection of curved bars and rings. Analyze the stresses due to unsymmetrical bending and determine the position of shear centre of different section.						

Unit I

Strain Energy & Impact Loading: Definitions, expressions for strain energy stored in a body when load is applied (i) gradually, (ii) suddenly and (iii) with impact, strain energy of beams in bending, beam deflections, strain energy of shafts in twisting, energy methods in determining spring deflection, Castigliano's theorem, Numerical.

Theories of Elastic Failures: Various theories of elastic failures with derivations and graphical representations, applications to problems of 2- dimensional stress system with (i) Combined direct loading and bending, and (ii) combined torsional and direct loading, Numericals.

Unit II

Thin Walled Vessels: Hoop & Longitudinal stresses & strains in cylindrical &spherical vessels & their derivations under internal pressure, wire would cylinders, Numericals.

Thick Cylinders & Spheres: Derivation of Lame's equations, radial & hoop stresses and strains in thick, and compound cylinders and spherical shells subjected to internal fluid pressure only, hub shrunk on solid shaft, Numericals.

Unit III

Rotating Rims & Discs: Stresses in uniform rotating rings & discs, rotating discs of uniform strength, stresses in (I) rotating rims, neglecting the effect of spokes, (ii) rotating cylinders, hollow cylinders & solids cylinders. Numericals.

Springs: Stresses in closed coiled helical springs, Stresses in open coiled helical springs subjected to axial loads and twisting couples, leaf springs, flat spiral springs, concentric springs, Numericals.

Unit IV

Bending of Curved Bars : Stresses in bars of initial large radius of curvature, bars of initial small radius of curvature, stresses in crane hooks, rings of circular & trapezoidal sections, deflection of curved bars & rings, deflection of rings by Castigliano's theorem, stresses in simple chain links, deflection of simple chain links, Problems.

Unsymmetrical Bending: Introduction to unsymmetrical bending, stresses due to unsymmetrical bending, deflection of beam due to unsymmetrical bending, shear center for angle, channel, and I-sections, Numericals.

Text Books:

1. Strength of Materials – R.K. Rajput, Dhanpat Rai & Sons.
2. Strength of Materials – Sadhu Singh, Khanna Publications.
3. Strength of Materials – R.K. Bansal, Laxmi Publications.

Reference Books:

1. Strength of Materials – Popov, PHI, New Delhi.
2. Strength of Materials – Robert I. Mott, Pearson, New Delhi
3. Strength of Material – Shaums Outline Series – McGraw Hill
4. Strength of Material – Rider – ELBS

Note: The paper setter will set the paper as per the question paper templates provided.

	B. Tech. (4th Semester) Mechanical Engineering						
MEC-208A	**Instrumentation & Control**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time(Hrs)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	To understand the basics of the measurement of various quantities using instruments, their accuracy and range and the techniques for controlling devices automatically.						
Course Outcomes							
CO1	Students will have basic knowledge about measurement systems and their components.						
CO2	Students will learn about various sensors used for measurement of mechanical quantities.						
CO3	Students will have basic knowledge of process monitoring and control.						

Unit I

Instrumentation System: introduction, typical applications of instrument systems, functional elements of a measurement system, classification of instruments, standards and calibration, static and dynamic characteristics of measurement systems.

Statistical Error Analysis: statistical analysis of data and measurement of uncertainty: probability, confidence interval or level, mean value and standard deviation calculation, standard normal distribution curve and probability tables, sampling and theory based on samples, goodness of fit, curve fitting of experimental data.

Unit II

Sensors and Transducers: introduction and classification, transducer selection and specifications, primary sensing elements, resistance transducers, variable inductance type transducers, capacitive transducers, piezo-electric transducers, strain gauges.Smart Sensors: Introduction, architecture of smart sensor, bio sensor and physical sensor, Piezo-resistive pressure sensor, microelectronic sensor.

Measurement of force, torque, shaft power, speed and acceleration: force and weight measurement system, measurement of torque, shaft power, speed and velocity: electrical and contactless tachometers, acceleration: vibrometers, seismic and piezo-electric accelerometer.

Unit III

Measurement of pressure, temperature and flow: Basic terms, Pressure: Liquid column manometers, elastic type pressure gauges, electrical types for pressure and vacuum, temperature measuring instruments: RTD sensors, NTC thermistor, thermocouples, and semiconductor based sensors. Flow Measurement: drag force flow meter, turbine flow meter, electronic flow meter, electromagnetic flow meter, hot-wire anemometer.

Instruments for measuring Humidity, Density, and Viscosity: Humidity definitions, Humidity measuring devices, Density and Specific Gravity, Basic terms, Density measuring devices, Density application considerations, Viscosity, Viscosity measuring instruments, basic terms used in pH, pH measuring devices, pH application considerations. Problems.

Unit IV

Basic Control System: Introduction, basic components of control system, classification : closed loop and open loop control system, transfer function, block diagram representation of closed loop system and its reduction techniques, mathematical modelling of various mechanical systems and their analogy with electrical systems, signal flow graph and its representation.

Mechanical Controllers: Basics of actuators: pneumatic controller, hydraulic controller and their comparison.

Text Books:

1.Instrument and control by Patranabis D., PHI Learning.
2.Fundamental of Industrial Instrumentation and Process control by W.C.DUNN, McGrawHill,
3. Thomas G. Beckwith, Roy D. Marangoni, John H. LienhardV , Mechanical Measurements (6th Edition), Pearson Education India, 2007
4. Gregory K. McMillan, Process/Industrial Instruments and Controls Handbook, Fifth Edition, McGraw-Hill: New York,1999.

Reference Books:

1. Mechanical Measurement and Control by A K Sawhney
2. Modern control Engineering by Katsuhiko Ogata, PHI publication

Note: The paper setter will set the paper as per the question paper templates provided.

	B. Tech. (4th Semester)Mechanical Engineering							
ES-206LA	**MATERIALS ENGINEERING LAB**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time (Hrs.)**
0	**0**	**2**	**1**	**-**	**40**	**60**	**100**	**3**
Purpose	Tomakethestudentsawareofmaterialstructureandpropertiesofmaterialusing differentexperiments.							
CourseOutcomes								
CO 1	Ability to design and conduct experiments, acquire data, analyze and interpret data							
CO 2	Ability to determine the grain size and microstructure in different Ferrous alloys by means of experiments.							
CO 3	Ability to learn about microstructures of different Non-Ferrous alloys by means of experiments.							
CO 4	To learn about heat treatment processes through experiments.							
CO 5	Ability to Analyze microstructure of Heat-treated specimens and perform Fatigue and creep test on different materials.							

List ofExperiments:

1. To Study various Crystal Structures through Ball Models.
2. To study the components and functions of Metallurgical Microscope.
3. To learn about the process of Specimen Preparation for metallographic examination.
4. To perform Standard test Methods for Estimation of Grain Size.
5. To perform Microstructural Analysis of Carbon Steels and low alloy steels.
6. To perform Microstructural Analysis of Cast Iron.
7. To perform Microstructural Analysis of Non-Ferrous Alloys: Brass & Bronze.
8. To perform Microstructural Analysis of Non-Ferrous Alloys: Aluminium Alloys.
9. To Perform annealing of a steel specimen and to analyze its microstructure.
10. To Perform Hardening of a steel specimen and to analyze its microstructure.
11. To performFatiguetest on fatiguetestingmachine.
12. To perform Creep test oncreep testingmachine.

Note: At least eight experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.

	B. Tech. (4th Semester) Mechanical Engineering							
MEC-210LA	**FLUID MECHANICS &FLUID MACHINES LAB**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose	To familiarize the students with the equipment and instrumentation of Fluid Mechanics and Machines							
Course Outcomes								
CO1	Operate fluid flow equipment and instrumentation.							
CO2	Collect and analyse data using fluid mechanics principles and experimentation methods.							
CO3	Determine the coefficient of discharge for various flow measurement devices.							
CO4	Calculate flow characteristics such as Reynolds number, friction factor from laboratory measurements.							
CO5	Analyze the performance characteristics of hydraulic pumps.							
CO6	Analyze the performance characteristics of hydraulic turbines.							

List of Experiments:

1. To verify the Bernoulli's Theorem.
2. To determine coefficient of discharge of an orifice meter.
3. To determine the coefficient of discharge of Venturimeter.
4. To determine the coefficient of discharge of Notch.
5. To find critical Reynolds number for a pipe flow.
6. To determine the friction factor for the pipes.
7. To determine the meta-centric height of a floating body.
8. Determination of the performance characteristics of a centrifugal pump.
9. Determination of the performance characteristics of a reciprocating pump.
10. Determination of the performance characteristics of a gear pump.
11. Determination of the performance characteristics of Pelton Wheel.
12. Determination of the performance characteristics of a Francis Turbine.
13. Determination of the performance characteristics of a Kaplan Turbine.
14. Determination of the performance characteristics of a Hydraulic Ram.

Note: At least ten experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.

	B. Tech. (4th Semester) Mechanical Engineering						
MC-902A	**Constitution of India**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**0**	**0**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	To know the basic features of Constitution of India						
	Course Outcomes						
CO1	The students will be able to know about salient features of the Constitution of India.						
CO2	To know about fundamental duties and federal structure of Constitution of India.						
CO3	To know about emergencyprovisions in Constitution of India.						
CO4	To know about fundamental rights under constitution of India.						

UNIT I

Meaning of the constitution law and constitutionalism, Historical perspective of the Constitution of India. Salient features and characteristics of the Constitution of India.

Scheme of the fundamental rights

UNIT II

The scheme of the Fundamental Duties and its legal status. The Directive Principles of State Policy – Its importance and implementation. Federal structure and distribution of legislative and financial powers between the Union and the States.

Parliamentary Form of Government in India – The constitution powers and status of the President of India

UNIT III

Amendment of the Constitutional Powers and Procedure. The historical perspectives of the constitutional amendments in India.

Emergency Provisions: National Emergency, President Rule, Financial Emergency. Local Self Government – Constitutional Scheme in India.

UNIT IV

Scheme of the Fundamental Right to Equality. Scheme of the Fundamental Right to certain Freedom

under Article 19.

Scope of the Right to Life and Personal Liberty under Article 21.

Text Books

1. Constitution of India. Prof. Narender Kumar (2008) 8th edition. Allahabad Law Agency.

Reference Books:

1. The constitution of India. P.M. Bakshi (2016) 15th edition. Universal law Publishing.

Fifth Semester

B. Tech (5th Semester) Mechanical Engineering							
HM-905	**ENTREPRENEURSHIP**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	To acquaint the knowledge about the entrepreneurship and entrepreneurial process in context of economic development, formalities required in launching a small enterprise, venture capital financing schemes and IPR.						
Course Outcomes							
CO1	Students will be able to understand: who the entrepreneurs are? what competencies are required to become an Entrepreneur?						
CO2	Students will have insights into the management, opportunity search, identification of a product, process of project finalization etc. required for small business enterprises.						
CO3	Students will be able to understand the meaning of small scale enterprise (SSE) and the setup formalities, operational and project management issues in the SSE.						
CO4	Students be able to know the different financial assistances available for the establishment of small scale industrial units and the IPR related issues.						

UNIT-I

Entrepreneurship: Concept and definitions, Entrepreneurship and economic development, classification and types of entrepreneurs, entrepreneurial competencies, factor affecting entrepreneurial Growth– economic, non-economic factors, EDP programmes, entrepreneurial training, traits/qualities of an entrepreneurs, manager vs entrepreneur, entrepreneurial challenges.

UNIT-II

Establishing Small Scale Enterprise: Opportunity scanning and identification, creativity and product development process, market survey and assessment, choice of technology and selection of site.

Planning a Small Scale Enterprises: Financing new/small enterprises, techno-economic feasibility assessment, preparation of business plan, forms of business organization/ownership.

UNIT–III

Small Enterprises and Enterprise Launching Formalities: Definition of small scale, rationale, objective, scopes, SSI, registration, NOC from pollution board, machinery and equipment selection, MSMEs – definition and significance in Indian economy, MSME schemes, operational issues in SSE: financial management issues, operational/project management issues in SSE, marketing management issues in SSE.

UNIT–IV

Institutional Interface for Small Scale Industry/Enterprises, Venture Capital: Concept, venture capital financing schemes offered by various financial institutions in India, legal issues–forming business entity, requirements for formation of a private/public limited company, entrepreneurship and Intellectual property rights: IPR and their importance (Patent, Copy Right, Trademarks), case studies-at least one in whole course.

Text books:

1. Entrepreneurship Development Small Business Enterprises by Poornima M Charantimath, Pearsons pub.
2. Entrepreneurship by Roy Rajiv, Oxford University Press.
3. Innovation and Entrepreneurship by Drucker. F, Peter, Harper business.
4. Entrepreneurship by Robert D. Hisrich, Mathew J. Manimala, Michael P Peters and Dean A. Shepherd, Tata Mc-Graw Hill Publishing Co. ltd. New Delhi.

Reference books:

1. Entrepreneurial Development by Dr. S.S. Khanka, S. Chand Publishing Company.
2. Entrepreneurship and Management of Small and Medium Enterprises by Dr. Vasant Desai, Himalaya Publishing House.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech (5th Semester) Mechanical Engineering							
MEC- 301	**HEAT TRANSFER**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs)**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose	To build a solid foundation in heat transfer and rigorous treatment of governing equations and solution procedures.						
Course Outcomes							
CO1	After completing the course, the students will be able to formulate and analyze a heat transfer problem involving any of the three modes of heat transfer.						
CO2	The students will be able to obtain exact solutions for the temperature variation using analytical methods where possible or employ approximate methods or empirical correlations to evaluate the rate of heat transfer.						
CO3	The students will be able to design devices such as heat exchangers and also estimate the insulation needed to reduce heat losses where necessary.						

UNIT-I

Introduction: Definition of heat, modes of heat transfer, basic laws of heat transfer, application of heat transfer, simple problems.

Conduction: Derivation of heat balance equation - steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, steady one dimensional heat conduction without internal heat generation, the plane slab, the cylindrical shell, the spherical shell, conduction through composite wall, critical insulation thickness, variable thermal conductivity, steady one dimensional heat conduction with uniform internal heat generation, the plane slab, the cylindrical and spherical systems, heat transfer through fins of uniform cross-section, governing equation, temperature distribution and heat dissipation rate, effectiveness and efficiency of fins.

Transient conduction: Lumped system approximation and Biot number, approximate solution to unsteady conduction heat transfer by the use of Heisler charts.

UNIT-II

Convection: Heat convection, basic equations, boundary layers, forced convection, external and internal flows, natural convective heat transfer, dimensionless parameters for forced and free convection heat transfer, boundary layer analogies, correlations for forced and free convection, approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow, estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection. Boiling and Condensation heat transfer, pool boiling curve, Nusselt theory of laminar film condensation.

UNIT-III

Radiation: Interaction of radiation with materials, definitions of radiative properties, monochromatic and total emissive power, Planck's distribution law, Stefan Boltzman's law, Wien's displacement law, Kirchoff's law, intensity of radiation, Lambert's cosine law, heat transfer between black surfaces, radiation shape factor, heat transfer between non-black surfaces: infinite parallel planes, infinite long concentric cylinders, small gray bodies and small body in large enclosure, electrical network approach, radiation shields.

UNIT-IV

Heat exchangers: Types of heat exchangers; overall heat transfer coefficient, fouling factor, analysis and design of heat exchangers using logarithmic mean temperature difference, and NTU method, effectiveness of heat exchangers, multipass heat exchangers, applications of heat exchangers.

Text books:

1. Fundamentals of Heat and Mass transfer – Frank P. Incropera, David P. Dewitt, T.L. Bergman and A.S. Lavine, Sixth Edition, Wiley Publications, 2007.
2. Heat Transfer: A Practical Approach - Yunus A Cengel, McGraw Hill, 2002.
3. Heat and Mass Transfer – P.K. Nag, Tata McGraw Hill.
4. Heat Transfer – J.P. Holman, Eighth Edition, McGraw Hill, 1997.

Reference books:

5. Heat Transfer – A. Bejan, John Wiley, 1993.
6. A Text book of Heat Transfer - S.P Sukhatme, University press.
7. Principles of Heat Transfer – Massoud Kaviany, John Wiley, 2002.
8. Heat and Mass Transfer - D.S Kumar, S.K. Kataria & Sons.
9. Heat Transfer – Y.V.C. Rao, University Press.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech (5th Semester) Mechanical Engineering							
MEC-303	**PRODUCTION TECHNOLOGY**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose:	To acquaint the knowledge of different type of machines and machine tools used in machining of metals, cutting tools used in different operations, work holding devices and CNC machines.						
Course Outcomes							
CO 1	After completing the course, the students will be capable of knowing different machines, machine tools and the machining operations.						
CO 2	The students will be able to analyze the machining operations.						
CO 3	The students will have a knowledge of different types of cutting tools and cutting fluids used in machining.						
CO 4	The students will have understanding of metrology and inspection tools with their applications.						
CO 5	The students will know about various thread operations, use of different workholding devices and different gear manufacturing processes.						
CO 6	Students will know the advancements of CNC over conventional machining methods and other programing and tools related aspects related to CNC.						

UNIT-I

Theory of metal machining: Overview of machining technology: types of machining operation, cutting tools, cutting conditions, theory of chip formation in metal cutting: orthogonal cutting model, actual chip formation, forces relationships and the merchant equation: forces in metal cutting, the merchant equation, power and energy relationships in machining, cutting temperatures.

Machine tools and machining operations: Turning and related operations: cutting conditions, operations related to turning, engine lathe, other lathes and turning machines, boring machines, drilling and related operations: cutting conditions, operations related to drilling, drill presses, Milling: types of milling operations, cutting conditions, milling machines, high speed machining, grinding machines: types, wet and dry grinding, abrasives, grit, grade and structure of wheels, selection of grinding wheels.

UNIT-II

Technology and materials of cutting tools: Tool life, tool wear, taylor tool life equation, tool materials: high speed steels, cast cobalt alloys, cemented carbides, cermets and coated carbides, ceramics, synthetic diamonds and cubic boron nitrides, tool geometry: single point tool geometry, effect of tool material on tool geometry, multiple-cutting-edge tools, cutting fluids: types of cutting fluids, applications and selection of cutting fluids.

Metrology and inspection: Limits, fits, and tolerances, gauge design, interchangeability, linear, angular, and form measurements (straightness, squareness, flatness, roundness, and cylindricity) by mechanical and optical methods, inspection of screw threads, surface finish measurement by contact and non-contact methods, tolerance analysis in manufacturing and assembly.

UNIT-III

Threads: Standard forms of screw threads, methods of making threads, thread cutting on lathe, thread chasing, thread milling, thread rolling, thread grinding, thread tapping, automatic screw cutting machines, inspection and measurement of threads.

Workholding devices for machine tools: Introduction, conventional fixture design, tool design steps, clamping considerations, chip disposal, unloading and loading time, example of jig design, types of jigs, conventional fixtures, modular fixturing, setup and changeover: single-minute-exchange-of-die (SMED),

clamps, other workholding devices: assembly jigs, magnetic workholders, electrostatic workholders, economic justification of jigs and fixtures.

UNIT-IV

Gear manufacturing and finishing: Introduction to different types of gears, terminology, methods of gears manufacturing, gear forming: selecting a form gear cutter for cutting spur gears, selecting gear cutter for cutting helical or spiral gear, broaching of gears, generating methods: gear shaper process, rack planning process, gear hobbing process. Gear finishing operations: Shaving, burnishing, grinding, lapping, honing, gears inspection.

Computer numerical control (CNC) machines: Classification of CNC machines, modes of operation of CNC, Working of Machine Structure, Automatic tool changer (ATC), Automatic pallet changer (APC), CNC axis and motion nomenclature, CNC toolings – tool pre-setting, qualified tool, tool holders and inserts, Axes Identification in CNC turning and Machining centers, CNC part programming: Programming format and Structure of part programme, ISO G and M codes for turning and milling-meaning and applications of important codes.

Text Books:

1. Fundamentals of modern manufacturing: materials processing and systems by Mikell P. Grover, John Wiley and Sons.
2. Materials and processes in manufacturing by J.T. Black and R.A. Kohser, John Wiley and Sons.
3. Production Technology by R. K. Jain, Khanna Publishers.
4. Machine Tools by R. Kesavan & B. Vijaya Ramnath, Laxmi Publications.
5. Machining and Machine Tools by A. B. Chattopadhyay, WILEY INDIA.

Reference Books:

1. Principles of Machine Tools by G.C. Sen & A. Bhattacharya, Tata McGraw Hill, New Delhi
2. Manufacturing Engg. & Tech by S. KalpakJian and S.R. Schmid, Pearsons.
3. Modern Machining Processes by P.C. Pandey & H.S. Shan, T.M.H. Company, New Delhi
4. Production Engineering: P.C. Sharma, S.Chand & Sons.
5. Introduction to Jig and Tool Design by Kempster M.H.A, Hodder & Stoughton, England

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (5th Semester) Mechanical Engineering							
MEC-305	**MECHANICAL VIBRATIONS AND TRIBOLOGY**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total Time**	**Time (Hrs)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose:	To understand the vibration systems with different degrees of freedom in different modes and conditions and the basics of tribology.						
Course Outcomes							
CO1	The students will be capable of understanding the vibration fundamentals for a single degree of freedom (D.O.F.) system under free and damped vibrations.						
CO2	The students will be able to analyze different types of forced vibration system in single degree of freedom (D.O.F.) and damped, undamped, free and forced systems with two D.O.F.						
CO3	The students will understand the principal modes of vibrations using different methods for various combinations of spring-mass and rotor-shaft systems and to study transverse, longitudinal and torsional vibration for beams, bars and shafts respectively.						
CO4	The students will understand the fundamentals of tribology, lubrication, friction and wear.						

UNIT-I

Fundamentals: Introduction, elements of a vibratory system, periodic and S.H.M., degrees of freedom (DOF), types of vibrations, work done by a harmonic force, beats, problems.

Free vibration systems with single degree of freedom

Undamped systems: Introduction, differential equations, torsional vibrations, spring and shaft combinations: series & parallel, linear and torsional systems, compound pendulum, bifilar and trifilar suspensions, problems.

Damped systems: Introduction, types of damping, differential equations of damped free vibrations, initial conditions, logarithmic decrement, vibrational energy, problems.

UNIT-II

Forced vibration systems with single degree of freedom: Introduction, excitation and sources, equations of motion, rotating and reciprocating unbalanced system, support motion, vibration isolation, force and motion transmissibility, forced vibration system with different types of damping, vibration measuring instruments, resonance, bandwidth, quality factor and half power points, critical speed of shaft with and without damping with single and multiple discs, problems.

Two degree of freedom system: Introduction, torsional vibrations, principal modes of vibrations for two D.O.F., damped and undamped forced and free vibrations, semi-definite systems, co-ordinate coupling, spring and mass type vibration absorber, problems.

UNIT-III

Multi-degree of freedom systems: Introduction, principal modes of vibrations for three or more DOF, influence coefficients, orthogonality principle, matrix method, matrix iteration method, Dunkerley's equation, Holzer's Method, Rayleigh Method, Rayleigh-Ritz method, Stodola method, problems.

Continuous systems: Introduction, lateral vibrations of strings, longitudinal vibrations of bars, transverse vibration of beams, torsional vibration of uniform shafts, problems.

UNIT-IV

Tribology: Introduction, tribology in design, tribology in industry, economic aspects.

Lubrication: Introduction, basic modes of lubrication, lubricants, properties of lubricants: physical and chemical, types of additives, extreme pressure lubricants, recycling of used oils and oil conservation, disposal of scrap oil, oil emulsion.

Friction and wear: Introduction, laws of friction, kinds of friction, causes of friction, friction measurement, theories of friction, effect of surface preparation. Introduction to wear, types of wear, various factors affecting wear, measurement of wear, wear between solids and liquids, theories of wear.

Text Books:

1. Mechanical Vibrations by G. K. Grover, Nem Chand and Bros., Roorkee
2. Elements of Mechanical Vibrations by Meirovitch, McGraw Hill
3. Introductory course on theory and practice of Mechanical Vibration by J.S. Rao and K.Gupta, New Age International.
4. Friction and wear of Materials by E. Robinowicz, Johan Wiley
5. Tribology an Introduction by Sushil Kumar Srivastava
6. Introduction to Tribology and Bearings by B. C. Majumdar, S. Chand and Company Ltd. New Delhi.

Reference Books:

1. Mechanical Vibrations by S. S. Rao, Pearson Education Inc. Dorling Kindersley (India) Pvt. Ltd. New Delhi.
2. Mechanical Vibrations by V.P. Singh, Dhanpat Rai & Co. Pvt. Ltd., Delhi
3. Engineering Tribology by Prashant Sahoo, PHI publications.
4. Principles of Tribology by J. Hailing, McMillan Press Ltd.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (5th Semester) Mechanical Engineering								
MEC- 307L	**HEAT TRANSFER LAB**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time (Hrs)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose	To impart practical knowledge of different modes of heat transfer by conducting experiments.							
Course Outcomes								
CO1	Design and conduct experiments, acquire data, analyze and interpret data.							
CO2	Measure the thermal conductivity of metal rod, insulating material and liquids etc.							
CO3	Understand the concept of composite wall and determine its thermal resistance.							
CO4	Measure heat transfer coefficients in free and forced convection.							
CO5	Measure the performance of a heat exchanger.							
CO6	Determine the Stefan Bolzman constant and emissivity.							

List of Experiments:

1. To determine the thermal conductivity of a metal rod.
2. To determine the thermal conductivity of an insulating slab.
3. To determine the thermal conductivity of a liquid using Guard plate method.
4. To determine the thermal conductivity of an insulating powder.
5. To determine the thermal resistance of a composite wall.
6. To plot the temperature distribution of a pin fin in free-convection.
7. To plot the temperature distribution of a pin fin in forced-convection.
8. To study the forced convection heat transfer from a cylindrical surface.
9. To determine the effectiveness of a concentric tube heat exchanger in a parallel flow arrangement.
10. To determine the effectiveness of a concentric tube heat exchanger in a counter flow arrangement.
11. To determine the Stefan-Boltzman constant.
12. To determine the emissivity of a given plate.
13. To determine the critical heat flux of a given wire.
14. To study the performance of an evacuated tube based solar water heater.

Note: At least eight experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.

B. Tech. (5th Semester) Mechanical Engineering								
MEC-309L	**PRODUCTION TECHNOLOGY LAB**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time (Hrs.)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose	To impart practical knowledge of various measuring instruments, machining and welding operations by performing experiments.							
Course Outcomes								
CO 1	The students will be able to gain the practical knowledge of different measuring instruments used in machining operations.							
CO 1	The students will be able to perform different machining operations for the preparation of a job piece.							
CO 2	The students will be able to prepare various jobs using TIG/MIG welding.							
CO 3	The students will be trained for manufacturing the job pieces on CNC lathe and CNC milling.							

LIST OF EXPERIMENTS:

1. Study of linear, angular measuring devices and to measure the linear and angular dimensions using various equipment's.
2. Manufacture and assembly of a unit consisting of 2 to 3 components to have the concept of tolerances and fits (shaft and bush assembly or shaft, key and bush assembly or any suitable assembly).
3. To prepare a job on a lathe having various operations viz. drilling, boring, taper turning, thread cutting, knurling, etc.
4. Demonstration of formation of cutting parameters of single point cutting tool using bench grinder / tool & cutter grinder.
5. To make a spur gear of given part drawing involving operations namely drilling, boring, reaming, honing, key slotting, gear teeth machining, lapping and gear teeth finishing.
6. Introduction to various grinding wheels and demonstration on the cylindrical and surface grinder.
7. To demonstrate surface milling /slot milling.
8. To cut gear teeth on milling machine using dividing head.
9. To cut V Groove/ dovetail / Rectangular groove using a shaper.
10. To prepare a useful product containing different types of welded joints using simple arc/TIG/MIG welding set.
11. To cut external threads on a lathe and practice thread measurements.
12. To study CNC lathe trainer and its components (hardware and software) especially controllers (Fanuc and Siemens) and make a CNC programme using APT language of given part drawing for machining cylindrical job involving operations namely turning, step turning, taper turning, threading, radius contour cutting, chamfering etc.
13. To study CNC milling trainer and its components (hardware and software) especially controllers (Fanuc and Siemens) and make a CNC programme using APT language of given drawing for milling job operations namely end cutting, side cutting, contour cutting, face cutting, etc. and

run the programme in simulation and actual mode in Cut Viewer or other software and run the program in actual mode using CNC controllers.

.**Note:** At least eight experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.

B. Tech. (5th Semester) Mechanical Engineering								
MEC-311L	**MECHANICAL VIBRATIONS AND TRIBOLOGY LAB**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total Time**	**Time (Hrs.)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose:	To provide practical knowledge of free and forced vibration system fundamentals and the mechanisms of friction, wear and lubrication.							
Course Outcomes								
CO1	The students will be able to know practically the concepts of free and forced vibrations for a spring mass system and will determine the natural frequency.							
CO2	The students will be able to diagnose the machinery faults, there causes and sources using Machinery Fault Simulator (MFS).							
CO3	The students will understand the concept of sliding wear and abrasive wear using wear and friction monitoring apparatus and dry abrasion tester respectively.							
CO4	The students will be capable of measuring the extreme pressure properties of different lubricants using four ball tester.							

LIST OF EXPERIMENTS:

1. To study undamped free vibrations and determine the natural frequency of:
   1.1 Spring mass system
   1.2 Simple Pendulum
   1.3 Torsional spring type double pendulum and compare them with theoretical values.
2. To study the torsional vibration of a single rotor shaft system and determine the natural frequency.
3. To study the free vibration of system for different damper settings. Draw decay curve and determine the log decrement and damping factor. Find also the natural frequency.
4. To verify the Dunkerley's rule.
5. To determine the radius of gyration for:
   5.1 Bifilar suspension.
   5.2 Compound pendulum.
   5.3 Trifilar suspension.
6. To study the forced vibration system with damping, Load magnification factor vs. Frequency and phase angle vs frequency curves. Also determine the damping factor.
7. To find out and locate machinery faults viz. vibrations and unbalancing using Machinery Fault Simulator (MFS) in:
   7.1 Direct Driven reciprocating pump;
   7.2 Direct Driven centrifugal pump;
   7.3 Defective straight tooth gearbox pinions.
8. To determine the wear rate, friction force and coefficient of friction of a metallic pin/ball by using wear and friction monitor apparatus.
9. To determine abrasion index of a material with the help of dry abrasion test rig.
10. To evaluate the wear and extreme pressure properties of a lubricating oil by using four ball tester.
11. To determine the roughness of a specimen using surface roughness tester.

Note: At least eight experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.

B. Tech. (5th Semester) Mechanical Engineering								
MEC-313 L	**PROJECT-I**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total Time**	**Time (Hrs.)**
0	**0**	**2**	**1**	**--**	**0**	**100**	**100**	**3**
Purpose:	To implement the engineering principles and theories into innovative practical projects for solving real world problems.							
Course Outcomes								
CO1	The students will be able to apply the theoretical knowledge into practical work.							
CO2	The students will be able to learn new things related to latest technologies with the help of practical work.							

The project work could be done for the problem statement of an industry or practical project in the institute. The students may also opt for the analysis based software projects with proper validation. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Note: The maximum number of students in a group should not exceed four.

	B. Tech. (5th Semester) Mechanical Engineering							
MEC-315	**INDUSTRIAL TRAINING-II**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time (Hrs.)**
2	**0**	**0**	**--**	**--**	**100**	**--**	**100**	**--**
Purpose	To provide an industrial exposure to the students and enhance their skills and creative capability for conversion of their innovative ideas into physical reality.							
Course Outcomes								
CO 1	The students could be capable of self-improvement through continuous professional development and life-long learning.							
CO 2	The students will be aware about the social, cultural, global and environmental responsibility as an engineer.							
CO 3	The students will be up-to-date with all the latest changes in technological world.							

Note: MEC-315 is a mandatory non-credit course in which the students will be evaluated for the industrial training undergone after 4th semester and students will be required to get passing marks to qualify.

The candidate has to submit a training report of his/her work/project/assignment completed in the industry during the training period. The evaluation will be made on the basis of submitted training report and viva-voce/presentation.

	B. Tech. (5th Semester) Mechanical Engineering							
MC-903	**ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**--**	**100**	**--**	**--**	**100**	**3**
Purpose	To impart basic principles of thought process, reasoning and inferencing.							
Course Outcomes								
CO 1	The students will be able to understand, connect up and explain basics of Indian traditional knowledge in modern scientific perspective.							

Course Contents

- Basic structure of Indian Knowledge System: अष्टादशविद्या -४वेद,४उपवेद (आयुर्वेद, धनुर्वेद, गन्धर्ववेद, स्थापत्य आदि) ६वेदांग (शिक्षा, कल्प, निरुक्त, व्याकरण, ज्योतिष, छंद) ४ उपाङ्ग (धर्मशास्त्र, मीमांसा, पुराण, तर्कशास्त्र)
- Modern Science and Indian Knowledge System
- Yoga and Holistic Health care
- Case studies

References

- V. Sivaramakrishnan (Ed.), *Cultural Heritage of India-course material*, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014
- Swami Jitatmanand, *Modern Physics and Vedant*, Bharatiya Vidya Bhavan
- Swami Jitatmanand, *Holistic Science and Vedant*, Bharatiya Vidya Bhavan
- Fritzof Capra, *Tao of Physics*
- Fritzof Capra, *The Wave of life*
- VN Jha (Eng. Trans.), *Tarkasangraha of Annam Bhatta*, International Chinmay Foundation, Velliarnad, Arnakulam
- *Yoga Sutra of Patanjali*, Ramakrishna Mission, Kolkata
- GN Jha (Eng. Trans.), Ed. RN Jha, *Yoga-darshanam with Vyasa Bhashya*, Vidyanidhi Prakashan, Delhi 2016
- RN Jha, *Science of Consciousness Psychotherapyand Yoga Practices*, Vidyanidhi Prakashan, Delhi 2016
- P B Sharma (English translation), *Shodashang Hridayan*

Pedagogy: Problem based learning, group discussions, collaborative mini projects.

Note: The paper setter will set the paper as per the question paper template provided.

Sixth Semester

B. Tech (6th Semester) Mechanical Engineering							
HM-901	**ORGANIZATIONAL BEHAVIOUR**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose:	To make the students conversant with the basics concepts of organizational culture and behavior for nurturing their managerial skills.						
Course Outcomes							
CO 1	An overview about organizational behavior as a discipline and understanding the concept of individual behavior.						
CO 2	Understand the concept and importance of personality, emotions and its importance in decision making and effective leadership.						
CO 3	Enabling the students to know about the importance of effective motivation and its contribution in group dynamics and resolving conflicts.						
CO 4	Understand how to overcome organizational stress by maintaining proper organizational culture and effective communication						

UNIT-I

Introduction to organizational behavior: Concept and importance of organizational behavior, role of Managers in OB, foundations or approaches to organizational behavior, challenges and opportunities for OB.

Foundation of individual behavior: Biographical characteristics, concept of abilities and learning, learning and learning cycle, components of learning, concept of values and attitude, types of attitude, attitude and workforce diversity.

UNIT-II

Introduction to personality and emotions: Definition and Meaning of Personality, Determinants of Personality, Personality Traits Influencing OB, Nature and Meaning of Emotions, Emotions dimensions, concept of Emotional intelligence.

Perception and individual decision making: meaning of perception, factors influencing perception, rational decision making process, concept of bounded rationality. Leadership-trait approaches, behavioural approaches, situational approaches, and emerging approaches to leadership.

UNIT-III

Motivation: Concept and theories of motivation, theories of motivation-Maslow, two factor theory, theory X and Y, ERG Theory, McClelland's theory of needs, goal setting theory, application of theories in organizational scenario, linkage between MBO and goal setting theory, employee recognition and involvement program.

Foundations of group behavior and conflict management: Defining and classifying of groups, stages of group development, Informal and formal groups- group dynamics, managing conflict and negotiation, a contemporary perspective of intergroup conflict, causes of group conflicts, managing intergroup conflict through resolution.

UNIT-IV

Introduction to Organizational Communication: Meaning and importance of communication process, importance of organizational communication, effective communication, organizational stress: definition and meaning sources and types of stress, impact of stress on organizations, stress management techniques.

Introduction to Organization Culture: Meaning and nature of organization culture, types of culture, managing cultural diversity, managing change and innovation-change at work, resistance to change, a model for managing organizational change.

Text Books:

1. Colquitt, Jason A., Jeffery A. LePine, and Michael Wesson. Organizational Behavior: Improving Performance and Commitment in the Workplace. 5th ed. New York: McGraw-Hill Education, 2017.
2. Hitt, Michael A., C. Chet Miller, and Adrienne Colella. Organizational Behavior. 4th ed. Hoboken, NJ: John Wiley, 2015.
3. Robbins, Stephen P., and Timothy Judge. Organizational Behavior. 17th ed. Harlow, UK: Pearson Education, 2017. Stephen P. Robins, Organisational Behavior, PHI Learning / Pearson Education, 11th edition, 2008.

Reference Books:

1. Schermerhorn, Hunt and Osborn, Organisational behavior, John Wiley.
2. Udai Pareek, Understanding Organisational Behaviour, Oxford Higher Education.
3. Mc Shane & Von Glinov, Organisational Behaviour, Tata Mc Graw Hill.
4. Aswathappa, K., Organisational Behaviour– Text and Problem, Himalaya Publication.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (6th Semester) Mechanical Engineering							
MEC-302	**MANUFACTURING TECHNOLOGY**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose:	To build a foundation in different manufacturing processes related to castings, metal forming, joining, powder metallurgy and plastic material shaping processes.						
Course Outcomes							
CO 1	After completing the course, students will be able to understand the casting fundamentals, and different casting processes.						
CO 2	The students will be familiarized with different metal forming processes and capable of doing analysis.						
CO 3	The students will understand different welding processes with their applications.						
CO 4	The student will have the basis understanding of powder metallurgy processes and different plastic shaping processes.						

UNIT-I

Fundamentals of castings: Introduction to casting: basic requirements of casting processes, casting terminology, solidification process: cooling curves, prediction of solidification time, the cast structure, molten metal problems, fluidity and pouring temperature, role of gating system, solidification shrinkage, riser and riser design, risering aids, Patterns, design considerations in castings.

Expandable-mold casting processes: Sand casting, cores and core making, other expendable-mold processes with multiple use patterns, expendable-mold processes with multiple use patterns, shakeout, cleaning and finishing. **Multiple-use-mold casting processes**: Permanent mold casting, die casting, squeeze casting and semisolid metal casting, centrifugal casting, cleaning treating and heat treating of castings, automation in foundry operations.

UNIT-II

Metal forming processes: classifications of metal forming processes, bulk deformation processes, material behavior in metal forming, temperature in metal forming, rolling: flat rolling and its analysis, shape rolling, rolling mills, forging: open-die forging, impression-die forging, flashless forging, forging hammers, presses, and dies, extrusion: types of extrusion, analysis of extrusion, extrusion dies and presses, defects in extruded products, wire and bar drawing, analysis of drawing, drawing practice, tube drawing

Sheet metal working: Cutting operations: shearing, blanking, and punching, engineering analysis of sheet-metal cutting, other sheet-metal-cutting operations, bending operations: v-bending and edge bending, engineering analysis of bending, drawing: mechanics of drawing, engineering analysis of drawing, defects in drawing.

UNIT-III

Joining processes: Principles of fusion welding processes, arc welding processes-consumable electrodes: shielded metal arc welding, gas metal arc welding, flux-cored arc welding, submerged arc welding, Arc welding processes-non-consumable electrodes: gas tungsten arc welding, plasma arc welding, resistance welding processes, other fusion-welding processes: electron-beam welding, laser-beam welding, electro-slag welding, thermit welding.

Principles of solid state welding processes: friction welding, explosive welding, ultrasonic welding processes. **Brazing, soldering, and adhesive bonding:** Principles of adhesive, brazing and soldering processes, origins of welding defects.

UNIT-IV

Powder metallurgy: Characterization of engineering powders: geometric features, other features production of metallic powders: atomization: other production methods, conventional pressing and sintering: blending and mixing of the powders, compaction, sintering, heat treatment and finishing, design considerations in powder metallurgy.

Shaping processes for plastics: Properties of polymer melts, extrusion, production of sheet and film, fiber and filament production (spinning), coating processes, injection molding, compression and transfer molding, blow molding and rotational molding, thermoforming.

Text Books:

1. Fundamentals of modern manufacturing: materials processing and systems by Mikell P. Grover, John Wiley and Sons.
2. Materials and processes in manufacturing by J.T. Black and R.A. Kohser, John Wiley and Sons.
3. Principles of Manufacturing Materials & Processes by Campbell J. S., Publisher – Mc Graw Hill.
4. Production Technology by R. K. Jain, Khanna Publishers
5. Manufacturing Technology-Foundry, Forming and Welding by P.N. Rao, Tata McGraw Hill
6. Advanced Manufacturing Process by Hofy, H.E., B and H Publication.
7. Manufacturing Science by Ghosh, A. and Mullik, A, East –West private Limited.

Reference Books:

1. Welding and Welding Technology by Richard L. Little Tata McGraw Hill Ltd.
2. Manufacturing Processes and Systems by Ostwald Phillip F., Munoz Jairo, John Wiley & Sons
3. Elements of Manufacturing Processes by B.S. Nagendra Parasher, RK Mittal, PHI N. Delhi

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (6th Semester) Mechanical Engineering							
MEC-304	**DESIGN OF MACHINE ELEMENTS**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major test**	**Minor Test**	**Total**	**Time (Hrs.)**
2	**4**	**0**	**6**	**75**	**25**	**100**	**4**
Purpose	To understand the fundamentals for solving engineering problems relating to design of machine components.						
Course Outcomes							
CO1	The students will understand the design procedures and methods, properties of engineering materials and their selection, design against static and fluctuating loads.						
CO2	The students will be able to solve the design problems of different types of joints i.e. bolted, riveted joint and welded joint and the problems related to the design of springs under different loading conditions.						
CO3	The students could solve the design problems of transmission shafts and keys.						
CO4	The students will be able to solve the design problems related to clutches and brakes and will understand the criteria for the selection of bearings from manufacturer's catalogue.						

UNIT-I

Introduction: Basic procedure of the design of machine elements, standards in machine design, selection of preferred sizes, engineering materials, properties and selection, BIS system of designation of steels.

Design against static load: Modes of failure, factor of safety, stress concentration: causes and mitigation.

Design against fluctuating load: Fluctuating stresses, endurance limit, low cycle and high cycle fatigue, notch sensitivity, endurance limit-approximate estimation, reversed stresses- design for finite and infinite life, cumulative damage in fatigue, Soderberg and Goodman lines, Modified Goodman diagrams.

UNIT-II

Bolted, riveted and welded Joints: Bolt of uniform strength**,** bolted joint- simple analysis, eccentrically loaded bolted joints, riveted joints for boiler shell according to I. B. R., riveted structural joint, eccentrically loaded riveted joint, types of welded joints, strength of welds under axial load, welds under eccentric loading.

Springs: Types of spring, helical spring terminology, design for helical springs, spring design-trial and error method, design against fluctuating load, surge in springs, design of leaf springs, rubber springs.

UNIT-III

Transmission shafts: Shaft design on strength basis and torsional rigidity basis, ASME code for shaft design, design of hollow shaft on strength basis and torsional rigidity basis, **Keys:** types of keys, design of square and flat keys.

Clutches: Various types of clutches, design of friction clutches-single disc, multi-disc, cone and centrifugal clutches, torque transmitting capacity, friction materials, thermal considerations.

Brakes: Energy equations, block brake with short shoe, block brake with long shoe, internal expanding brake, band brakes, disc brakes, thermal considerations.

UNIT-IV

Rolling contact bearings: Types of rolling contact bearing, selection of bearing-type, static and dynamic load carrying capacity, equivalent bearing load, load-life relationship, selection of bearings

from manufacturer's catalogue, selection of taper roller bearing, design for cyclic loads and speeds, bearing failure-causes and analysis.

Sliding contact bearings: Basic modes of lubrication, Raimondi and Boyd method, bearing design-selection of parameters, bearing materials, bearings failure-causes and remidies.

Text Books:

1. Mechanical Engineering Design by Joseph E. Shigley and Charles R. Mischke, Tata McGraw Hill Book Co.
2. Design of Machine Element by V. B. Bhandari, Mc Graw Hill Edu. Pvt. Ltd.
3. Machine Design by R.S. Khurmi and J.K. Gupta, S. Chand.

Reference Books:

1. Machine Component Design by Robert C. Juvinall and Kurt M. Marshek, Wiley India Pvt. Ltd.
2. Mechanical Design of Machine Elements and Machines by Collins and Busby, Wiley India Pvt. Ltd.
3. Machine Design by U.C. Jindal, Pearsons publications.
4. Analysis and Design of Machine elements by V.K. Jadon and Suresh Verma, IK International Publishing House.

Design Data Books:

1. Design Data Book of Engineers, Compiled by Faculty of Mechanical Engineering, PSG College of Technology, Publisher Kalaikathir Achchagam, Coimbataore, 2009.
2. Design Data Handbook for Mechanical Engineers in SI and Metric Units by Mahadevan and Balaveera Reddy.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (6th Semester) Mechanical Engineering								
MEC-310 L	**PROJECT-II**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total Time**	**Time (Hrs.)**
0	**0**	**6**	**3**	**--**	**0**	**100**	**100**	**3**
Purpose	To implement the engineering principles and theories into innovative practical projects for solving real world problems.							
Course Outcomes								
CO1	The students will be able to apply the theoretical knowledge into practical work.							
CO2	The students will be able to learn new things related to latest technologies with the help of practical work.							

The project work could be done for the problem statement of an industry or practical project in the institute. The analysis based software projects undergone in the previous semester can be extended to its fabrication i.e. functional machine/product in this semester. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Note: The maximum number of students in a group should not exceed four.

B. Tech. (6th Semester) Mechanical Engineering							
MEP-302	**INTERNAL COMBUSTION ENGINES**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose:	To provide the detailed understanding of internal combustion engine, air compressors and gas turbines mainly based on its performance and emission parameters.						
Course Outcomes							
CO1	Enable the students to understand the basic concepts of Internal and External combustion engines and to familiarize with different air standard cycles.						
CO2	Equip the students with types of injection systems, carburetor, detonation and C.I. combustion chambers and to understand their applications.						
CO3	Students will have the ability to understand the performance, combustion and emission parameters of S.I. and C.I. engines. Also to understand various lubrication systems.						
CO4	Enable the students to understand the basic concepts of reciprocating air compressors and gas turbine along with exhaust gas heat exchanger.						

UNIT-I

Heat engines; Internal and external combustion engines; Classification of I.C. Engines; Cycle of operations in four strokes and two-stroke IC engines; Wankle Engine.

Air standard cycles: Assumptions made in air standard cycles; Otto cycle; Diesel cycle; Dual combustion cycle; Comparison of Otto, diesel and dual combustion cycles; Sterling and Ericsson cycles; Air standard efficiency, Specific work output. Specific weight; Work ratio; Mean effective pressure; Deviation of actual engine cycle from ideal cycle.

UNIT-II

Carburetor and Injection systems: Mixture requirements for various operating conditions in S.I. Engines; Elementary carburetor, Calculation of fuel air ratio; The complete carburetor; Requirements of a diesel injection system; Type of injection system; Petrol injection; Requirements of ignition system; Types of ignition systems, ignition timing; Spark plugs.

Engine parameters and knocking: S.I. engines; Ignition limits; Stages of combustion in S. I. Engines; Ignition lag; Velocity of flame propagation; Detonation; Effects of engine variables on detonation; Theories of detonation; Octane rating of fuels; Pre-ignition; S.I. engine combustion chambers. Stages of combustion in C.I. Engines; Delay period; Variables affecting delay period; Knock in C.I. Engines; Cetane rating; C.I. Engine combustion chambers.

UNIT-III

Lubrication and cooling systems: Functions of a lubricating system, Types of lubrication system; Mist, Wet sump and dry sump systems; Properties of lubricating oil; SAE rating of lubricants; Engine performance and lubrication; Necessity of engine cooling; Disadvantages of overcooling; Cooling systems; Air-cooling, Water-cooling; Radiators.

Heat balance and emission control: Performance parameters; BHP, IHP, Mechanical efficiency; Brake mean effective pressure and indicative mean effective pressure, Torque, Volumetric efficiency; Specific fuel consumption (BSFC, ISFC); Thermal efficiency; Heat balance; Basic engine measurements; Fuel and air consumption, Brake power, Indicated power and friction power, Heat lost to coolant and exhaust gases; Performance curves; Pollutants from S.I. and C.I. Engines; Methods of emission control, Alternative fuels for I.C. Engines; The current scenario on the pollution front.

UNIT-IV

Air compressor: Working of a single stage reciprocating air compressor; Calculation of work input; Volumetric efficiency; Isothermal efficiency; Advantages of multi stage compression; Two stage compressor with inter-cooling; Perfect inter cooling; Optimum intercooler pressure; Rotary air compressors and their applications; Isentropic efficiency.

Gas turbine: Brayton cycle; Components of a gas turbine plant; Open and closed types of gas turbine plants; Optimum pressure ratio; Improvements of the basic gas turbine cycle; Multi stage compression with inter-cooling; Multi stage expansion with reheating between stages; Exhaust gas heat exchanger; Application of gas turbines.

Text books:

1. Internal Combustion Engine by V. Ganeshan Tata Mc-Graw Hill Publications.
2. Internal Combustion Engine by Mathur & Sharma, Dhanpat Rai Publications.
3. Internal Combustion Engine by Ramalingam Sci-tech publications.
4. Internal Combustion Engine Fundamentals by John B. Heywood, Tata Mc-Graw Hill Publications.

Reference Books

1. Heat Power Engineering by Dr. V.P. Vasandhani & Dr. D.S. Kumar
2. Fundamentals of Internal Combustion Engine by H. N. Gupta, PHI publications.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech (6th Semester) Mechanical Engineering							
MEP-304	**GAS DYNAMICS AND JET PROPULSION**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs)**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose:	To familiarize the students for the concept of compressible and incompressible flows and to understand the aircraft and rocket propulsion.						
Course Outcomes							
CO 1	To enable the students to understand compressible flow fundamentals, Mach number, types of waves and effect of Mach number on compressibility.						
CO 2	Equip the students for compressible flow with friction and its effect in flow through nozzles. Also to understand the effect of friction in flow through nozzles.						
CO 3	Students will understand the concepts of normal and oblique shock in compressible flow. Also to study Rayleigh line and Rayleigh flow equation.						
CO 4	Students will learn the aircraft propulsion systems and rocket propulsion with their applications. Also to learn the solid and liquid propellants.						

UNIT-I

Compressible flow – fundamentals: Energy and momentum equations for compressible fluid flows, various regions of flows, reference velocities, stagnation state, velocity of sound, critical states, Mach number, critical Mach number, types of waves, Mach cone, Mach angle, effect of Mach number on compressibility

UNIT-II

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

UNIT-III

Flow through constant area ducts: Flow in constant area ducts with friction (Fanno flow) - Fanno curves and Fanno flow equation, variation of flow properties, variation of Mach number with duct length. Flow in constant area ducts with heat transfer (Rayleigh flow), Rayleigh line and Rayleigh flow equation, variation of flow properties, maximum heat transfer.

Normal and oblique shock: Governing equations, variation of flow parameters like static pressure, static temperature, density, stagnation pressure and entropy across the normal shock, Prandtl – Meyer equation, impossibility of shock in subsonic flows, flow in convergent and divergent nozzle with shock. Flow with Oblique Shock – Fundamental relations, Prandtl‟s equation, Variation of flow parameters.

UNIT-IV

Propulsion: Aircraft propulsion – types of jet engines – study of turbojet engine components – diffuser, compressor, combustion chamber, turbine and exhaust systems, performance of turbo jet engines – thrust, thrust power, propulsive and overall efficiencies, thrust augmentation in turbo jet engine, ram jet and pulse jet engines. Rocket propulsion – rocket engines thrust equation – effective jet velocity specific impulse – rocket engine performance, solid and liquid propellants.

Text Books:

1. Fundamental of compressible flow with Aircraft and Rocket propulsion by S.M., Yahya, New Age International (p) Ltd., New Delhi.
2. Compressible fluid flow by Patrich.H. Oosthvizen, William E.Carscallen, McGraw-Hill.
3. Gas turbine theory by Cohen.H., Rogers R.E.C and Sravanamutoo, Addison Wesley Ltd.

Reference Books:

1. Gas Turbines by V. Ganesan, Tata McGraw-Hill, New Delhi.
2. Gas Dynamics by E. Rathakrishnan, Prentice Hall of India, New Delhi.

B. Tech (6th Semester) Mechanical Engineering							
MEP-306	**Design of Transmission Systems**						
L	**T**	**P**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose	To understand the components of transmission systems and make the students capable of design the transmission system and its various elements.						
Course Outcomes							
CO 1	The students will be capable of designing and selection of belt drives, pulleys and the chain drives from manufacturer's catalogue.						
CO2	The students will be able to understand the mechanism of manual transmission, clutch synchronization and gear drives.						
CO4	The students will be able to apply the Lewi's and Buckingam's equations for the design of spur, helical and bevel gears.						
CO5	The students will be capable of designing worm gear based on strength rating, wear rating and thermal rating and to understand the selection of belts and chain drives from manufacturer's catalogue.						
CO6	The students will be able to understand about the structure of torque converters, torque formulation and torque capacity.						
CO7	The students will be capable of designing the gear boxes, couplings and their selection for real application.						

UNIT-I

Flat belt drives and pulleys: Introduction, Selection of flat belts from manufacturer's catalogue, Pulleys for flat belts. **V-Belts and pulley:** Selection of V-Belts and V-grooved pulley. **Chain Drives:** Roller chains, geometric relationships, polygonal effect, power rating, sprocket wheels, design of chain drives, chain lubrication.

Manual transmissions: Powertrain layout and manual transmission structure, power flows and gear ratios.

UNIT-II

Manual transmission clutches: Clutch structure, clutch torque capacity, synchronizer and synchronization: shift without synchronizer, shift with synchronizer, equivalent mass moment of inertia, equation of motion during synchronization, condition for synchronization, shifting mechanisms.

Gear drives: Classification of gears, selection of type of gears, law of gearing, standard systems of gear tooth, interference and undercutting, backlash.

Design of spur gears: geometry and nomenclature, force analysis, material selection, beam strength of gear tooth, effective load on gear tooth, module estimation based on beam strength, wear strength of gear tooth, module estimation based on wear strength, spur gear design procedure.

Design of helical gears: geometry and nomenclature, force analysis, beam strength of helical gears, effective load on gear tooth, wear strength of helical gears, design procedure.

UNIT-III

Design of bevel gears: Geometry and nomenclature, force analysis, beam strength of bevel gears, effective load on gear tooth, wear strength of bevel gears, design procedure. **Design of worm gears:** Terminology, force analysis, friction in worm gears, material selection, strength rating and wear rating, thermal considerations and design procedure.

Torque converters: Torque converter structure and functions: torque multiplication and fluid coupling, torque converter locking up, automatic transmission fluid (ATF) circulation and torque formulation, torque capacity and input–output characteristics.

UNIT-IV

Design of speed reducers (gear boxes): Geometric progression, standard step ratio, ray diagram, kinematics layout, design of sliding mesh gear box, design of multi speed gear box for machine tool applications, constant mesh gear box, speed reducer unit, variable speed gear box.

Design of couplings: Design of muff coupling, clamp coupling, rigid flange couplings and bushed-pin flexible couplings.

Text Books:

1. Mechanical Engineering Design, Joseph E. Shigley and Charles R. Mischke, Tata McGraw Hill Book Co.
2. Automotive Power Transmission Systems, Yi Zhang and Chris Mi, Wiley Publications.
3. Design of Machine Element, V. B. Bhandari, Mc Graw Hill Edu. Pvt. Ltd.
4. Machine Design, R.S. Khurmi and J.K. Gupta, S. Chand.

Reference Books:

1. Machine Component Design, Robert C. Juvinall and Kurt M. Marshek, Wiley India Pvt. Ltd.
2. Mechanical Design of Machine Elements and Machines, Collins and Busby, Wiley India Pvt. Ltd.
3. Machine Design, U.C. Jindal, Pearsons publications.
4. Design of Transmission Systems, E.V.V. Ramamurthy and S. Ramachandaran, Air Walk Publications.
5. Handbook of Gear Design and Manufacture, S. P. Radzevich, CRC Press, T&F.

Design Data Books:

1. Design Data Book of Engineers, Compiled by Faculty of Mechanical Engineering, PSG College of Technology, Publisher Kalaikathir Achchagam, Coimbataore, 2009.
2. Design Data Handbook for Mechanical Engineers in SI and Metric Units, 4th Ed, Mahadevan and Balaveera Reddy.
3. Machine design data book, V.B. Bhandari, Mc Graw Hill Edu. Pvt. Ltd.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech (6th Semester) Mechanical Engineering							
MEP-308	**Composite Materials**						
L	**T**	**P**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs)**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose	To acquaint with the knowledge of different composite materials manufacturing techniques and familiarization with the basic expressions and methods used in the mechanics of composite structures, characterization techniques and understanding of practical implementation.						
Course Outcomes							
CO 1	Students will be able to understand the different reinforcement and matrix material with their practical application.						
CO 2	Students will understand different composite fabrication techniques and will be able to analyse the behaviour of unidirectional composites at micro and macro level.						
CO 3	Students will be able to determine the stresses and strains in the short fiber reinforced composites and laminated composites.						
CO 4	Students will understand different experimental techniques for physical and mechanical characterization and different non-destructive techniques.						

Unit- I

Introduction: Definitions, characteristics, classification, particulate composites, fiber-reinforced composites, applications of fiber composites, Advance fibers: glass fibers, carbon and graphite fibers, aramid fibers, boron fibers, other fibers, matrix materials.

Emerging composite materials: Nanocomposites, carbon-carbon composites, bio-composites, composites in "smart" structures.

Unit- II

Fabrication of composites: Fabrication of thermosetting resin Matrix composites: Hand lay-up technique, bag molding processes, resin transfer molding, filament winding, pultrusion; Fabrication of thermoplastic-resin matrix composites (Short-fiber composites), Fabrication of Metal matrix and ceramic matrix composites.

Behavior of unidirectional composites: Nomenclature, volume and void fraction, longitudinal behavior of unidirectional composites, transverse stiffness and strength, failure modes, expansion co-efficient and transport properties.

Unit-III

Short-fiber composites: Introduction, theories of stress transfer: approximate analysis of stress transfer, stress distribution from finite-element analysis, average fiber stress. Modulus and strength of short-fiber composites: prediction of modulus, prediction of strength, effect of matrix ductility.

Analysis of laminated composites: Introduction, laminate strains, variation of stresses in laminates, resultant forces and moments, laminate description system, determination of laminate stresses and strains, analysis of laminates after initial failure, performance of fiber composites: fatigue and impact effects.

Unit-IV

Experimental characterization of composites: Introduction, measurement of physical properties: density, constituent weight and volume fractions, void volume fraction, thermal expansion coefficient,

moisture absorption and diffusivity and moisture expansion co-efficient, measurement of mechanical properties: properties in tension, compression, in-place shear properties.

Damage identification using non-destructive evaluation techniques:- Ultrasonic, X-Radiography, Laser Shearography, Thermography.

Text Books:

1. Analysis and performance of Fiber Composites by Bhagwan D. Agarwal, Lawrence J. Broutman, K. Chandrashekhara, Wiley India Pvt. Ltd., India.
2. Fiber Reinforced Composites: Materials Manufacturing and Design by P.K. Mallick, 3rd Edition, CRC Press.
3. Mechanics of Composite Materials by Autar K. Kaw, 2nd Edition, CRC Taylor and Francis Group.
4. Composite Materials, Design and Applications by Daniel Gay, Suong V. Hoa, 2nd Edition, CRC Taylor and Francis Group.

Reference Books:

1. Mechanics of Composite Materials by R. M. Jones, CRC Press.
2. Fibrous Materials by K. K. Chawla, Cambridge University Press.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (6th Semester) Mechanical Engineering							
MEP-310	**REFRIGERATION AND AIR CONDITIONING**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose	The objective of this course is to make the students aware of refrigeration, Air-conditioning, various methods of refrigeration. The course will help the students to build the fundamental concepts in order to solve engineering problems and to design HVAC applications.						
Course Outcomes							
CO 1	Students should be able to understand different refrigeration processes like ice refrigeration, evaporative refrigeration, refrigeration by expansion of air, steam jet refrigeration systems etc.						
CO 2	Students will identify, formulate and solve air refrigeration, vapour refrigeration and vapour absorption refrigeration problems.						
CO 3	Students will identify and understand refrigerants and their uses as per their properties and environmental effects etc.						
CO 4	Students should grab the knowledge of psychometric properties, psychometric chart and its use for different cooling and heating processes along with humidification and dehumidification.						
CO 5	Students should be able to design various air-conditioning systems by including the internal and external heat gain.						

REFRIGERATION

UNIT-I

Introduction: Basics of heat pump & refrigerator, Carnot refrigeration and heat pump, units of refrigeration, COP of refrigerator and heat pump, Carnot COP, Ice refrigeration, evaporative refrigeration, refrigeration by expansion of air, refrigeration by throttling of gas, vapour refrigeration system, steam jet refrigeration, thermo- electric cooling, adiabatic demagnetization.

Air refrigeration: Basic principle of operation of air refrigeration system, Bell Coleman air refrigerator, advantages of using air refrigeration in air craft, disadvantage of air refrigeration in comparison to other cold producing methods, simple air refrigeration in air craft, simple evaporative type, air refrigeration in air craft, necessity of cooling the aircraft.

UNIT-II

Simple vapour compression refrigeration system: Simple vapour compression refrigeration system, different compression processes (wet, dry and saturated Compression, superheated compression), Limitations of vapour compression refrigeration system if used on reverse Carnot cycle, representation of theoretical and actual cycle on T-S and P-H charts, effects of operating conditions on the performance of the system, advantages of vapour compression system over air refrigeration system.

Advanced vapour compression refrigeration system: Methods of improving COP, flash chamber, flash inter cooler, optimum inter stage pressure for two stage refrigeration system, single expansion and multi expansion cases, basic introduction of single load and multi load systems, cascade systems.

Vapour absorption refrigeration system and special topics: Basic absorption system, COP and maximum COP of the absorption system. Actual NH_3 absorption system, function of various components, Li-Br absorption system, Selection of refrigerant and absorbent pair in vapour absorption system, Electro-Lux refrigerator, comparison of compression and absorption refrigeration system, Nomenclature of refrigerants, desirable properties of refrigerants, cold storage and Ice Plants.

AIR-CONDITIONING

UNIT-III

Introduction: Difference between refrigeration and Air-conditioning, Psychrometric properties of moist air (wet bulb, dry bulb, dew point temperature, relative and specific humidity, temperature of adiabatic saturation), empirical relation to calculate P_v of moist air.

Psychrometry: Psychrometric chart, construction and use, mixing of two air streams, sensible heating and cooling, latent heating and cooling, humidification and dehumidification, cooling with dehumidification, cooling with adiabatic humidification, heating and humidification, By- pass factor of coil, sensible heat factor, ADP of cooling coil, Air washer.

UNIT-IV

Air-conditioning Systems: Classification, factors affecting air-conditioning systems, comfort air-conditioning system, winter air-conditioning system, summer air-conditioning system, year round air-conditioning system, unitary air-conditioning system, central air-conditioning system, Room sensible heat factor, Grand sensible heat factor, effective room sensible heat factor.

Cooling Load calculation: Inside design conditions, comfort conditions, components of cooling load, internal heat gains (occupancy, lighting, appliances, product and processes), system heat gain (supply air duct, A.C. fan, return air duct), External heat gain (heat gain through building, solar heat gain through outside walls and roofs), sol-air temperature, solar heat gain through glass windows, heat gain due to ventilation and infiltration.

Industrial and Commercial Application: Transport air conditioning, evaporative condensers, cooling towers, heat pumps.

Text Books:

1. Refrigeration and Air-conditioning by C.P. Arora, Tata McGraw-Hill
2. Basic Refrigeration and Air-conditioning by Ananthana and Rayanan, McGraw-Hill

Reference Books:

1. Refrigeration and Air Conditioning by Arora and Domkundwar, Dhanpat Rai.
2. Refrigeration and air-conditioning by R.C.Arora, PHI

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech (6th Semester) Mechanical Engineering							
MEP-312	**PRODUCT ENGINEERING**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose	To acquaint the students with the knowledge of engineering techniques used to produce an engineering product.						
Course Outcomes							
CO1	Students will be able to attain the theoretical knowledge of different work, method and time study, recording charts and techniques.						
CO2	Students will be able to understand the importance of inventory control and solve the problems related queuing theory.						
CO3	Students will be able to attain the theoretical knowledge of sales forecasting and understand the network analysis representations.						
CO4	Students will be familiarize with the concept of value engineering and different modern approaches of product design.						

Unit-I

Introduction to Work Study: Work study, human considerations in work study, relationship of work-study person with management, relationship of work-study person and supervisor, Method Study: procedure of method study, Therbligs, Motion study, cycle graph and chronocycle graph: equipment used, procedure and uses, principles of motion economy, Work measurement: definitions and objectives, time-study procedures, work-measurement techniques, job selection for work measurement, equipment's and forms used for time study, performance rating, determination of normal time and standard time allowances, pre-determined motion time systems.

Ergonomics: Human being as applicator of forces, Anthropometry, the design of controls, the design of displays, Man/Machine information exchange, Workplace layout from ergonomic considerations.

Unit-II

Inventory Control: Functions of inventory; Types of inventory; Control importance functions, Inventory costs, factors affecting inventory control, various inventory controls models; A.B.C. analysis, lead-time calculations.

Queuing Theory: Introduction, applications of Queuing theory, waiting time and idle time cost, Single channel queuing theory and multi-channel queuing theory with Poisson arrivals and exponential services, numerical on single channel and multi channels theory.

Unit-III

Sales Forecasting: Introduction, objectives and importance of sales forecasting, Types of forecasting, Methods of sales forecasting, Collective opinion method, Delphi technique, economic indicator method; Regression analysis.

Network Analysis: Phases of project management, network representation, techniques for drawing network, numbering of events (Fulkersen rule), PERT calculations, Critical path method (CPM): Forward pass computation, backward pass computation, computation of float and slack time, critical

path, time cost optimization algorithm, updating a project, resource allocation and scheduling, Management operation system technique (MOST).

Unit-IV

Value Engineering: Value, Nature and measurement of value, Maximum value, Normal degree of value, Importance of value, value analysis job plan, creativity, steps to problem solving and value analysis, value analysis tests, value engineering idea generation check list, Cost reduction through value engineering-case study, materials and process selection in value engineering.

Modern Approaches: Concurrent engineering, Quality function deployment (QFD), Reverse engineering, 3D printing.

Text Books:

1. Work study and Ergonomics by Prof. P.C. Tewari, Ane Books Pvt. Ltd., New Delhi-110002.
2. Operations Research by A. M., Natarajan and P. Balasubramanie, Pearson Education India.
3. Industrial Engineering and Production Management by TelSang Martand, S. Chand and company Ltd.

Reference Books:

1. Operation Research by Prem Kumar Gupta and D.S. Heera, S. Chand Publications.
2. Motion and time study: Improving Productivity by Marvin E, Mundel and David L, Pearson Education.
3. Work study and Ergonomics by S. K. Sharma and Savita Sharma, S. K. Kataria and Sons, Delhi.
4. Product design and engineering by A. K. Chitale and Gupta, PHI

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (6th Semester) Mechanical Engineering								
MEC-306 L	**MECHANICAL ENGINEERING LAB-I**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total Time**	**Time (Hrs.)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose:	To provide practical knowledge in the concerned subject that a student opt from the program electives offered in the curriculum.							

INTERNAL COMBUSTION ENGINES PRACTICALS:

COURSE OUTCOMES:

CO 1: The students will be able to understand the principles, construction and working of S.I. and C.I. engines.

CO 2: The students will be familiarized with fuel injection systems, lubrication and cooling systems.

CO 3: The students will also be able to calculate the performance parameters of reciprocating air compressor, petrol and diesel engines.

LIST OF EXPERIMENTS

1. To make a trial on single cylinder 4-stroke Diesel Engine to calculate B. H. P., S.F.C. and to draw its characteristics curves.
2. To make a trial on 4-stroke high-speed diesel engine and to draw its Heat Balance Sheet.
3. To make a trial on Wiley's jeep Engine at constant speed to calculate B. H. P., S. F. C. Thermal efficiency and to draw its characteristic Curves.
4. To make Morse Test to calculate IHP of the multi cylinder petrol engine and to determine its mechanical efficiency.
5. To calculate the isothermal efficiency and volumetric efficiency of a 2 stage reciprocating air compressor.
6. To find out the efficiency of an air Blower.
7. To make a trial on the Boiler to calculate equivalent evaporation and efficiency of the boiler.
8. To study the following models;
   (a) Gas Turbine (b) Wankle Engine.
9. To study
   (a) Lubrication and cooling systems employed in various I. C. Engines in the Lab
   (b) Braking system of automobile in the lab
10. To study a Carburetor.
11. To study (I) the Fuel Injection System of a C. I. Engine. (II) Battery Ignition system of a S.I. Engine
12. To study Cooling Tower.
13. To make a trial with multi-cylinder four stroke vertical Diesel Engine test Rig with Hydraulic Dynamometer.

DESIGN OF TRANSMISSION SYSTEMS PRACTICALS:

COURSE OUTCOMES:

CO 1: The students will be familiarized with different modules of SOLIDWORKS/ANSYS for the analysis and simulation of transmission elements.

CO 2: The students will be able to apply the design principles and concepts in designing and simulation of various transmission elements of an automobile under different operating conditions.

CO 3: The students will be capable of understanding the constructional details and working of different transmission components used in automobiles.

LIST OF EXPERIMENTS

1. To model and simulate the V-belt drive/belt conveyor.
2. To simulate and analyze the rack and pinion arrangement under different loading conditions.
3. Static structural analysis of different gears.
4. Transient and explicit analysis on transmission system gears.
5. To simulate and analyze rigid flange coupling and bushed-pin flexible coupling.
6. To simulate and analyze the camshaft.
7. Static structure and fatigue analysis of crank shaft.
8. To study the construction details, working principles and operations of different types of automotive clutches.
9. To study the direct-shift continuous variable transmission (CVT) system.
10. To study the constructional details, working principles and operations of different types of automotive brakes.

GAS DYNAMICS AND JET PROPULSION PRACTICALS

COURSE OUTCOMES:

CO 1: Students will be able to simulate and analyse the flow through the nozzle and an airfoil.

CO 2: Students will be able to understand the simulation of vortex shedding phenomenon.

CO 3: Students will have an experience to validate the computer program for coutte flow.

CO 4: Students will be able to validate the computer based program of fully developed laminar flow in a pipe.

LIST OF EXPERIMENTS

1. To simulate and analyze the compressible flow through a nozzle.
2. To simulate and analyze the transonic flow over an airfoil.
3. To simulate vortex shedding phenomenon over a cylinder in laminar flow.
4. To make and validate a computer program for the coutte flow.
5. To make and validate a computer program for the fully developed laminar flow in circular pipe.
6. To simulate and analyze the laminar flow pipe.

Note: At least six experiments are required to be performed by students from the above list and remaining four may be performed from the experiments developed by the institute.

B. Tech. (6th Semester) Mechanical Engineering								
MEC-308 L	**MECHANICAL ENGINEERING LAB-II**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total Time**	**Time (Hrs.)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose:	To provide practical knowledge in the concerned subject that a student opt from the program electives offered in the curriculum.							

COMPOSITE MATERIALS PRACTICALS

COURSE OUTCOMES:

CO 1: The students will have a practical exposure with different types of composites development techniques.

CO 2: The students will be able to practically implement the theoretical knowledge in the fabrication of different types of composites such as polymer matrix composites, MMC etc.

CO 3: The students will be capable of analysing the physical, mechanical and tribological behavior of the developed composites.

LIST OF EXPERIMENTS

1. To study the hot compression molding technique for the preparation of thermosetting-resin matrix composites.
2. To develop the advanced fiber reinforced polymer composites and characterize for their physical properties (density, constituent weight and volume fractions, void volume fraction, thermal expansion coefficients, moisture absorption and diffusivity, moisture expansion coefficients).
3. To find the hardness and tensile and flexural properties of the advanced fiber reinforced polymer composites.
4. To develop the particle reinforced polymer composites and characterize for their physical properties (density, constituent weight and volume fractions, void volume fraction, thermal expansion coefficients, moisture absorption and diffusivity, moisture expansion coefficients).
5. To develop the Al metal-matrix composites using friction stir casting and characterize for various mechanical properties.
6. To find the friction and wear properties of Al metal matrix composites using pin-on-disc apparatus.
7. To find the hardness and tensile and flexural properties of the particle reinforced polymer composites.
8. To find the friction and wear properties of fiber reinforced/particle reinforced polymer composites using pin-on-disc apparatus.

REFRIGERATION AND AIR CONDITIONING PRACTICALS

COURSE OUTCOMES:

CO 1: The students will be able to understand the basics and working principle of water cooler.

CO 2: The students will be able to understand different cycles of operation in air-conditioning practically.

CO 3: The students will understand the humidity measurement and its importance in air-conditioning.

CO 4: The students will know about the various control devices and parts of refrigeration and air-conditioning systems used in actual practice.

LIST OF EXPERIMENTS

1. To study and perform experiment on basic vapour compression Refrigeration Cycle.
2. To study and perform experiment on Solar Air-conditioner based on vapour absorption cycle.
3. To find C.O.P. of water cooler.
4. To study and perform experiments on compound compression and multi-load systems.
5. To study and perform experiment on vapour absorption apparatus.
6. Perform the experiment & calculate various performance parameters on a blower apparatus.
7. To find the performance parameter of cooling tower.
8. To study various components in room air conditioner.
9. To find RH of atmospheric air by using Sling Psychrometer.
10. To find performance of a refrigeration test rig system by using different expansion devices.
11. To study different control devices of a refrigeration system.
12. To find the performance parameters of Ice Plant.
13. To study and perform experiment on Cascade system.

PRODUCT ENGINEERING PRACTICALS

COURSE OUTCOMES:

CO 1: The students will be able to understand the concept of P-Chart and C-Chart.

CO 2: The students will understand the normal distribution and universal distribution.

CO 3: The students will be able to interpret the two handed process chart and Multi activity chart (Man-Machine Chart).

CO 4: The students will be able to interpret the concept of $\bar{X}$, R Charts and Process capability.

LIST OF EXPERIMENTS

1. To draw left and right hand process charts and to conduct time study for the bolt, washer & nut assembly of present and improved methods.
2. To show that sample means for a normal universe follow a normal distribution.
3. To learn performance rating through observation of the activity of dealing pack of 52 playing cards.
4. To study the changes in heart beat rate for different subjects using Treadmill.
5. To plot the operating charters tic curve for a single sampling attributes plan of a given lot of plastic balls and to compare the actual O.C curve with theoretical O.C curve.
6. To study the changes in heart beat rate for different subjects using Ergocycle.
7. To draw P-Chart for fraction defective and to check the control of the process for a given set of plastic balls.
8. To draw a C- chart for a given set of metal discs and to check the control of the process by taking each disk with 10 holes of each 6 mm size as one unit.
9. To show that the sample means from a rectangular universe follow a normal distribution.

10. To draw multiple activity chart or man-machine chart for the subject of toasting 3 slices of bread in one electric double compartment toaster.
11. To draw $\bar{X}$ and R charts and to determine the process capability from the measurement of large diameter of a given set of stepped pins.
12. Measure the skill and dexterity in the moment of wrist and fingers using pin board.

Note: At least eight experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.

Seventh Semester

B. Tech. (7th Semester) Mechanical Engineering							
MEO-401	**SMART MATERIALS**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The purpose of this course is to develop the understanding of various aspects of smart materials, smart structures and their applications.						
Course Outcomes							
CO1	Students will be able to recognize the key concepts behind classification and fabrication of smart materials and various functions of intelligent materials.						
CO2	Students will be able to categorize the various types of smart structure systems, actuators and sensors.						
CO3	Students will be able to describe the various types of SMA based hybrid composites and smart battery materials.						
CO4	Students will be able to perceive the structure and properties of various types of nanotubes.						

UNIT-I

Smart materials: key concepts: Introduction to smart materials, definition of smart materials, define smart materials, basic principles behind smart properties, classification of smart materials according to their production technologies and applications in various industries, approaches to fabrication of smart materials, properties of smart materials, nanoscale and microscale structure property relationship, Intelligent materials, primitive functions of intelligent materials, intelligence inherent in materials, intelligent materials in harmony with humanity, intelligent biological materials, biomimetics.

UNIT-II

Smart materials and structural systems: Introduction, actuator materials, sensing technologies, sensing technologies, microsensors, intelligent systems, hybrid smart materials, passive sensory smart structures, reactive actuator based smart structures, active sensing and reactive smart structures, smart skins.

UNIT–III

Shape memory alloys: Phase transition, shape-memory effect, shape memory alloy fiber/metal matrix composites, shape memory alloy fiber/polymer matrix composites, SMA particulate / aluminum matrix composites.

Smart battery materials: Introduction, electrochemical concepts involved in a battery, types of batteries, lithium ion batteries, layered oxide cathodes, spinel oxide cathodes, olivine oxide cathodes, carbon anodes.

UNIT–IV

Nanoscale intelligent materials and structures: Introduction, nanotube geometric structures, structures of carbon nanotubes, structures of non-carbon nanotubes, designations of nanotubes and nanostructured materials, mechanical and physical properties of nanotubes; elastic properties, electrical conductivity, magnetoresistance, piezo-resistance, electrokinetics of nanotube, piezoelectric properties, electrochemical effects, nanotube power generation, nanotube contact phenomena.

Text books:

1. Smart Materials and Structures - M.V. Gandhi and B.S. Thompson, Chapman and Hall pub.
2. Encyclopedia of Smart Materials - Mel Shwartz Vol.1 and 2, John Wiley & Sons, Inc.
3. Nano engineering of Structural, Functional, and Smart Materials - Mark J. Schulz, Ajit D. Kelkar, and Mannur J. Sundaresan , Taylor and Francis Pub.

Reference books:

1. Micro and smart systems - Ananthasuresh, Wiley India Ltd.
2. Coursera course Smart Materials: Microscale and Macroscale Approaches - Peter the great St. Petersburg Polytechnic University.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (7th Semester) Mechanical Engineering							
MEO-405	**NON-DESTRUCTIVE TESTING**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The purpose of this course is to make the students understand about different inspection and testing methods of components safely and without damage.						
Course Outcomes							
CO1	Students will be able to learn the fundamental concepts of NDT.						
CO2	Students will be able to describe the different methods of NDE.						
CO3	Students will be able to describe the concept of thermography and eddy current testing.						
CO4	Students will be able to explain the ultrasonic testing and acoustic emissions.						

UNIT-I

Introduction to NDT: NDT vs destructive testing, overview of the don-destructive, Testing methods for the detection of manufacturing defects as well as material characterization, relative merits and limitations, various physical characteristics of materials and their applications in NDT, visual inspection – unaided and aided

UNIT-II

Surface NDE methods: Liquid penetrant testing – principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, testing procedure, interpretation of results, magnetic particle testing-theory of magnetism, inspection materials magnetization methods, interpretation and evaluation of test indications, principles and methods of demagnetization, residual magnetism.

UNIT–III

Thermography and eddy current testing (ET): Thermography- principles, contact and non-contact inspection methods, techniques for applying liquid crystals, advantages and limitations – infrared radiation and infrared detectors, instrumentations and methods, applications, eddy current testing-generation of eddy currents, properties of eddy currents, eddy current sensing elements, probes, instrumentation, types of arrangement, applications, advantages, limitations, interpretation/evaluation

UNIT–IV

Ultrasonic testing (UT) and acoustic emission (AE): Ultrasonic testing-principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan, phased array ultrasound, time of flight diffraction, acoustic emission technique–principle, AE parameters, applications.

Text books:

1. Non-Destructive Testing - Baldev Raj, T. Jayakumar, M. Thavasimuthu Narosa Publishing House.
2. Non-Destructive Testing Techniques - Ravi Prakash, 1st revised edition, New Age International Publishers.

Reference books:

1. ASM Metals Handbook,Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio.
2. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.
3. Handbook of Nondestructive evaluation by Charles, J. Hellier, McGraw Hill, New York 2001.
4. Introduction to Non-destructive testing: a training guide by Paul E Mix, Wiley, 2nd Edition New Jersey, 2005.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (7th Semester) Mechanical Engineering							
MEO-407	**MANUFACTURING COST ESTIMATION**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The purpose of this course is to impart the students with the knowledge of cost estimating function and controls, organizing and staffing for cost estimation and cost estimation of machining, joining and finishing processes.						
Course Outcomes							
CO1	Students will be able to describe cost reduction techniques, cost estimating functions, and establish staff and organization for cost estimation.						
CO2	Students will be able to discuss cost estimating controls and various estimating procedures.						
CO3	Students will be able to estimate the costs for different machining and casting processes.						
CO4	Students will be able to estimate the costs for different joining and surface finishing processes.						

UNIT-I

The estimating function and costing studies: Explanation of terms, importance of the life of the product, target cost, product costs, purpose of estimating, types of estimates, a systematic approach to cost reduction, cost reduction examples, team efforts.

Organizing and staffing for estimating: Coordinated product cost estimating, cost estimating department, type of organization and cost estimating, qualifications of a cost estimator, development of a cost estimator.

UNIT-II

Cost estimating controls: Administrative controls, initiating cost requests, estimating methods, controlling the cost estimate, controlling estimate deviations, estimating in a changing cost environment, do's and don'ts of cost estimating.

Estimating procedures: Cost estimating analysis, part analysis, preliminary manufacturing plan, facilities, direct material cost, tooling costs, manufacturing time, direct labour costs, factory burden, total manufacturing cost.

UNIT–III

Cost estimation for machining: Traditional machining operations defined, gathering information, economical machining, cost modelling and calculations, grinding application, milling application, non-traditional machining applications.

Estimating casting costs: Casting materials, casting processes, determining material costs, foundry tooling defined, molding costs, core costs, machining and cleaning costs, heat treatment, inspection and shipping costs, foundry burden.

UNIT–IV

Estimation of cost: Joining Costs: Welding, Braze Welding, Brazing, Soldering, Electron Beam Welding, Laser Beam Welding, Plasma Arc Welding, Adhesive Bonding, Fastening, Ultrasonic Welding.

Estimating surface finishing costs: Deburring, ultrasonic cleaning, polishing, honing, hybrid finishing processes, painting, electroplating, cost modelling and calculations.

Text books:

1. Realistic cost estimating for manufacturing. Third Edition - Lembersky, Michael Society of Manufacturing Engineers, 2016.
2. Process Planning and Cost Estimation, Second Edition - R. Kesavan, C. Elanchezhian, B. Vijaya Ramanath, New age international publishers.

Reference books:

1. Process Planning And The Cost Estimation - M. Adithan, New age international publishers.
2. Estimating and Costing for the Metal Manufacturing Industries - Robert Creese (Author), M. Adithan (Author), CRC Press

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (7th Semester) Mechanical Engineering							
MEO-409	**ERGONOMICS**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	0	0	3	75	25	100	3
Purpose	The purpose of this course is to make the students aware of the human factor engineering principles and its application to different disciplines.						
Course Outcomes							
CO1	Students will be able to explain the ergonomics fundamentals and anthropometry.						
CO 2	Students will be able to analyse the human posture, relative movements and human behavior and perception.						
CO 3	Students will be able to apply the ergonomics principles in visuals display and product designing.						
CO 4	Students will be able to describe the workstation design and occupational safety.						

UNIT-I

Discipline approach: ergonomics/ human factors: Introduction to ergonomics, Fitting task to man their contractual structure, domain, philosophy and objective, mutual task comfort: two way dialogue, communication model, ergonomics/ human factors fundamentals, physiology (work physiology) and stress.

Human physical dimension concern: Human body- structure and function, anthropometrics, Anthropometry: body growth and somatotypes, static and dynamic anthropometry, stand posture-erect, Anthropometry landmark: sitting postures, Anthropometry: squatting and cross-legged postures, anthropometric measuring techniques, statistical treatment of data and percentile calculations.

UNIT-II

Posture and movement: Human body- structure and function, posture and job relation, posture and body supportive devices, chair characteristics, vertical work surface, horizontal work surface, movement, work counter

Behaviour and perception: Communication and cognitive issues, psycho-social behaviour aspects, behaviour and stereotype, information processing and perception, cognitive aspects and mental workload, human error and risk perception

UNIT-III

Visual Issues: Visual performance, visual displays, environments factors, environmental factors influencing human performance

Ergonomic design process: Ergonomics design methodology, Ergonomics criteria/check while designing, Design process involving ergonomics check, some checklists for task easiness.

UNIT-IV

Performance support and design intervention: Occupational safety and stress at workplace in view to reduce the potential fatigue, errors, discomforts and unsafe acts workstation design, furniture support, vertical arm reach and design application possibility

Humanising design: Design and human compatibility, comfort and adaptability aspects, Design Ergonomics in India: scope for exploration.

Text Books:

1. Introduction to Ergonomics - R. Bridger-CRC Press, Taylor & Francis Group.
2. Human Factors in Engineering and Design-M. Sanders, E. McCormick, McGraw-Hill International Editions: Psychology Series.
3. An Introduction to Human Factors Engineering-C. Wicknes, S. Gordon, Y. Liu and S. Gordon-Becker, New York.
4. Indian Anthropometric Dimensions for Ergonomic Design Practice-D. Chakrabarti, National Institute of Design, Ahmedabad.

Reference Books:

1. Handbook of Human Factors and Ergonomics-G. Salvendy, John Wiley & Sons, Inc.
2. Ergonomics for Beginners, A Quick Reference Guide, J. Dul and B. Weerdmeester, CRC Press, Taylor & Francis Group.

Note: The paper setter will set the paper as per the question paper templates provided.

B. Tech. (7th Semester) Mechanical Engineering							
MEO-411	**AIR AND NOISE POLLUTION**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	0	0	3	75	25	100	3
Purpose	The objective of this course is to analyze the emissions from automobiles, industries and to describe various techniques of reducing these emissions. Also to understand the concept to control noise pollution.						
Course Outcomes							
CO1	Students will be able to analyze the emissions from industries and various vehicles.						
CO2	Students will be able to understand standards, alternative control strategies and AAQ guidelines.						
CO3	Students will be able to describe various processes for desulfurization, flue control methods for various exhaust gases.						
CO4	Students will be able to explain the characterization of noise, physical sound and various noise barriers.						

UNIT-I

Introduction: Concept of unpolluted air, gaseous and vapour pollutants in atmosphere, scales of air pollution, primary and secondary pollutants, ambient air quality, monitoring of pollutants (SO_2, NO_2, O_3, PAN, particulates, hydrocarbons, PAH's) and their health effects, stack monitoring for SO_x, NO_x, CO, CO_2, Hydrocarbons, Fluorides, Ammonia, VOCs, effects of air pollution on vegetation, materials and structures, stack monitoring for thermal power plant, oil refinery industry, fertilizer industry, non-ferrous metal industry. recent techniques of online stack monitoring, emission inventory, trends of AAQ in urban, rural and Industrial areas.

UNIT-II

Air quality: National and International air emission standards and AAQ guidelines, indoor air quality, averaging time, air pollution system, alternative control strategies, GLC estimates for multiple sources using standard software (e.g., EPA's ISC model), determination of effective stack height.

UNIT–III

Emission Standards and Particulate matter: Distribution and sources of particulate matter, Hood duct design, particulate collection mechanisms, control systems and their design, flue-gas desulfurization processes, flue gas control methods for NO_x, emission standards for automobiles, origin of exhaust emissions from gasoline, diesel, CNG and LPG engines, crankcase and evaporative emissions, emission reduction by fuel changes, emission reduction by engine design changes, catalytic converters, diesel engine emissions.

UNIT–IV

Noise: Characteristics, sources, types of noise, impact of noise.

Physics of sound- Speed of sound, sound pressure, frequency, wavelength, RMS sound pressure, sound pressure level, loudness, sound power level and sound energy density, sound propagation, wind and temperature gradient.

Enclosures and Barriers: Lead as a noise barrier, plenum barriers, barrier around pipe, wires and rectangular ductwork, high transmission loss ceilings, acoustical foams, nylon in noise reduction, damping compounds.

Noise measuring equipments: Sound level meter, octave band analyzer, statistical analyzer and noise average meter.

Text books:

1. Rao M.N. and Rao H.V.N., "Air Pollution", Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. Wang L.K., Pereira N.C., Hung Y.T., "Advanced Air and noise pollution control", Volume I andII, Humana Press, New Jersey.

Reference books:

1. Ghassemi A., "Pollution Control and Waste Minimization", Marcel Dekker, Inc., New York.
2. Rao C.S., "Environmental Pollution Control Engineering", New Age International (P) Ltd., New Delhi.
3. Singal S.P., "Noise Pollution and Control Strategy", Alpha Science International, New Delhi.
4. Ray T.K., "Air Pollution Control in Industries", Volume I, Tbi, New Delhi.
5. Stern A.C., Bauble R.W., Fox D.L., Turner B., "Fundamentals of Air Pollution, Hardcover", Elsevier Science and Technology Books.
6. Narayanan P., "Environmental Pollution Principles, Analysis and Control", CBS Publishers

Note: The paper setter will set the paper as per the question paper template provided.

MEC-401	AUTOMATION IN MANUFACTURING						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The purpose of this course is to impart knowledge of production automation, robotics, flexible manufacturing, CNC programming, material handling and automated storage systems.						
Course Outcomes							
CO1	Students will be able to explain the role automation in manufacturing and robotics in industry.						
CO2	Students will be able to describe the group technology and flexible manufacturing techniques in the automated production line and manufacturing system.						
CO3	Students will be able to explain computer aided process planning and shop floor manufacturing activities.						
CO4	Students will be able to develop CNC programs and understand the concept automated guided vehicle and automated storage system in material handling.						

UNIT-I

Introduction: Production system, automation in production system, manual labour in production system, automation principle and strategies, manufacturing industries and products, manufacturing operations, product facilities, product/ production relationship, basic elements of an automation system, advance automation function, level of automation.

Industrial robotics: Robot anatomy and related attributes, joint and links, common robot configuration, joint drive system, sensors in robotics, robot control system, end effectors, grippers and tools, applications of industrial robots, material handling, processing operation, assembly and inspection, robot programming.

UNIT-II

Group technology and cellular manufacturing: Part families, parts classifications and coding, production flow analysis, cellular Manufacturing- composite part concept, machine cell design, applications of group technology, grouping parts and machines by rank order clustering technique, arranging machines in a G.T. cell.

Flexible manufacturing: Introduction, FMS components, flexibility in manufacturing – machine, product, routing, operation, types of FMS, FMS layouts, FMS planning and control issues, deadlock in FMS, FMS benefits and applications.

UNIT- III

Process planning: Introduction, manual process planning, computer aided process planning – variant, generative, decision logic decision tables, decision trees, Introduction to artificial intelligence.

Shop floor control: Introduction, shop floor control features, major displays, major reports, phases of SFC, order release, order scheduling, order progress, manufacturing control, methodology, applications,

shop floor data collections, Types of data collection system, data input techniques, automatic data, collection system.

UNIT- IV

CNC basics and part programming: Introduction, historical, background, basic components of an NC, steps in NC, verifications of numerical control machine tool programs, classification of NC Machine tool, basics of motion control and feedback for NC M/C, NC part programming, part programming methods, modern machining system, automatically programmed tools, DNC, adaptive control.

Automated guided vehicle and storage system: Functions of AGV, types of AGV, safety consideration for AGV, design of AGV; Introduction to storage system, storage system performance, storage location strategies, conventional storage method and equipment, automated storage system, fixed aisle automated storage/ retrieval system, carousel storage systems, analysis of storage system, fixed aisle automated storage/ retrieval systems, carousel storage systems.

Text Books:

1. CAD/CAM/CIM-P. Radhakrishnan, S. Subramanayan and V.Raju, New Age International (P) Ltd., New Delhi.
2. Computer Integrated Manufacturing- Alavudeen and Venkateshwaran, Prentice- Hall of India Pvt. Ltd., New Delhi.

Reference Books:

1. Automation, Production System and Computer Integrated Manufacturing- Mikell P. Groover, Pearson fourth edition.
2. CAD/CAM: Computer Aided Design and Manufacturing-Groover-M.P. and Zimmers E. W.,Prentice Hall International, New Delhi, 1992.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (7th Semester) Mechanical Engineering								
MEC-403L	**MECHANICAL ENGINEERING LAB-III**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total Time**	**Time (Hrs.)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose:	To provide practical knowledge in the concerned subject that a student opt from the program electives offered in the curriculum.							

COMPUTER AIDED DESIGN PRACTICALS

Course Outcomes

CO1 Students will be able to draw and design 2D models.

CO 2 Students will be able to draw and design 3D modelling.

CO 3 Students will be able to assemble the parts.

List of experiments:

1 To study the 2 dimensional drawing, orthographic views, front view, top view and side view.
2 Introduction to Solid Works and working with sketch mode.
3 To study the wireframe, surface and solid modelling.
4 Working with the tools like Pattern, Copy, Rotate, Move and Mirror etc.
5 Working with creating 3D features (Extrude & Revolve).
6 Working with the tools like Hole, Round, and Chamfer etc.
7 Create the part drawing of product 1 using any 3D software.
8 Draw the part drawing of product 2 using any 3D software.
9 Draw the part drawing of product 3 using any 3D software.
10 Make assembly by using any 3D software.

Note: Product 1, 2 and 3 must be based on MEP-401.

FINITE ELEMENT ANALYSIS LAB:

Course Outcomes

CO1 Students will be able to apply the basic theory of elasticity to continuum problems

CO2 Students will be able to formulate Finite Element problems like bar, truss and beam elements for linear static structural analysis

CO3 Students will be able to formulate 2D and axisymmetric finite elements

CO4 Students will be able to formulate and solve finite element equations for 1D heat transfer elements

List of Experiments:

1. To solve problems related to solid mechanics, heat transfer and free vibration by using NASTRAN/SIMULIA/ANSYS/ABAQUS.
2. Introduction of GUI of the software in the above mentioned areas realistic problems.
3. To analyze beams and frames (bending and torsion problems).

4. To analyze plane stress and plane strain problems.
5. Problems leading to analysis of axisymmetric solids.
6. Problems leading to analysis of three dimensional solids: (a) Heat Transfer problems (b) Modal analysis problem:

By writing own code for finite element analysis using MATLAB for:

7. Plane stress and Plane strain problems.
8. Modal analysis problems.

Reference Books:

1. Finite Element Method using MATLAB-Young W Kwon and Hyochoong Bang, CRC Press Washington, USA.
2. Finite Element Method: A Practical Course-G. R. LIU and S. S. Quek, Elsevier Science, Butterworth – Heinemann publication.

POWER PLANT ENGINEERING LAB:

Course Outcomes

CO1 Students will be able to explain the constructional features and working of different boilers, accessories, mountings, heat balance sheet preparation and to analyze the quality of steam.

CO2 Students will be able to describe the functions of different cooling towers and condensers and calculate their efficiencies.

CO3 Student will be able to calculate the calorific value of fuels using a bomb calorimeter.

CO4 Student will be able to explain the functioning and use of solar photovoltaic systems and calculate the efficiency of a solar cell.

List of Experiments:

1. To study high pressure boilers.
2. To study low pressure boilers.
2. To study about the mountings & accessories of high and low-pressure boilers.
3. To prepare the heat balance sheet for the given boiler.
5. To find the calorific value of a given sample of solid/liquid fuel(s) using a bomb calorimeter.
6. To find power output and efficiency of impulse and reaction steam turbine.
7. To study cooling tower and calculate its efficiency.
8. To study various types of condenser and calculate efficiency.
9. To find the dryness fraction of steam using separating and throttling calorimeters.
10. To study solar photovoltaic systems and calculation of efficiency of a solar cell.

MECHATRONIC SYSTEMS PRACTICALS

Course Outcomes

CO1 Students will be able to control the speed of DC motor and servo motor using 8051 microcontrollers.

CO2 Students will be able to control the motion of single and double acting cylinder using Pneumatic and Hydraulic training kit.

CO3 Students will be able to control traffic light signals using PLC and 8051 microcontrollers.

CO4 Students will be able to perform operations of addition, subtraction, multiplication and division using 8086 Microprocessor.

List of Experiments

1 To run a stepper motor at different speeds and directions using 8051 assembly language.

2 To control traffic light by interfacing with PLC kit.

3 To perform speed control of DC motor with 8051 microcontroller.

4 To perform experiment on hydraulic trainer kit.

5 To perform experiment on pneumatic trainer kit.

6 To study various types of sensors and transducers.

7 To control a traffic light system using 8051 Microcontroller

8 To perform the 8-bit addition and subtraction using 8086 Microprocessor.

9 To perform the 8-bit multiplication and division using 8086 Microprocessor.

INDUSTRIAL ROBOTICS PRACTICALS

Course Outcomes

CO 1 Students will be able to analyze the movement of various positions of robotics arm.
CO 2 Students will be able to design the robotics systems.
CO 3 Students will be able to analyze the pneumatic and hydraulic systems.
CO 4 Students will be able to demonstrate sensors, grippers etc.

List of Experiments

1. Recoding Robot positions (Absolute positions, Delete Positions, Save and load positions and Move the Robot to recorded positions).
2. Demonstration of Cartesian/ cylindrical/ spherical robot.
3. Study of different types of grippers.
4. Study of sensor integration.
5. Study of robotic system design.
6. Setting robot for any one industrial application after industrial visit.
7. Study the major equipment/Software/Components in Robotics Lab, e.g. Robotic Arm components, Arena etc.
8. Study of pneumatic and hydraulic system in Robotics.

SOLAR ENERGY ANALYSIS PRACTICALS

Course Outcomes

CO 1 Students will be able to analyze the solar based heating concepts and flow of working fluid in collector.
CO 2 Students will be able to analyze the solar parabolic trough and evacuated tube collector.
CO 3 Students will be able to know about the solar energy storage by different means and understand the sun-earth relationships for sun tracking.
CO 4 Students will able to describe the functioning of solar PV collector power plant.

List of Experiments:

1. To evaluate the system efficiency and heat transfer of evacuated tube collector in different parts of system at different ambient conditions.
2. Evaluation of system thermal efficiency solar collector during charging storing and discharging the PCM.
3. To determine the thermal Performance of the Parabolic Trough collector with different inlet temperature of water and oil.
4. To evaluate the thermal performance of flat plate collector in thermosiphon and forced mode of flow at different radiation level.
5. To find the drying rate and drying time of different fruits and vegetables in flat plate based solar dryer.
6. To determine the efficiency of solar photo voltaic collector with and without sun tracking.

B. Tech. (7th Semester) Mechanical Engineering								
MEC-405L	**PROJECT-III**							
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Practical**	**Total Time**	**Time (Hrs.)**
0	**0**	**10**	**5**	**0**	**100**	**100**	**200**	**3**
Purpose:	To implement the engineering principles and theories into innovative practical projects for solving real world problems.							
Course Outcomes								
CO1	Students will be able to apply the theoretical knowledge into practical/software projects.							
CO2	Students will be able to design new products using latest technologies.							

The project work could be done for the problem statement of an industry or practical project in the institute. The students may also opt for the analysis based software projects with proper validation. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Note: The maximum number of students in a group should not exceed four.

B. Tech. (7th Semester) Mechanical Engineering							
MEP-401	**COMPUTER AIDED DESIGN**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	To apply the computer's technology in designing.						
Course Outcomes							
CO1	To understand the fundamentals of CAD and analyze the CAD hardware.						
CO2	Students will be able to evaluate the CAD software and various transformation operations.						
CO3	Students will be able to analyze the geometric modeling.						
CO4	Students will be able to create surface modeling and understand the data exchange.						

UNIT-I

Fundamentals of CAD: Introduction, Traditional product cycle, CAD/CAM product cycle, rapid prototypic, design for everything, computer aided design, computer aided engineering, customer relationship management, product lifecycle management,

CAD hardware: Introduction, basic structure of computer, input, storage, processing, output, control, microcomputer, minicomputer, mainframes, supercomputer**,** input out device, LAN, MAN, WAN.

UNIT-II

CAD Software: Introduction, system software, application software, General CAD process, selection of CAD system, database management system, data structure, database types, function of database management system, advantages of DBMS, database coordinate system.

Geometric transformations: Introduction, 2D transformation, translation, rotation, scaling, homogeneous coordinate relationship, reflection transformation, shear transformation, inverse transformation for translation, rotation, scaling, reflection, shear, composite transformation, examples of composite transformation, geometric transformations in engineering design, solved examples.

UNIT-III

Geometric modeling: Need of geometric modeling, requirements of geometric modeling, wire frame modeling, surface modeling, solid modeling, difference between wireframe, surface and solid modeling, introduction to solid modeling, set theory, representation schemes for solid models, boundary representation, cellular decomposition, feature based modeling, Euler theory, mass property calculation.

Mathematical representation of 2D entity: Introduction, parametric representation, of analytic curves, lines, circle, conic selection, ellipse, parabola, hyperbola, parametric representation of synthetic curve, Hermite cubic spline curve, Bezier curves, B- spline curve, non-uniform rational, B splines, manipulation of curves.

UNIT-IV

Mathematical representation of surface entity: Introduction, surface entities, analytic surface, plane surface, tabulated surface, ruled surface, surface of revolution, sweep surface, synthetic surface, Hermite Bicubic surface, Bazier surface, bilinear surface, coons surface

Data exchange formats: Introduction, CAD/CAM data exchange, neutral file formats, data exchange format, initial graphics exchange specification, standard triangular language, standard for exchange of product data.

Text Books:

1. CAD/CAM – Principle Practice and Manufacturing Management - Chris McMahon and Jimmie Browne, Addison Wesley England, Second Edition, 2000.
2. CAD/CAM Theory and Practice, Mastering CAD/CAM - Ibrahim Zeid, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Reference Books:

1. Mathematical Elements for Computer Graphics - NC-Rogers, D.F. and Adams, McGraw Hill, NY, 1989
2. CAD/CAM/CIM - P. Radhakrishnan, S. Subramanayan and V. Raju, New Age International (P) Ltd., New Delhi.
3. CAD/CAM: Computer Aided Design and Manufacturing - Groover M.P. and Zimmers E. W., Prentice Hall International, New Delhi, 1992.
4. CAD/CAM/CAE - Chougule N. K, Scitech publications (INDIA) PVT. LTD.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (7th Semester) Mechanical Engineering							
MEP-403	**FINITE ELEMENT ANALYSIS**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	0	0	3	75	25	100	3
Purpose	The purpose of this course is to understand the formulation of FEA problems and to describe various methods of FEM. Also to understand the FEM with CI continuity and FDM.						
Course Outcomes							
CO1	Students will be able to understand the basic steps in FEM formulation. Also to study various concepts associated and assembly along with the boundary conditions in FEM formulation.						
CO2	Students will be able to analyze how FEM problems are formulated in 1-D elements. Also to discuss shape functions, h and p approximations; and various solvers associated in FEM.						
CO3	Students will be able to study FEM formulation of 2-D elements using various methods like Galerkin approach, Weighted Residual etc. Also to understand the natural coordinates, numerical integration and various other concepts related to 2-D FEM formulation.						
CO4	Students will be able to describe the axi-symmetric problems along with plane stress and plane strain problems with regards to solid mechanics. Also to discuss various elements of FEM, FEM with CI continuity and FDM problems.						

UNIT-1

Introduction: Basic steps in FEM formulation, general applicability of the method, variational functional, Ritz Method.

Variational FEM: Derivation of elemental equations, assembly, imposition of boundary conditions, solution of the equations.

UNIT-II

1-D Elements: Basis functions and shape functions, convergence criteria, h and p approximations, natural coordinates, numerical integration, Gauss elimination based solvers, computer implementation: pre-processor, processor, post-processor.

UNIT-III

Methods of FEA: Alternate formulation: Weighted Residual Method, Galerkin Method;

Problems with C1 Continuity: beam bending, connectivity and assembly of C1 continuity elements.

2-D Elements (Triangles and Quadrilaterals) and Shape Functions: Natural Coordinates, Numerical Integration, Elemental Equations, .Connectivity and Assembly, Imposition of Boundary Conditions.

Axisymmetric (Heat Conduction) problem, plane strain and plane stress solid mechanics problems, sub-parametric, iso-parametric and super-parametric elements; elements with C1 continuity.

UNIT-IV

Free vibration problems and FDM: Formulation of eigenvalue problems, FEM formulation, time-dependent problems, combination of Galerkin FEM and FDM (Finite Difference Method), convergence and stability of FD Scheme.

Text Books:

1. Finite element analysis-C. S. Krishnamoorthy, Tata McGraw Hill
2. An introduction to Finite element method-J. N Reddy, Tata Mc. Graw Hill
3. Finite Element Method with applications in Engineering-Y. M. Desai, Pearson Education India.

Reference Books:

1. Nonlinear Finite Elements for Continua and Structures (Paperback)-Belytschko (shelved 1 time as *finite-elements*)
2. The Finite Element Method for Three-Dimensional Thermomechanical Applications (Hardcover)-Guido Dhondt (shelved 1 time as *finite-elements*)
3. Numerical Solution of Partial Differential Equations by the Finite Element Method (Paperback)- Claes Johnson (shelved 1 time as *finite-elements*)

Note: The paper setter will set the paper as per the question paper template provided.

	B. Tech. (7th semester) Mechanical Engineering						
MEP-405	**POWER PLANT ENGINEERING**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	To understand modern aspects of power generation, different power plants, their combinations, operation and components, energy demand and supply and power plant economics.						
Course Outcomes							
CO1	Students will be able to analyze the economics of power generation and describe the variety of power plants.						
CO2	Students will be able to analyze steam power cycles and understand the coal handling process in detail.						
CO3	Students will be able to understand about the operation & advancements of Solar, Diesel and Gas turbine power plants.						
CO4	Students will be able to describe the role of nuclear energy in power generation and various combinations of power plants and their operation.						

UNIT-I

Economics of power generation: Introduction to economics of power generation, different terms and definitions, hydrology, rainfall, runoff, hydrographs, flow duration curves, cost analysis, power plant locations, selection of power plant equipment, factors affecting economics of generation and distribution of power, performance and operating characteristics of power plants, economic load sharing, tariff for electrical energy.

Different types of power plants: Recent developments in power plants, geothermal power plants, tidal power plants, windmills, solar power plants, hydroelectric power plant: site selection, classification, estimation of power availability, selection of water turbines, advantages and disadvantages of hydro power plants.

UNIT-II

Analysis of steam cycle: The ideal Rankine cycle, externally irreversible Rankine cycle, superheat, reheat, regeneration, internally irreversible Rankine cycle, open feed water heaters, closed type feed water heaters with drains cascaded backward and pumped forward, typical layout of steam power plant, efficiency and heat rate.

Coal handling plant: Coal Handling: unloading, feeding, crushing, feeding system, conveyor system, stacking system, magnetic separator/ metal detector, bin/chute vibratory system, coal weighment, coal sampling, fire-fighting system, dust suppression system, dust extraction system, mechanical stokers, pulverized fuels and burners, ash handling and disposal.

UNIT-III

Solar Power Plants: Introduction; solar collectors: flat plate and concentrating; absorber coating; solar pond electric power plant; solar thermal electric conversion systems: low temperature, medium

temperature and high temperature; solar electric power generation: solar photovoltaics, solar cell working and principle; combination of solar and hydropower plants; solar chimney power plant system.

Diesel engine & gas turbine power plants: Introduction, Types, layout of diesel engine power plant, different components of diesel power plant, performance characteristics, supercharging, layout and components of gas turbine power plants, gas turbine fuels, material selection for gas turbines.

UNIT-IV

Nuclear power plants: Basic theory and terminology, nuclear fission and fusion processes, fission chain reaction, moderation, fertile materials, nuclear fuels, general components of nuclear reactor, different types of reactors: PWR, BWR, GCR, LMFBR, CANDU-PHW, disposal of nuclear waste and related issues.

Power plant combinations: Combination of hydro power plants with steam plants, GT-ST Combined Cycle plant, combined cycles with heat recovery boiler, PFBC combined cycle, STIG (steam injected gas turbine) cycle, combined cycles with multi-pressure steam, combined cycle for nuclear power plants.

Text Books:

1. Power Plant Engineering-Morse, D. Van Nostrand.
2. Power Plant Engineering-PK Nag, McGraw Hill.
3. Power Plant Technology-El-Wakil, McGraw Hill.

Reference Books:

1. Power Plant Engineering-P.C. Sharma, SK Kataria & Sons.
2. Power Plant Engineering-Domkundwar, Dhanpat Rai & Co.
3. Power Plant Technology-G.D.Rai, Khanna Publishers.
4. Power Plant Engineering-R.K. Rajput, Laxmi Publications.

Note: The paper setter will set the paper as per the question paper templates provided.

B. Tech (7th Semester) Mechanical Engineering							
MEP-407	**MECHATRONIC SYSTEMS**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The purpose of this course is to provide students with an in-depth knowledge of mechatronics systems. The subject will give knowledge of electronics components to students and assist them to acquire inter disciplinary skills.						
Course Outcomes							
CO1	Students will be able to understand Mechatronics systems and their applications. The students will be able to understand different sensors and transducers as well as able to select the transducers as per applications.						
CO2	Students will be able to describe different types of number systems and Boolean algebra and able to convert number systems from one system to another. The students will be able to explain pin configuration and architecture of microprocessor.						
CO3	Students will be able to understand the architecture of microcontroller and structure of PLC. The students will also be able to draw the ladder diagram.						
CO4	Students will be able to understand various types of actuator. The students will also be able to explain the working of DC and servo motor.						

UNIT-I

Introduction: Definition of mechatronics, multi-disciplinary scenario, evaluation of mechatronics, objectives, advantages & disadvantages of mechatronics, an overview of mechatronics, microprocessor based controllers, principle of working of automatic camera, automatic washing machine & engine management system.

Review of sensors and transducers: Definition and classification of transducers, definition & classification of sensors, performance terminology, working principle and application of displacement, position & proximity, velocity and motion, force, fluid pressure, liquid flow, liquid level, temperature, light sensors, selection of transducers.

UNIT-II

Digital principles: Introduction, digital number system, range and weight of binary number system, octal and hexadecimal number systems, conversion, BCD number systems, gray code, Boolean algebra, logic states, logic functions, more logic gates, universal gates, exclusive-OR gate, minimization of Boolean expression using Karnaugh map.

Microprocessor: 8086 CPU architecture: 8086 Block diagram, description of data registers, address registers; pointer and index registers, PSW, Queue, BIU and EU, 8086 Pin diagram descriptions, 8086 minimum mode and maximum mode CPU module.

UNIT–III

Micro controller: Introduction of 8051 microcontroller & its block diagram, comparison of microprocessor and microcontroller

PLC: Programmable logic controllers, basic structure, input/output processing, ladder diagram timers, internal relays and counters, shift registers, master and jump controls, data handling, analogue input/output, selection of a PLC.

UNIT–IV

Actuators: Definition, classification of actuators, mechanical actuation systems, types of motion, kinematics chains, cams, gear trains, ratchet and pawl, belt and chain drives, bearings, brief survey of electromechanical actuators, drive requirements for cutting movements, requirements of feed drives, calculation of drive requirements on feed motor shaft.

Motors: DC motors & Control of DC motors, DC & AC servomotors, stepper motors-types, characteristics, advantages, limitations and applications, mechanical aspects of motor selection.

Text books:

1. A Textbook of Mechatronics-R. K Rajput, S. Chand & Company, Edition 2010
2. Mechatronics, W. Bolton – Pearson Education Asia - 2nd Edition, 2011.

Reference books:

1. Mechatronics, HMT Ltd., McGraw Hill Education, 2017
2. Mechatronics Principles, Concepts and Application-Nitaigour and Premchand, Mahilik – Tata McGraw Hill – 2003
3. Mechatronics: An Introduction-Robert H. Bishop, CRC Press, 2015
4. Mechatronics: Integrated Mechanical Electronic System- Ramachandran, Vijayaraghavan, Balasundaran- Wiley Publication, 2008

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. 7th Semester Mechanical Engineering							
MEP-409	**INDUSTRIAL ROBOTICS**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The purpose of this course is to make the students understand about the fundamental of robotics technology, its components and robotics cell design and control.						
Course Outcomes							
CO1	Students will be able to understand the fundamentals of robotics and find its applications.						
CO2	Students will be able to explain the use of different sensors and end effectors in robotics.						
CO3	Students will be able to describe the application of robotics in manufacturing.						
CO4	Students will be able to design and analyze the work cell and robotic motion.						

UNIT-I

Introduction: Automation and robotics, robotics in science fiction, a brief history of robotics, the robotics market and the future prospectus,

Fundamental of robotics: Robot anatomy, work volume, robot drives systems, control systems, precession of movement, end effectors, robot application.

UNIT-II

Sensors in robotics: Type of sensors in robotics, exteroceptors or external sensors, force and torque sensors, proximity sensors (position sensors), range sensors, machine vision sensors, velocity sensors. tactile sensor, proximately and range sensors, use of sensor in robotics.

Robot end effectors: Types of end effectors, characteristics of end-of-arm tooling, elements of end-of-arm tooling.

UNIT-III

Material transfer and equipments: General consideration in robot material handling, material transfer applications, machine loading and unloading,

Grippers: Tool selection of gripper, gripping mechanism, types of gripper, mechanical gripper, vacuum and magnetic grippers.

UNIT-IV

Robot cell design and control: Robot cell layouts, multiple robots and machine interface, other considerations in work cell design, work cell control, interlocks, the work cell controller, robot motion analysis and control: introduction to manipulator kinematics, manipulator path control, robot dynamics, configuration of robot control.

Text books:

1. Robot Analysis and Control- Asada, H., and J. J. Slotine, Wiley.

2. CAD/CAM: Computer Aided Design and Manufacturing- Groover M.P. and Zimmers E. W., Prentice Hall International, New Delhi.

Reference Books:

1. Robotics and Control-R. K. Mittal, I. J. Nagrath, McGraw Hill.
2. Fundamental of Robotics Analysis and Control-Robert J Schilling, Pearson
3. Industrial Automation and Robotics-J K Arora, Laxmi Publications

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Note: The paper setter will set the paper as per the question paper templates provided.

B. Tech. (7th Semester) Mechanical Engineering							
MEP-411	**SOLAR ENERGY ANALYSIS**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The purpose of this course is to make the students aware about the importance, availability, use and applications of solar energy.						
Course Outcomes							
CO1	Students will be able to describe the sun-earth relationships and various solar activities based on sun and earth rotation.						
CO 2	Students will be able to analyze the concentrating collector in solar energy applications and solar energy storage by different means.						
CO 3	Students will be able to apply the solar based heating-cooling concepts in building structures and explain the water heating flow systems.						
CO 4	Students will be able to analyze solar power generation, refrigeration and air-conditioning systems.						

Unit-I

Introduction: Basic Heat transfer principles, availability of solar energy, nature of solar energy, solar energy and environment, sun as the source of radiation, solar radiation: measurement of solar radiation, irradiance, solar constant, insolation, radiosity, emissive power, earth's equator, meridian longitude, sun earth angles, sunrise, sun set and day length, solar time, equation of time, various methods of using solar energy, photo thermal, photovoltaic, photosynthesis, present & future scope of solar energy.

Unit-II

Solar thermal energy: Stationary collectors, FPC, CPC, ETC, sun tracking, concentrating collectors, PTC, PDR, HFC, Fresnel collectors, solar thermal power plants, solar chimney power plant, solar pond, solar water heater, solar cooker, types- solar disinfection, limitations of solar thermal energy.

Heat Storage: Sensible and latent heat storage, chemical energy system, performance calculations.

Unit-III

Flow systems: Natural and forced flow systems, water heating systems for domestic, industrial and space heating requirements, solar distillation.

Solar heating and cooling: Direct, indirect and isolated heating concepts, cooling concepts, load calculation methods, performance evaluation methods.

Unit-IV

Solar thermal power generation: Introduction, paraboloid concentrating systems, cylindrical concentrating systems, central receiver system.

Solar refrigeration and air conditioning systems: Introduction, solar refrigeration and air conditioning systems, solar desiccant cooling.

Text Books:

1. Solar Thermal Engineering Process - Duffie and Beckman.
2. Advanced Solar Energy Technology - H.P. Garg, Kluver.
3. Solar Energy- S.P. Sukhatme, TMH.

Reference Books:

1. Solar Energy- J.S. Hsieh, Pearson College DIV.
2. Solar Thermal Engineering- P.J. Lunde, John Wiley & Sons.

Note: The paper setter will set the paper as per the question paper templates provided.

B. Tech. (7th Semester) Mechanical Engineering								
MEC-407	**INDUSTRIAL TRAINING-III**							
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time (Hrs.)**
2	**0**	**0**	**--**	**--**	**100**	**--**	**100**	**--**
Purpose	To provide an industrial exposure to the students and enhance their skills and creative capability for conversion of their innovative ideas into physical reality.							
Course Outcomes								
CO 1	Students will be able to self-improve through continuous professional development and life-long learning.							
CO 2	Students will be able to develop social, cultural, global and environmental responsibility as an engineer.							
CO 3	Students will be able to weigh all the latest changes in technological world.							

Note: MEC-407 is a mandatory non-credit course in which the students will be evaluated for the industrial training undergone for minimum 4 weeks after 6th semester and students will be required to get passing marks to qualify.

The candidate has to submit a training report of his/her work/project/assignment completed in the industry during the training period. The evaluation will be made on the basis of training report submitted and viva-voce/presentation.

Eighth Semester

B. Tech. (8th Semester) Mechanical Engineering								
MEC-402L	**Project-IV**							
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time (Hrs.)**
0	**0**	**10**	**5**	**0**	**100**	**100**	**200**	**3**
Purpose	To implement the engineering principles and theories into innovative practical projects for solving real world problems.							
Course Outcomes								
CO1	Students will be able to apply the theoretical knowledge into practical/software projects.							
CO2	Students will be able to design new products using latest technologies.							

The project work could be done for the problem statement of an industry or practical project in the institute. The students may also opt for the analysis based software projects with proper validation. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Note: The maximum number of students in a group should not exceed four.

B. Tech. (8th Semester) Mechanical Engineering							
MEO-402	**SUPPLY CHAIN MANAGEMENT**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The main objective of the course is to impart students with the knowledge of the performance, driver and metrics, network design, economies and uncertainties in Supply chain management.						
Course Outcomes							
CO1	Students will be able to explain the basics of Supply chain management and its performance.						
CO2	Students will be able to discuss supply chain metrics and the process of designing the supply chain networks.						
CO3	Students will be able to explain various aspects and functions of the supply chain network. Also, they will be able to explain the design process of the Global supply chain network.						
CO4	Students will be able to describe how to manage economies and uncertainties in the supply chain.						

UNIT-I

Understanding the supply chain: Introduction, definition, the objective of a supply chain, the importance of supply chain decisions, decision phases in a supply chain, process views of a supply chain, examples of supply chains.

Supply chain performance: Achieving strategic fit and scope: Competitive and supply chain strategies, achieving strategic fit, expanding strategic scope, challenges to achieving and maintaining strategic fit.

UNIT-II

Supply chain drivers and metrics: Financial measures of performance, drivers of supply chain performance, framework for structuring drivers, facilities, inventory, transportation, information, sourcing, pricing.

Designing the supply chain network: Designing distribution networks and applications to online sales: the role of distribution in the supply chain, factors influencing distribution network design, design options for a distribution network, online sales and the distribution network, distribution networks in practice.

UNIT-III

Network design in the supply chain: The role of network design in the supply chain, factors influencing network design decisions, framework for network design decisions, models for facility location and capacity allocation, making network design decisions in practice.

Designing global supply chain networks: The impact of globalization on supply chain networks, the offshoring decision: total cost, risk management in global supply chains, discounted cash flows, evaluating network design decisions using decision trees, to onshore or offshore: evaluation of global supply chain design decisions under uncertainty, making global supply chain design decisions under uncertainty in practice.

UNIT-IV

Managing economies of scale in a supply chain: Cycle inventory, the role of cycle inventory in a supply chain, estimating cycle inventory–related costs in practice, economies of scale to exploit fixed costs, economies of scale to exploit quantity discounts, short-term discounting: trade promotions, managing multi-echelon cycle inventory.

Managing uncertainty in a supply chain: Safety inventory, the role of safety inventory in a supply chain, determining the appropriate level of safety inventory, impact of supply uncertainty on safety inventory, impact of aggregation on safety inventory, impact of replenishment policies on safety inventory, managing safety inventory in a multie-chelon supply chain, the role of IT in inventory management, estimating and managing safety inventory in practice.

Text books:

1. Supply chain Management: Strategy, Planning and Operations - Chopra, S., and Meindl, P., Fifth Edition, Pearson Education (Singapore) Pte. Ltd, 2004.
2. Designing & Managing the Supply Chain: Concepts, Strategies & Case studies - Simchi-Levi, P., Kaminsky, Ravi Shankar, E., Third Edition, Tata McGraw-Hill Edition, 2003.

Reference books:

1. Purchasing and Supply Chain Management: Text and Cases - Doebler, D.W. and Burt, D.N., McGraw-Hill Publishing Company Limited, New Delhi, 1996.
2. Supply Chain Management for Competitive Advantage - Rangaraj, TMH.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (8th Semester) Mechanical Engineering							
MEO-404	**COMPETITIVE MANUFACTURING SYSTEMS**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The objective of this course is to make the students understand about the concepts of competitive manufacturing management systems.						
Course Outcomes							
CO1	Students will be able to interpret the tactics, strategies and tools of continuous improvements of products and services.						
CO2	Students will be able to implement the just in time and total quality management philosophy for continuous improvement and identify the elements of lean and wasteless production.						
CO3	Students will be able to describe how to reduce the setup time and how to maintain and improve the equipment efficiency.						
CO4	Students will be able to explain the pull-push production system and will be able to know the systems for eliminating defects.						

UNIT-I

Fundamentals of continuous improvement: Continuous improvement as tactics and strategy-Incremental improvement: Kaizen, improvement threshold, innovation improvement making the leap, improvement as strategy, finding and implementing improvements-PDCA cycle, value analysis/value engineering, process engineering.

Basic problem solving and improvement tools: Check list, histogram, Pareto analysis, scatter diagram, process flow chart, cause and effect analysis, run diagram.

UNIT-II

JIT: value added and waste elimination: Value added focus- necessary and unnecessary activities, support organization, sources of waste-Toyota's seven wastes, Canon's none wastes, JIT principles-simplification, cleanliness and organization, visibility, cycling time, agility, variation reduction, ,measurement, Meaning of JIT-philosophy, method, JIT limitations and implementation barriers, social impact of JIT.

Total quality management (TQM): Quality, Framework for managing total quality, employee involvement, benchmarking, quality certification, implementing TQM.

Elements of lean production: Lot size basics-lot size and setup reduction, kinds of lots, Lot sizing-process and purchase batches, EOQ based methods, transfer batches, Lot size reduction- Effect of lot size reduction on competitive criteria, cases for larger process batches, minimum lot size, small buffer stock, EOQ models for lot sizing.

UNIT-III

Setup time reduction: Setup reduction methodology-Shingo and SMED, SMED methodology for setup reduction, techniques for setup reduction-separate internal and external activities, improve internal setups, improve external setups.

Maintaining and improving equipment: Equipment maintenance-breakdown repair, equipment problems and competitiveness, preventive maintenance, total predictive maintenance, Equipment effectiveness-equipment losses, maintainability, reliability, availability, efficiency, quality rate, preventive maintenance programs, Total productive maintenance-perform TPM preventive maintenance, develop in house quality to restore and redesign equipment, eliminate human error in operation and maintenance, Implementing TPM-program feasibility, master plan, target areas, management support.

UNIT-IV

Pull production systems: Production control systems, Pull systems and Push systems- pull production process, push production process, rules for pull production, process improvement, necessary conditions for pull production systems, pull system as a fixed quantity/reorder point system, conveyance Kanbans, production Kanbans, Signal Kanbans, CONWIP method of pull production.

Systems for eliminating defects: Inspection (screening), self-checks and successive checks, requirements for self-checking, successive checkings, automation, cycle time, limits of inspection, source inspection and POKAYOKE: POKAYOKE functions, ideas, continuous improvements, JIDOKA-autonomation, andons.

Text Books:

1. Competitive Manufacturing Management – John M. Nicholas, TMH.
2. Manufacturing Management – Principles and Concepts, Gibson, Greenhalgh and Kerr, Champan and Hall.

Reference Books:

1. Production and Operation Management – K.C. Jain, Dreamtech Press.
2. Operations management-William J. Stevenson, McGraw Hill Education.

Note: The paper setter will set the paper as per the question paper templates provided.

B. Tech. 8TH Semester Mechanical Engineering							
MEO-406	**CONCURRENT ENGINEERING**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The objective of this course is to familiarize students with the concepts, approaches and implementation techniques related to concurrent engineering.						
Course Outcomes							
CO1	Students will be able to describe the basic concepts of concurrent engineering and implement concurrent engineering techniques.						
CO2	Students will be able to identify the concept of life cycle management.						
CO3	Students will be able to analyze reengineering and system engineering approaches and processes.						
CO4	Students will be able to appraise different information modeling systems and product realization taxonomy.						

UNIT – I

Concurrent engineering concept: Concurrent engineering definitions, basic principles of CE, components of CE, concurrency and simultaneity, modes of concurrency, modes of cooperation, CE design methodologies, benefits of concurrent engineering,

Review of CE technique: Design for manufacture (DFM), design for assembly (DFA), quality function deployment (QFD), rapid prototyping (RP), total design (TD), organizing for CE, CE tool box.

UNIT – II

Life-cycle management: Introduction, shrinking life-cycle, product development cycle, product-life cycle, life-cycle management, new product introduction, strategic technology insertions, managing continuity, managing revision changes, life-cycle cost drivers, life-cycle management tools, sequential versus concurrent engineering.

UNIT – III

Process-reengineering: Introduction, understanding and managing change, reengineering approaches work-flow mapping, information flow-charting, process improvement methodology, change management methodology, concurrent process reengineering.

System engineering: System engineering process, systems thinking, approaches to system complexity, sharing and collaboration in CE, system integration, management and reporting structure.

UNIT – IV

Information modeling systems: Information modeling, modeling methodology, foundation of information modeling, concurrent engineering process invariant, enterprise model-class, specification model-class, product model-class, process model-class, cognitive models, merits and demerits.

Product realization taxonomy: Development methodology for CPRT, concurrent product realization taxonomy, pull system of product realization, description of parallel tracks, description of 2-T loops, description of 3-T loop.

Text Books:-

1. Concurrent Engineering Fundamental, (Vol 1) integrated Product and Process Organization - Biren Prasad.
2. Concurrent Engineering - G.S. SAWHNEYUNIVERSITY SCIENCE PRESS (An Imprint of Laxmi Publications Pvt. Ltd.) An ISO 9001:2008 Company.
3. Concurrent Engineering Fundamentals: Integrated Product Development - Prasad, Prentice hall India

Reference Books:

1. Design for Concurrent Engineering - J. Cleetus, CE Research Centre, Morgantown
2. Concurrent Engineering in Product Design and Development - I. Moustapha, New Age International
3. Concurrent Engineering: Automation Tools and Technology - Andrew Kusiak - , Wiley Eastern

Note: The paper setter will set the paper as per the question paper templates provided.

B. Tech. (8th Semester) Mechanical Engineering							
MEO-408	**LUBRICANTS AND LUBRICATION**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The purpose of the course is to make the students aware of the different properties and composition of lubricants and understand the fundamental concepts of hydrodynamic, hydrostatic and extreme pressure lubrication.						
Course Outcomes							
CO1	Students will be able to describe properties and composition of lubricants.						
CO2	Students will be able to understand the basics of hydrodynamic lubrication and analyse the thermal and non-Newtonian effects in hydrodynamic lubrication.						
CO3	Students will be able to explain and analyze the hydrostatic lubrication, and extreme pressure lubrication at different temperature-load combinations.						
CO4	Students will be able to understand and analyze the elastohydrodynamic lubrication.						

UNIT-I

Physical properties of lubricants: Introduction, relationship of viscosity with temperature, pressure and shear rate, viscosity index, viscosity measurement, viscosity of mixtures; Viscosity classification, thermal properties of lubricants, temperature characteristics of lubricants, neutralization number, carbon residue, optical properties, additive compatibility and solubility, lubricant impurities and contaminants.

Lubricants and their composition: Mineral oil based liquid lubricants – sources, types, synthetic oils – manufacturing of synthetic oils, hydrocarbon synthetic lubricants, silicon analogues of hydrocarbons, organohalogens; new developments in synthetic lubricants, emulsions and aqueous lubricants, greases, grease characteristics, lubricant additives.

UNIT-II

Hydrodynamic lubrication: Introduction, Reynolds equation, pressure distribution, load capacity, coefficient of friction, lubricant flow; converging diverging wedges, journal bearings, thermal effects in bearings, isoviscous and non-isoviscous thermal analysis, hydrodynamic lubrication with non-Newtonian fluids, squeeze films.

UNIT–III

Hydrostatic lubrication: Introduction, hydrostatic bearing analysis, general approach, optimization of bearing design, aerostatic bearings, stability.

Extreme pressure lubrication: Lubrication mechanisms for low temperature-low load, low temperature - high load, high temperature – medium load and high temperature – high load, boundary and EP lubrication of non-metallic surfaces.

UNIT–IV

Elastohydrodynamic lubrication: Introduction, contact stresses, geometry of contacting bodies, contact area, pressure, maximum deflection and position of maximum shear stress, EHL of lubricating films,

pressure distribution, film thickness formulae, effect of non-dimensional parameters, lubrication regimes, partial EHL, surface temperature at conjunction.

Text books:

1. Engineering Tribology - Gwidon W. Stachowiak, Andrew W. Batchelor, Butter worth, Heinemann.
2. Introduction to Tribology of Bearings - B.C. Majumdar, S. Chand Co.

Reference books:

1. Friction and Lubrication - E.P. Bowden and Tabor. D., Heinemann Educational Books Ltd.
2. Engineering Tribology - Ross Beckett, Larsen and Keller Education
3. Fundamentals of Fluid Film Lubrication - Bernard Hamrock, Bo Jacobson, and Steven R. Schmid, Taylor and Francis.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. 8th Semester) Mechanical Engineering							
MEO-410	**TOTAL QUALITY MANAGEMENT**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The purpose of this course is to develop an understanding of quality management framework, philosophies, in-depth knowledge of various tools and techniques with their application in the manufacturing and service industry.						
Course Outcomes							
CO1	Students will be able to understand quality management philosophies and frameworks.						
CO2	Students will be able to describe various tools and techniques of quality management.						
CO3	Students will be able to explain the applications of quality tools and techniques in both manufacturing and service industry						
CO4	Students will be able to describe various quality systems like ISO and its standards.						

UNIT-I

Introduction and philosophies of quality management: introduction, need for quality ,evolution of quality, definitions of quality, dimensions of product and service quality, basic concepts of TQM, TQM framework, benefits, awareness and obstacles, quality, vision, mission and policy statements, contributions of Deming, Juran and Crosby , barriers to TQM, quality statements, customer focus, customer orientation, customer satisfaction, customer complaints, and customer retention, costs of quality.

UNIT-II

Principles of quality management: Leadership, strategic quality planning, quality councils, employee involvement, motivation, empowerment, team and teamwork, quality circles recognition and reward, performance appraisal, continuous process improvement , PDCA cycle, 5S, Kaizen , supplier partnership, partnering, supplier selection, supplier rating.

Process capability: Meaning, significance and measurement, six sigma concepts of process capability.

UNIT–III

Tools and techniques for quality management: Quality functions development (QFD), benefits, voice of customer, information organization, house of quality (HOQ), building a HOQ, QFD process.

Failure mode effect analysis (FMEA): Requirements of reliability, failure rate, FMEA stages, design, process and documentation, seven old (statistical) tools, seven new management tools, bench marking and POKAYOKE.

UNIT–IV

Quality systems organizing and implementation: Need for ISO: 9000, ISO: 9001-2008 quality system, elements, documentation, quality auditing, QS: 9000, ISO: 14000, concepts, requirements and benefits, TQM implementation in manufacturing and service sectors, quality audits, TQM culture.

Text Books:

1. Total Quality Management-Dale H. Besterfield, Pearson Education (First Indian Reprints 2004).

2. Total Quality Management-Shridhara Bhat K, Himalaya Publishing House, First Edition 2002.

Reference Books:

1. Competitive Manufacturing Management – John M. Nicholas, TMH.
2. Total Quality Management- R Kesavan, C Elanchezhian, B Vijaya Ramnath, IK International.
3. Total Quality Management: Principles, Methods, and Applications-Sunil Luthra, Dixit Garg, Ashish Agarwal, Sachin K. Mangla, CRC Press.
4. Total Quality Management-Poornima M. Charantimath, Pearson Pub.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. 8th Semester) Mechanical Engineering							
MEO-412	**ENERGY CONSERVATION AND MANAGEMENT**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Objective	To impart students, the knowledge of various energy management and conservation techniques, building audit and survey procedures for energy management.						
Course Outcomes							
CO1	Students will be able to describe various renewable sources of energy and the technicalities, operating principles and classification of HVAC Systems.						
CO2	Students will be able to describe the methodology of Site and Building Surveys.						
CO3	Students will be able to explain various energy analysis techniques and the principle and classification of Process Energy.						
CO4	Students will be able to discuss the implementation of various energy management techniques in building designs.						

UNIT-I

Renewable energy: Introduction; solar energy; wind energy; energy from water; energy from earth; energy from biomass.

Heating, venting and air conditioning systems: General principles; the requirements for human comfort; description of typical systems-dual duct HVAC system; multi zone HVAC systems: variable and volume systems, terminal repeat system, evaporative systems, package system; basic principle governing HVAC system, package system; energy management opportunities in HVAC systems; modeling of heating and cooling loads in buildings; problems.

UNIT-II

Site and building surveys: Phases involved in surveys: initiation phase, audit and analysis phase, implementation phase; general methodology for building and site energy audit; site survey: methodology, site survey-electrical system, steam and water systems; building survey: methodology, basic energy audit instrumentation, measurement for building surveys.

UNIT-III

Energy analysis techniques: Introduction; annual energy consumption; normalized performance indicators; time-dependent energy analysis; linear regression; single independent; correlation coefficients; multivariable analysis; CUSUM.

Process energy: General principles; process heat; energy saving in: condensate return, steam generation and distribution, automotive fuel control, hot water and water pumping; direct and indirect fired furnaces over process electricity; other process energy forms-compressed air and manufacturing processes; problems.

UNIT-IV

Waste heat recovery: Introduction, recuperative heat exchangers, heat exchanger theory; number of transfer units (NTU) concept, run-around coils, regenerative heat exchangers, heat pumps, energy

efficient heating: thermal comfort, building heat loss; U values, heat loss calculations, heating energy calculations; intermittent heating; radiant heat; radiant heating; low-emissivity glazing.

Passive solar and low energy building design: Introduction, passive solar heating, direct gain techniques, indirect gain techniques, isolated gain techniques, thermosiphon systems, passive solar cooling, shading techniques, solar control glazing, advanced fenestration, natural ventilation, thermal mass, night venting, termodeck, building form, building operation.

Text Book:

1. Energy Management and Conservation Handbook, Second Edition - Frank Kreith, D. Yogi Goswami.
2. Energy Management, Supply and Conservation, Second Edition - Clive Beggs
3. Energy Management Principles - Criag B. Smith, Published by Pergamon Press.
4. Energy Systems and Developments – Jyoti Parikh, Oxford University Press.

Reference Books:

1. Energy, Resources, Demand and Conservation with reference to India – Chaman Kashkari, Tata Mc Graw Hill Co. Ltd.
2. Integrated Renewable Energy for Rural Development–Proceedings of Natural Solar Energy Convention, Calcutta.

Note: The paper setter will set the paper as per the question paper templates provided.

B. Tech. 8th Semester) Mechanical Engineering							
MEP-402	**Non-Conventional Machining**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	This course provides comprehensive knowledge about the advanced technologies and different Non-conventional machining processes.						
Course Outcomes							
CO 1	Students will be able to compare conventional and non-conventional machining processes and recognize the need for Non-conventional machining processes.						
CO 2	Students will be able to know about the constructional features, performance parameters, process characteristics, applications, advantages and limitations of USM.						
CO 3	Students will be able to know about the constructional features, performance parameters, process characteristics, applications, advantages and limitations of AJM, WJM and AWJM.						
CO 4	Students will be able to identify the need of chemical and electro-chemical machining processes along with the constructional features, process parameters, process characteristics, applications, advantages and limitations.						
CO 5	Students will be able to explain the constructional feature of the equipment, process parameters, process characteristics, applications, advantages and limitations EDM, LBM and EBM.						

UNIT-I

Introduction to non-conventional machining: Introduction to non-conventional machining(NCM) processes, characteristics of conventional machining processes, characteristics of non-conventional machining processes, need for development of non-conventional machining processes, comparison of conventional and non-conventional machining processes, , classification of non-conventional machining processes, history of non-conventional processes, advantages of non-conventional machining processes, disadvantages of non-conventional machining processes, applications of non-conventional machining processes.

Ultrasonic machining (USM): process principle, equipment, design consideration for tool, tool feed mechanism, abrasive slurry, Liquid media, operation of USM, process parameters, process capabilities, mechanics of cutting in USM applications of USM, advantages of USM, disadvantages of USM, Mechanics of cutting in USM, ultrasonic welding

UNIT-II

Abrasive jet machining (AJM): process principle, equipment, process parameters, process capabilities, applications of AJM, advantages of AJM, disadvantages of AJM, Mechanics of cutting in AJM.

Water jet machining (WJM): process principle, equipment, process parameters, process capabilities, Metal removal rate, applications of WJM, advantages of WJM, disadvantages of WJM.
Abrasive water jet machining (AWJM): process principle, equipment, process parameters, process capabilities, Metal removal rate, applications of AWJM, advantages of AWJM, disadvantages of AWJM.

UNIT-III

Chemical machining: Introduction, process principle, five steps of chemical machining, elements of process, Influence of etchant medium, selection of maskant and etchants, chemical blanking, accuracy of chemical blanking, applications of chemical machining, advantages of chemical machining, disadvantages of chemical machining, chemical milling, photochemical machining.
Electrochemical machining (ECM): classification of ECM processes, fundamental principles of ECM, elements of ECM process, electro-chemistry of ECM process, process parameters, process characteristics, tool design, accuracy, determination of metal removal rate, evaluation of metal removal rate of an alloy, surface finish and work material characteristics, economic consideration, advantage, limitation and application, basics of electrochemical grinding, deburring and honing.

UNIT-IV

Electric discharge machining (EDM): Principal and metal removal mechanism, generators, electrode feed control, electrode material, tool electrode tool design, EDM wire cutting, surface finish, accuracy and application.
Laser beam machining (LBM): Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations.
Electron beam machining (EBM): Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.

Text Books:

1. Unconventional Machining processes- T. Jagdeesha, I.K. International Publishing house
2. Advanced Machining processes- V.K. Jain, Allied Publishers private Ltd.
3. Unconventional Manufacturing process- M.K. Singh, New Age International
4. Modern machining processes – P.C. Pandey and M.S. Shan, TMH

Reference Books:

1. Non-traditional Manufacturing Processes –G.F. Benedict, Marcel Dekker,Inc.
2. Advanced Method of Machining –J.A. McGeough, Chapman and Hall.
3. Electrochemical Machining of Metals –Ruryantsev & Davydov, Mir Pub.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (8th Semester) Mechanical Engineering							
MEP-404	**AUTOMOBILE ENGINEERING**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The objective of this course is to enable the students to understand various automobiles and their components. Also to describe the steering geometry, components and the mechanism involved in the automobile.						
Course Outcomes							
CO1	Students will be able to understand the basics of the engine cylinder and functions of the clutch.						
CO2	Students will be able to explain the working of the gearbox, transmission, and new safety features etc.						
CO3	Students will be able to describe how the rear axle, brake systems and wheel operate.						
CO4	Students will be able to understand the steering geometry and suspension system.						

UNIT-I

Introduction: Classification of automobile engines, use of engines, merits and demerits of vertical and horizontal engines, reasons for using single-cylinder two-stroke air-cooled petrol engine on two-wheelers, reasons for using multi-cylinder diesel engine for commercial vehicles, merits and demerits of two-stroke and four-stroke cycle engines, advantages of a multi-cylinder engine for the same power.

Clutch: Introduction, function of a clutch, main parts of a clutch, clutch types, clutch actuating mechanism, clutch construction, driven member-(friction or clutch disc), automatic transmission devices, troubleshooting/service procedures.

UNIT-II

Gear box: Introduction, type of gear boxes, three speed gearbox, merits and demerits of gear boxes, gear shifting mechanisms, epicyclic gearbox, gear reduction, overdrive, Maruti 800 gear box, five-speed gearbox, six speed gearbox.

Propeller shaft, universal joint and other features: Introduction, drive mechanism from gearbox to final drive in cars, propeller shaft (constructional features), shaft, universal joints, centre bearing in propeller shaft drive, propeller shaft, problems, ABS, GPS vehicle tracking, autonomous emergency braking (AEB), automatic transmission, electronic stability control (ESC), forward collision warning.

UNIT-III

Rear axle assembly: Introduction, purpose of the final drive, final drive requirements, the final drive, the differential, axle housing, maintenance of rear axle, troubleshooting in differentials.

Brake system: Introduction, functions of a brake, requirements of a brake system, brake actuating mechanism, leading and trailing shoes, classification of brakes, tandem master cylinder, drum brakes, self-energized brakes, disc brakes, floating-caliper brakes, power brakes, air-hydraulic brakes, air brake system, emergency and parking brakes.

Wheel and tyre: Introduction, types of automobile wheels, tyres, types of tyres, tyre tread, tyre selection, tyre service parameters, tyre maintenance.

UNIT-IV

Suspension system: Introduction, brief history, need for a good suspension system, stages in suspension system, elements of a suspension system, suspension systems, suspension system maintenance and troubleshooting, inspection and service of suspension system (general), troubleshooting of suspension systems.

Steering and front axle: Function of the steering system, steering gears, steering mechanisms used in some Indian vehicles, steering linkage, steering wheel and column, front axle, steering heads, steering geometry, wheel alignment, adjusting steering angles, Ackerman linkage, power Steering, under steering and over steering, steering lock, turning radius.

Text Books:

1. Automobile Engineering -By K.M. Gupta, Umesh Publications.
2. Automobile Engineering- Sudheer kumar, University Science Press.
3. Automobile Engineering- K.K Jain, Tata McGraw-Hill Publishing Company Limited.

Reference Books:

1. The Motor Vehicle - By Newton, Steeds and Garrett Basic.
2. Automobile Engineering - By Kirpal Singh, Standard Publication.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (8th Semester) Mechanical Engineering							
MEP-406	**PRODUCT DESIGN AND MANUFACTURING**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The objective of the course is to understand the importance of design factors, manufacturing, assembly and environmental guidelines, prototyping and patenting requirements in product design, manufacturing, development and economics.						
Course Outcomes							
CO1	Students will be able to describe the concept of product design, design considerations, design practiced by the industry, production and marketing, and aesthetics.						
CO2	Students will be able to explain and apply manufacturing, assembly and environmental guidelines in product design, manufacturing and development.						
CO3	Students will be able to apply the value engineering concepts in product designing and will be able to understand the application of prototyping in product design.						
CO4	Students will be able to explain the patenting, and intellectual property. They will also be able to understand the manufacturing and economic aspects related to a product.						

UNIT-I

Introduction: Introduction to product design, design by evolution and innovation, essential factors of product design, production consumption cycle, flow and value addition in production consumption cycle, morphology of design (the seven phases)

Product design practice and industry: Product strategies, time to market, analysis of the product, the three s's, designer and his role, myth and reality, basic design considerations, problems faced by industrial designer, role of aesthetics in product design.

UNIT-II

Design for manufacture and assembly: Overview and motivation, basic method: design guidelines: design for assembly, design for piece part production, advanced method: manufacturing cost analysis, cost driver modeling, critique for design for assembly method.

Design for the environment: Environmental objectives, basic DFE methods, design guidelines, life cycle assessment, techniques to reduce environmental impact.

UNIT-III

Value engineering: Value, nature and measurement of value, maximum value, normal degree of value, importance of value, value analysis job plan, creativity, steps to problem solving and value analysis, value analysis tests, value engineering idea generation checklist, cost reduction through value engineering-case study, materials and process selection in value engineering.

Prototyping: Prototyping essentials, types of prototypes, uses of prototypes, reverse engineering, rapid prototyping techniques, scale, dimensional analysis, and similitude, basic method: physical prototype design and planning- guidelines for prototype design, sample prototype application, 3-D printing.

UNIT-IV

Patents and intellectual property: What is intellectual property? Overview of patents, utility patents, invention disclosure.

Product development economics: Elements of economic analysis, base case financial model, sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.

Text Books:

1. Product Design and Development-Karl T. Ulrich and Steven D Eppinger, TMH.
2. Product Design and Engineering-A. K. Chitale and Gupta, PHI.

Reference Books:

1. Product Design and Process Engineering-Niebel and Draper, McGraw-Hill.
2. Product Design-Techniques in Reverse Engineering and New Product Development- Kevin Otto and Kristin Wood, Pearsons.

Note: The paper setter will set the paper as per the question paper templates provided.

B. Tech. (8th Semester) Mechanical Engineering							
MEP-408	**WELDING TECHNOLOGY**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	To expand the student's knowledge base and practical aspects in various areas of welding processes.						
Course Outcomes							
CO 1	Students will be able to explain the applications of welding and allied processes in various industries.						
CO 2	Students will be able to select arc welding power source and process parameters based on particular applications.						
CO 3	Students will be able to describe working of various gas welding equipment and will be able to suggest weld positions based on the application.						
CO 4	Students will be able to test weld for different defects and learn about the performance of TIG welding of aluminium and MIG welding of steels.						

UNIT-I

Introduction to welding technology: History of metal-working, early developments in welding, development of modern welding, functions of welding in industries, application of welding in different industries

Welding and allied processes: Fusion welding, electric resistance welding, solid phase welding, braze welding, thermal cutting, thermal spraying, welding compared to riveting and casting.

UNIT-II

Arc welding process and equipment: Working principle of arc welding processes, static characteristics curves, open circuit voltage, current rating and duty cycles, classes of insulation, power factor.

Different types of AC and DC power sources, arc welding transformers; methods to control welding current in welding transformers, arc welding generators, arc welding rectifiers comparison of power source, factors for selection of power sources.

Special power sources; universal type, multi-operator type, solid state power source, inverter based multi-process power source units.

UNIT–III

Gas welding process and equipment: Working principle of gas welding process, gases used, welding flames, setup and equipment, gas cylinders, handling fuel and oxygen cylinders, pressure regulators, hoses, welding torch; selection of welding torch tip size, torch lighters, lighting equal pressure type torch, lighting injector type welding torch, torch adjustments, shutting off torch, torch position and movements, puddling, types of oxy-acetylene welds made without the use of welding rod and with the use of welding rod, selection of welding rod size, welding positions, trolleys, filler rod and fluxes, protective equipment and clothing.

UNIT–IV

Inspection and testing welds: Non-destructive tests, destructive tests, visual inspection, magnetic particle inspection, liquid particle inspection, ultrasonic inspection, X-ray inspection, eddy current inspection, inspecting welds using pneumatic and hydraulic pressure, bend tests, impact tests, laboratory methods of testing welds

TIG welding of aluminum and magnesium: TIG equipment for aluminium, clean the parts using caustic cleaners and scouring pads, heat transfer in aluminium, aluminium arcing, balling tungsten, welding machine settings, striking the arc, aluminium weld procedure, square wave welders, TIG welding magnesium, TIG welding aluminium cylinder heads, weld fixture.

MIG welding of steel and stainless steel: Metal transfer modes, wire size, starting to MIG weld, aircraft seat welding, stress relieving, MIG welding tips, MIG welding stainless steel, backside protection, MIG welding titanium

Text books:

1. Welding Principle and Practices- Edward R. Bohnart, McGraw-Hill Publications.
2. Modern Arc Welding Technology -S.V. Nadkarni, Oxford and IBH Publishing Pvt. Ltd.
3. Modern Welding - Althouse, Goodheart Willcox co. Inc.
4. Performance Welding Handbook - Robert Finch, MBI publishing company.
5. Welding Processes and Technology - O.P. Khanna, Dhanpat rai publications
6. Welding Science and Technology- Ibrahim Khan, New Age International Publishers.
7. Welding Processes and Technology - R.S. Parmar, Khanna Publishers

Reference books:

1. Welding - A.C. Davies, Cambridge University Press.

Note: The paper setter will set the paper as per the question paper template provided.

	B. Tech. (8th Semester) Mechanical Engineering						
MEP-410	**DESIGN OF PRESSURE VESSELS AND PIPING**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The course aims to impart basic knowledge of design of pressure vessels and piping system. It is also aimed to introduce various standards used for the pressure vessel design.						
Course Outcomes							
CO1	Students will be able to analyze thin plates and shells for various types of stresses.						
CO 2	Students will be able to design shells, end closures and tall cylinder columns of pressure vessels.						
CO 3	Students will be able to explain the buckling and fracture in the pressure vessel.						
CO 4	Students will be able to design piping systems and explain the piping code, behavior and support.						

Unit-I

Stresses in pressure vessels: General theory of membrane stresses in vessel under internal pressure and its application to shells (cylindrical, conical and spherical) and end closures, bending of circular plates and determination of stresses in simply supported and clamped circular plate, thermal stresses, stress concentration in plate having circular hole due to bi-axial loading, excessive elastic deformation, plastic instability, brittle rupture and creep, theory of reinforced opening and reinforcement limits.

Unit-II

Design of vessels: Design of tall cylindrical self-supporting process columns, supports for short vertical vessels, stress concentration: at a variable thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings, theory of reinforcement, pressure vessel design.

Unit-III

Buckling and fracture analysis in vessels: Buckling phenomenon, elastic buckling of circular ring and cylinders under external pressure, collapse of thick walled cylinders or tubes under external pressure, effect of supports on elastic buckling of cylinders, buckling under combined external pressure and axial loading, control and significance of fracture mechanics in vessels, FEM application

UNIT-IV

piping design: Flow diagram, Piping layout and piping stress analysis; Flexibility factor and stress intensification factor; Design of piping system as per B 31.1 piping code. Piping components - bends, tees, bellows and valves. Types of piping supports and their behaviour; Introduction to piping Codes and Standards.

Text Book:

1. Theory and Design of Pressure Vessels-John F. Harvey, CBS Publishers and Distributors, 1987.
2. American Standard Code for Pressure Piping, B 31.1", ASME.

3. Pressure Vessel Design Handbook-Henry H Bednar, CBS publishers and distributors
4. Chemical Process Equipment, Selection and Design-Stanley M Wales, Butterworths, Series in Chemical Engineering, 1988. Elsevier.
5. Pressure Vessels: ASME Code Simplified-J. Phillip Ellenberger, ASME.
6. Fundamentals of Piping Design-Smith P, Elsevier.

Reference Books:

1. Pressure Vessels, Design Hand Book-Henry H. Bedner, CBS Publishers and Distributors, 1987.
2. Chemical Process Equipment, Selection and Design-Butterworths series in Chemical Engineering", Stanley, M. Wales, 1988
3. Pressure Vessel Design-Harvey J F, CBS Publication.
4. Process Equipment Design-Brownell L. E and Young. E. D, Wiley Eastern Ltd., India
5. ASME Pressure Vessel and Boiler Code-Section VIII Div. 1, 2, and 3", ASME.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech (8th Semester) Mechanical Engineering							
MEP-412	**QUALITY AND RELIABILITY ENGINEERING**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The purpose of this course is to provide students with an in-depth knowledge of quality and reliability. The course addresses the principles and techniques of Statistical Quality Control and their practical uses as well as give insight to modern reliability engineering tools.						
Course Outcomes							
CO1	Students will be able to understand the concept of quality value and engineering and application of statistical methods for quality control. The student will also be able to solve the problems related with dispersion of data.						
CO2	Students will be able to understand different control charts and will solve the problems on control charts. They will also understand various sampling plans and design sampling plans.						
CO3	Students will be able to explain the loss function and tolerance design for online quality control. They will come to know the concept of reliability and will be able to understand the mathematical derivations of different failure rates.						
CO4	Students will be able to describe various hazard models and solve problems for finding reliability of complex systems.						

UNIT-I

Quality value and engineering: Quality systems, quality engineering in product design and production process, system design, parameter design, tolerance design, statistical methods for quality control and improvement, mean, median, mode, standard deviation, calculating area, Normal distribution tables, finding the Z score, Central limit theorem.

UNIT-II

Variation in process: Control charts for variables: X-bar and R charts, Control charts for attributes P, C and U-Chart, Establishing and interpreting control charts process capability, Quality rating, Short run SPC.

Acceptance sampling by variables and attributes, single, double, sequential and continuous sampling plans, design of various sampling plan.

UNIT–III

Loss function, tolerance design: N type, L type, S type; determination of tolerance for these types, online quality control – variable characteristics, attribute characteristics, parameter design.

Concept and definition of reliability: Reliability Parameters: Reliability as a function of time, failure rate as a function of time, Bath-tub curve, constant failure rate, increasing failure rate, mean time to failure (MTTF), MTTF as a function of failure rate, mean time between failure (MTBF), mean down time (MDT), maintainability & availability

UNIT–IV

Brief discussion on hazard models: Constant hazard model, linearly increasing hazard model, nonlinear hazard model and Weilbull distribution, Advantages of weibull distribution, System reliability models: series system, parallel system, series-parallel system

Complex system: Reliability of series, parallel & standby systems & complex systems & reliability prediction and system effectiveness, reliability testing

Text books:

1. Reliability Engineering, (3rdEdition) - LS Srinath, Affiliated East West Pvt Ltd, 1991..
2. Reliability Engineering- E. Bala Guruswamy, Tata McGraw Hill, 1994.
3. Statistical Quality Control- M. Mahajan, Dhanpat Rai & Co., 2018.
4. Statistical Process Control- Eugene Grant, Richard Leavenworth, McGraw Hill.

Reference books:

1. Introduction to Reliability Engineering- Lewis E. E., John Wiley & Sons - 1987
2. Reliability Based Design-Rao S. S., McGraw Hill - 1992
3. Practical Reliability Engineering- O'cconer P. D. T., John Wiley & Sons Ltd. - 2003
4. Statistical Quality Control-Eugene G. L., McGraw-Hill - 1996

Note: The paper setter will set the paper as per the question paper template provided.