Departmental Curriculum

First Year First Semester							
Mandatory Induction Program- 3 weeks duration							
Sl No.	**Category**	**Subject Code**	**Subject Name**	**Total No. of contact hours**			**Credits**
				L	**T**	**P**	
Theory							
1	Basic Science course	BS-PH101	Physics-I	3	1	0	4
2	Basic Science course	BS-M102	Mathematics –IB	3	1	0	4
3	Engineering Science Courses	ES-EE101	Basic Electrical Engineering	3	1	0	4
	Total Theory			**9**	**3**	**0**	**12**
Practical							
1	Basic Science course	BS-PH191	Physics-I Laboratory	0	0	3	1.5
2	Engineering Science Courses	ES-EE191	Basic Electrical Engineering Laboratory	0	0	2	1
3	Engineering Science Courses	ES-ME192	Workshop/Manufacturing Practices	1	0	4	3
	Total Practical			**1**	**0**	**9**	**5.5**
			Total of First Semester	**10**	**3**	**9**	**17.5**

First Year Second Semester							
Sl No.	**Category**	**Subject Code**	**Subject Name**	**Total No. of contact hours**			**Credits**
				L	**T**	**P**	
Theory							
1	Basic Science course	BS-CH201	Chemistry-I (Gr-A)	3	1	0	4
2	Basic Science course	BS-M202	Mathematics –IIB	3	1	0	4
3	Engineering Science Courses	ES-CS201	Programming for Problem Solving	3	0	0	3
4	Humanities and Social Sciences including Management courses	HM-HU201	English	2	0	0	2
	Total Theory			**11**	**2**	**0**	**13**
Practical							
1	Basic Science course	BS-CH291	Chemistry-I Laboratory	0	0	3	1.5

2	Engineering Science Courses	ES-CS291	Programming for Problem Solving	0	0	4	2
3	Engineering Science Courses	ES-ME291	Engineering Graphics & Design (Gr-A)	1	0	4	3
4	Humanities and Social Sciences including Management courses	HM-HU291	Language Laboratory	0	0	2	1
	Total Practical			**1**	**0**	**13**	**7.5**
			Total of Second Semester	**12**	**2**	**13**	**20.5**

Second Year Third Semester							
Sl No.	**Category**	**Subject Code**	**Subject Name**	**Total No. of contact hours**			**Credits**
				L	**T**	**P**	
Theory							
1	Basic Science course	BS-M301	Mathematics III	3	1	0	4
2	Basic Science course	BS-BIO301	Biology	3	0	0	3
3	Engineering Science Courses	ES-ECE301	Basic Electronics Engineering	3	0	0	3
4	Engineering Science Courses	ES-ME301	Engineering Mechanics	3	1	0	4
5	Professional Core courses	PC-ME301	Thermodynamics	3	1	0	4
6	Professional Core courses	PC-ME302	Manufacturing Processes	4	0	0	4
	Total Theory			**19**	**3**	**0**	**22**
Practical							
1	Professional Core courses	PC-ME391	Practice of Manufacturing Processes	0	0	3	1.5
	Total Practical			**0**	**0**	**3**	**1.5**
			Total of Third Semester	**19**	**3**	**3**	**23.5**

Second Year Fourth Semester

Sl No.	Category	Subject Code	Subject Name	Total No. of contact hours			Credits
				L	T	P	
Theory							
1	Engineering Science Courses	ES-ME401	Materials Engineering	3	0	0	3
2	Professional Core courses	PC-ME401	Applied Thermodynamics	3	1	0	4
3	Professional Core courses	PC-ME402	Fluid Mechanics & Fluid Machines	3	1	0	4
4	Professional Core courses	PC-ME403	Strength of Materials	3	1	0	4
5	Professional Core courses	PC-ME404	Metrology andInstrumentation	3	1	0	4
	Total Theory			**15**	**4**	**0**	**19**
Practical							
1	Professional Core courses	PC-ME491	Practice of Manufacturing Processes and Systems Laboratory	0	0	3	1.5
2	Professional Core courses	PC-ME492	Machine Drawing- I	0	0	3	1.5
3	Mandatory courses	MC 481	Environmental Science	-	-	2	0
	Total Practical			**0**	**0**	**8**	**3**
			Total of Fourth Semester	**15**	**4**	**8**	**22**

Third Year Fifth Semester					
Sl No.	**Category**	**Subject Cod**	**Subject Name**	**Total No. of contact hours**	**Credits**

		e		L	T	P	
Theory							
1	Professional Core courses	PC-ME501	Heat Transfer	3	1	0	4
2	Professional Core courses	PC-ME502	Solid Mechanics	3	1	0	4
3	Professional Core courses	PC-ME503	Kinematics & Theory of Machines	3	1	0	4
4	Humanities and Social Sciences including Management courses	HM-HU501	Effective Technical Communication	3	0	0	3
5	Mandatory courses	MC501	Essence of Indian Knowledge Tradition	-	2	-	0
	Total Theory			**12**	**5**	**0**	**15**
Practical/ Sessional							
1	Professional Core courses	PC-ME591	Mechanical Engineering Laboratory I (Thermal)	0	0	3	1.5
2	Professional Core courses	PC-ME592	Machine Drawing-II	0	0	3	1.5
3	Project (Summer internship)	PW-ME581	Project-I (30 hrs. Total)	0	0	2	1
	Total Practical			**0**	**0**	**8**	**4**
	Total of Fifth Semester			**12**	**5**	**8**	**19**

Third Year Sixth Semester							
Sl No.	**Category**	**Subject Code**	**Subject Name**	**Total No. of contact hours**			**Credits**
				L	**T**	**P**	
Theory							
1	Professional Core courses	PC-ME601	Manufacturing Technology	4	0	0	4
2	Professional Core courses	PC-ME602	Design of Machine Elements	3	1	0	4
3	Professional Elective courses	PE-ME601	Elective-I	3	0	0	3
4	Professional Elective courses	PE-ME602	Elective-II	3	0	0	3

5	Humanities and Social Sciences including Management courses	HM-HU601	Operations Research	3	0	0	3
6	Mandatory courses	MC601	Constitution of India	-	2	-	0
	Total Theory			**16**	**3**	**0**	**17**
Practical/ Sessional							
1	Professional Core courses	PC-ME691	Mechanical Engineering Laboratory II (Design)	0	0	3	1.5
2	Project (or Summer internship)	PW-ME681	Project-II (90 hrs. Total)	0	0	4	2
	Total Practical			**0**	**0**	**7**	**3.5**
	Total of Sixth Semester			**16**	**3**	**7**	**20.5**

List of Professional Electives in Semester VI for (Elective-I) PE-ME 601 and (Elective-II) PE-ME602

Subject Code	Subject name
Thermo-Fluid Group	
A	Internal Combustion Engines and Gas Turbines
B	Refrigeration and Air Conditioning
C	Turbo Machinery
D	Fluid Power Control
E	Advanced Fluid Mechanics
Design Group	
F	Composite Materials
G	Mechatronics
Manufacturing Group	
H	Robotics
I	Material Handling
J	Principles and Practices of Management

Note: If a student chooses the paper, **Turbo Machinery (Code: C)** as a **Professional Elective**-I in **Semester VI**, its paper code will be **PE-ME601C**.

Fourth Year Seventh Semester

Sl No.	Category	Subject Code	Subject Name	Total No. of contact hours			Credits
				L	T	P	
Theory							
1	Professional Core courses	PC-ME701	Advanced Manufacturing Technology	3	0	0	3
2	Professional Elective courses	PE-ME701	Elective III	3	0	0	3
3	Professional Elective courses	PE-ME702	Elective-IV	3	0	0	3
4	Open Elective courses	OE-ME 701	Open Elective- I	3	0	0	3
5	Humanities and Social Sciences including Management courses	HM-HU701	Economics for Engineers	2	0	0	2
	Total Theory			**14**	**0**	**0**	**14**
Practical/ Sessional							
1	Professional Core courses	PC-ME791	Mechanical Engineering Laboratory III (Manufacturing)	0	0	3	1.5
2	Project	PW-ME781	Project-III	0	0	6	3
	Total Practical			**0**	**0**	**9**	**4.5**
			Total of Seventh Semester	**14**	**0**	**9**	**18.5**

List of Professional Electives in Semester VII for (Elective-III)PE-ME701 and(Elective-IV)PE-ME702

Subject Code	Subject name
Thermo-Fluid Group	
A	Automobile Engineering
B	Gas Dynamics and Jet Propulsion
C	Computational Fluid Dynamics
D	Elements of Atmospheric Fluid Dynamics
Design Group	

E	Selection and Testing of Materials
F	Mechanical Vibration
G	Finite Element Analysis
Manufacturing Group	
H	Advanced Welding Technology
I	Quantity Production Methods
J	CAD/CAM

List of Open Electives (OE-ME701) in Semester VII

Subject Code	Subject Name
A	Industrial Engineering
B	Project Management
C	Introduction to Product Design and Development
D	Non-conventional Energy Sources
E	Biomechanics and Biomaterials
F	Computational Methods in Engineering
G	Artificial Intelligence (AI)
H	Machine Learning
I	Water Resource Engineering

Note: If a student chooses the paper, **Industrial Engineering (Code: A)** as an **Open Elective-I in Semester VII**, its paper code will be **OE-ME701A**.

Fourth Year Eighth Semester							
Sl No.	**Category**	**Subject Code**	**Subject Name**	**Total No. of contact hours**			**Credits**
				L	**T**	**P**	
Theory							
1	Professional Elective courses	PE-	Elective V	3	0	0	3

		ME801					
2	Professional Elective courses	PE-ME802	Elective VI	3	0	0	3
3	Open Elective courses	OE-ME 801	Open Elective-II	3	0	0	3
4	Open Elective courses	OE-ME 802	Open Elective- III	3	0	0	3
	Total Theory			**12**	**0**	**0**	**12**
Practical/ Sessional							
1	Project	PW-ME881	Project-IV	0	0	10	5
2	Professional Core courses	PW-ME882	Comprehensive viva	0	0	0	1.5
	Total Practical			**0**	**0**	**10**	**6.5**
			Total of Eighth Semester	**12**	**0**	**10**	**18.5**
Total Credit							**160**

List of Professional Electives in Semester VIII for(Elective-V) PE-ME801 and (Elective-VI)PE-ME802

Subject Code	Subject name
Thermo-Fluid Group	
A	Analysis and Performance of Fluid Machines
B	Power Plant Engineering
C	Cryogenics
D	Introduction to Wind Engineering
Design Group	
E	Tribology
F	3DPrintingandDesign
Manufacturing Group	
G	Micro and Nano Manufacturing
H	Process Planning and Cost Estimation
I	Maintenance Engineering

List of Open Electives (OE-ME801andOE-ME802) in Semester VIII

Subject Code	Subject Name
A	Total Quality Management
B	Entrepreneurship Development
C	Safety and Occupational Health
D	Industrial Pollution and Control
E	Energy Conservation and Management
F	Waste to Energy-An Overview
G	Automation & Control
H	Internet of Things(IoT)
I	Block Chain
J	Cyber Security
K	Quantum Computing
L	Data Sciences
M	Virtual Reality(VR)

Department of Mechanical Engineering

Syllabus & Course Outcomes

1st Semester

BS-CH101: Chemistry-I

Course Code : BS-CH101 **Course**
Title : Chemistry-I **L-T-P**
: 3-1-0
Category **:** Basic Science Courses
Semester : First
Credit 4
Stream **:** B. Tech. (For EE and ECE).
Full Marks : 100 (30 for Continuous Evaluation; 70 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the learner will be able to:

COURSE OUTCOMES (COs)	
CODE	**DESCRIPTION**
BS-CH101.CO 1	Analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces and list major chemical reactions that are used in the synthesis of molecules
BS-CH101.CO 2	Rationalise bulk properties and processes using thermodynamic considerations

BS-CH101.CO 3	Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
BS-CH101.CO 4	Rationalise periodic properties such as ionization potential, electronegativity, oxidation states andelectronegativity.

CO-PO Mapping

Co & PO Mapping BS-CH101 to PO attainment

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	3	3	2	3	2	1	2	1	1	2	2
CO2	3	3	3	2	3	3	-	1	1	-	-	3
CO3	3	3	3	3	2	2	2	1	2	3	3	1
CO4	3	3	3	3	1	3	1	-	1	-	1	1
Average	2.75	3	3	2.5	1.5	2.25	1.33	1.33	1.25	2.0	2.0	1.75

Syllabus (BS-CH101)

Unit I: Atomic and molecular structure

Schrodinger equation. Particle in a box solutions and their applications for simple sample. Molecular orbitals of diatomic molecules (e.g.H2). Energy level diagrams of diatomic. Pi- molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

Unit II: Spectroscopic techniques and applications

Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications inmedicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magneticresonance and magnetic resonance imaging, surface characterisation techniques. Diffraction and scattering

Unit III: Intermolecular forces and potential energy surfaces

Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena.

Unit IV: Use of free energy in chemical equilibria

First and second laws of thermodynamics and thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams.

Unit V: Periodic properties

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

Unit VI: Stereochemistry

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and

chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds

Unit VII: Organic reactions and synthesis of a drug molecule

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

molecule.

Books

Learning Resources:

- Engineering Chemistry, Satyaprakash, Khanna Book Publishing, Delhi
- Fundamentals of Molecular Spectroscopy, by C. N. Banwell
- Physical Chemistry, by P. W. Atkins
- Spectroscopy of Organic Compounds, by P.S.Kalsi, New Age International Pvt Ltd Publishers
- Physical Chemistry, P. C. Rakshit, Sarat Book House
- Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition

BS-PH101: Physics

Course Code : BS-PH101 **Course Title** : Physics-I **L-T-P** : 3-1-0
Category **:** Basic Science Courses
Semester : First
Credit 4
Stream **:** B. Tech. (All branches except EE and ECE). **Full Marks** : 100 (30 for Continuous Evaluation; 70 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the learner will be able to:

COURSE OUTCOMES (COs)	
CODE	DESCRIPTION

BS-PH101.CO1	Learn basic concepts of quantum physics, simple quantum mechanics calculations; Macrostate, Microstate, Density of states, Qualitative treatment of MB, FD and BE statistics.
BS-PH101.CO2	Solve problems including constraints & friction. Basic ideas of vector calculus and partial differential equations. Harmonic oscillator. Damped harmonic motion forced oscillations and

	Resonance. Motion of a rigid body.
BS-PH101.CO3	Learn the application of wave properties of light Interference, Diffraction and Polarization; Lasers: Principles and working of laser
BS-PH101.CO4	Learn Maxwell's equations. Polarization, Dielectrics; Magnetization, magnetic-hysteresis.

CO-PO Mapping

CO–PO Mapping BS-PH101 to PO attainment

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	2	2	1	2	-	-	2	1	2
CO 2	3	3	3	2	2	1	2	-	-	2	1	2

CO	3	3	3	3	2	1	2	-	-	2	1	2

3												
CO 4	3	3	3	2	2	1	2	-	-	2	1	2

Syllabus

UNIT 1. Mechanics

Problems including constraints & friction. Basic ideas of vector calculus and partial differential equations. Potential energy function F = -grad V, equipotential surfaces and meaning of gradient. Conservative and non-conservative forces. Conservation laws of energy & momentum. Non-inertial frames of reference. Harmonic oscillator; Damped harmonic motion forced oscillations and resonance. Motion of a rigid body in a plane and in 3D. Angular velocity vector. Moment of inertia.

UNIT 2. Optics

Distinction between interference and diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits (only the expressions for max;min, & intensity and qualitative discussion of fringes); diffraction grating(resolution

formulae only), characteristics of diffraction grating and its applications.

Polarization: Introduction, polarization by reflection, polarization by double reflection, scattering of light, circular and elliptical polarization, optical activity.

Lasers: Principles and working of laser – population inversion, pumping, various modes, threshold population inversion with examples

UNIT 3. Electromagnetism and Dielectric Magnetic Properties of Materials

Maxwell's equations, Polarization, permeability and dielectric constant, polar and non-polar

Dielectrics, internal fields in a solid, Clausius-Mossotti equation (expression only), applications of dielectrics.

Magnetization: permeability and susceptibility, classification of magnetic materials, ferromagnetism, magnetic domains and hysteresis, applications.

UNIT 4. Quantum Mechanics

Introduction to quantum physics, black body radiation, explanation using the photon concept, Compton effect, de Broglie hypothesis, wave-particle duality, verification of matter waves, uncertainty

principle, Schrodinger wave equation, particle in box, quantum harmonic oscillator, hydrogen atom.

UNIT 5. Statistical Mechanics

Macrostate, Microstate, Density of states, Qualitative treatment of Maxwell Boltzmann, Fermi-Dirac and Bose-Einstein statistics.

Books

Learning Resources:

1. Introduction to Electrodynamics, David J. Griffiths, Pearson Education India Learning Private Limited
2. Principles of Physics, 10ed, David Halliday, Robert Resnick Jearl Walker, Wiley
3. Electricity, Magnetism, and Light, Wayne M. Saslow, Academic Press
4. Engineering Mechanics (In SI Units) (SIE), S. Timoshenko, D.H. Young, J.V. Rao, Sukumar Pati , McGraw Hill Education
5. Classical mechanics, Narayan Rana, Pramod Joag, McGraw Hill Education
6. Introduction to Classical Mechanics, R Takwale, P Puranik, McGraw Hill Education
7. Engineering Mechanics, M.K. Harbola, Cengage India

8. An Introduction to Mechanics (SIE), David Kleppner, Robert Kolenkow, McGraw Hill Education
9. Principles of mechanics, John L. Synge and Byron A. Griffith, New York, McGraw-Hill
10. Mechanics (Dover Books on Physics) , J. P. Den Hartog , Dover Publications Inc.
11. Engineering Mechanics: Dynamics, L.G. Kraige J.L. Meriam, Wiley
12. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Robert Eisberg, Robert Resnick, Wiley
13. Introduction to Quantum Mechanics, J. Griffiths David , Pearson Education
14. Modern Quantum Mechanics, J. J. Sakurai, Cambridge University Press
15. Optics , Hecht, Pearson Education
16. Optics, Ghatak, McGraw Hill Education India Private Limited
17. Fundamentals of Statistical and Thermal Physics, Reif, Sarat Book Distributors
18. Statistical Mechanics , Pathria , Elsevier
19. Statistical Physics, L.D.Landau , E.M. Lifshitz, Butterworth-Heinemann

BS-M101: Mathematics - IA

Course Code : BS-M101 **Course Title** : Mathematics - IA **L-T-P** : 3-1-0
Category **:** Basic Science Courses
Semester : First
Credit 4
Stream **:** B. Tech. (For CSE).
Full Marks : 100 (30 for Continuous Evaluation; 70 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the student will be able to:

COURSE OUTCOMES (COs)	
CODE	**DESCRIPTION**
BS-M 101.CO 1	Apply the concept and techniques to differential and integral calculus to determine curvature and evaluation of different types of improper integrals.
BS-M 101.CO 2	Understand the domain of applications of mean value theorems to engineering problems.
BS-M 101.CO 3	Learn different types of matrices, concept of rank, methods of matrix inversion and their applications.
BS-M 101.CO 4	Understand linear spaces, its basis and dimension with corresponding applications in the field of computer science.
BS-M 101.CO 5	Learn and apply the concept of Eigen values, Eigen vectors, Diagonalization of matrices and Orthogonalization in inner product spaces for understanding physical and engineering problems.

CO-PO Mapping

Co & PO Mapping BS-M101 to PO attainment

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	3	2	1	1	1	-	2	-	2	2
CO2	3	3	2	1	2	2	2	-	1	-	-	1
CO3	3	3	2	2	2	2	2	-	2	-	2	2
CO4	3	3	2	2	3	2	2	-	-	-	1	2
CO5	3	3	3	2	1	1	-	-	-	-	2	1
Average	3	3	2.4	1.8	1.8	1.6	1.75		1.67		1.75	1.6

Syllabus (BS-M101)

Syllabus

Module 1: Calculus (Integration) [8L]

Evolutes and involutes; 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.

Module 2: Calculus (Differentiation) [6L]

Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin's theorems with remainders; Indeterminate forms and L'Hospital's rule; Maxima and minima.

Module 3: Matrices [7L]

Matrices, Vectors: addition and scalar multiplication, matrix multiplication; Linear systems of equations, linear Independence, rank of a matrix, determinants, Cramer's Rule, inverse of a matrix, Gauss elimination and Gauss-Jordan elimination.

Module 4: Vector Spaces [9L]

Vector Space, linear dependence of vectors, Basis, Dimension; Linear transformations (maps), Range and Kernel of a linear map, Rank and Nullity, Inverse of a linear transformation, Rank-Nullity theorem, composition of linear maps, Matrix associated with a linear map.

Module 5: Vector Spaces (Continued) [10L]

Eigenvalues, Eigenvectors, Symmetric, Skew-symmetric, and Orthogonal Matrices, Eigenbases. Diagonalization; Inner product spaces, Gram-Schmidt orthogonalization.

Books

Learning Resources:

1. Reena Garg, Engineering Mathematics-I, Khanna Publishers.

2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.

3. Michael Greenberg, Advanced Engineering Mathematics, Pearson.

4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.

5. Kanti B. Dutta, Mathematical Methods of Science and Engineering,

Cenage Learning.

6. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, NewDelhi.

7. S.K. Mapa, Higher Algebra: Abstract and Linear, Sarat Book House Pvt.Ltd.

8. Hoffman and Kunze: Linear algebra, PHI.

BS-M102: Mathematics - IB

Course Code : BS-M102 **Course Title**

: Mathematics - IB **L-T-P**

: 3-1-0

Category **:** Basic Science Courses

Semester : First

Credit 4

Stream **:** B. Tech. (For Except CSE).

Full Marks : 100 (30 for Continuous Evaluation; 70 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the student will be able to:

COURSE OUTCOMES (COs)	
CODE	**DESCRIPTION**
BS-M 102.CO 1	Apply the concept and techniques of differential and integral calculus to determine curvature and evaluation of different types of improper integrals.
BS-M 102.CO 2	Understand the domain of applications of mean value theorems to engineering problems.
BS-M 102.CO 3	Learn the tools of power series and Fourier series to analyze engineering problems and apply the concept of convergence of infinite series in many approximation techniques in engineering disciplines.

BS-M 102.CO 4	Apply the knowledge for addressing the real life problems which comprise of several variables or attributes and identify extremum points of different surfaces of higher dimensions.
BS-M 102.CO 5	Learn and apply the concept of rank-nullity, eigen values, eigen vectors, diagonalization and orthogonalization of matrices for understanding physical and engineering problems.

CO-PO Mapping

CO & PO Mapping BS-M102 to PO attainment

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	3	2	2	2	2	-	-	1	2	2
CO2	3	3	2	2	2	2	-	-	2	-	1	2
CO3	3	3	3	2	2	-	2	-	2	1	-	1
CO4	3	3	2	2	3	2	-	-	-	-	2	2
CO5	3	3	2	2	2	2	1	-	1	1	2	1
Average	3	3	2.4	2	2.2	2	1.67	-	1.67	1	1.75	1.6

Syllabus (BS-M102)

Syllabus

Module 1: Calculus (Integration) [8L]

Evolutes and involutes; 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.

Module 2: Calculus (Differentiation) [6L]

Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin's theorems with remainders; Indeterminate forms and L'Hospital's rule; Maxima and minima.

Module 3: Sequence and Series [11L]

Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

Module 4: Multivariate Calculus [9L]

Limit, continuity and partial derivatives, Directional derivatives, Total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, Curl and Divergence.

Module 5: Matrices [8L]

Inverse and rank of a matrix, Rank-nullity theorem; System of linear equations; Symmetric, Skew-symmetric and Orthogonal matrices; Determinants; Eigenvalues and Eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.

Books

Learning Resources:

1. Reena Garg, Engineering Mathematics-I, Khanna Publishers.

2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.

3. Michael Greenberg, Advanced Engineering Mathematics, Pearson.

4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.

5. Kanti B. Dutta, Mathematical Methods of Science and Engineering, Cenage Learning.

6. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, NewDelhi.

ES-EE101: Basic Electrical Engineering

Course Code : ES-EE101
Course Title : Basic electrical enginnering
L-T-P : 3-1-0
Category **:** Engineering Science Courses
Semester : First
Credit 4

Stream : B. Tech.

Full Marks : 100 (30 for Continuous Evaluation; 70 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the student will be able to:

Course outcome codes	Statement
ES-EE-101.1	To describe fundamentals of DC and AC circuits
ES-EE-101.2	To explain the operating principle of transformer
ES-EE-101.3	To illustrate construction, working of Electrical Machines
ES-EE-101.4	To classify different power converters and installation process

CO-PO Mapping

Co & PO Mapping ES-EE101 to PO attainment

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
ESEE-101.1	3	2	2	2	2	2	1	-	2	2	2	3	2	2
ESEE-101.2	3	2	2	2	2	2	1	-	2	2	2	3	2	2

ESEE-101.3	3	2	2	2	2	2	1	-	2	2	2	3	2	2
ESEE-101.4	3	2	2	2	2	2	1	-	2	2	2	3	2	2
Average	3	2	2	2	2	2	1	-	2	2	2	3	2	2

Syllabus (ES-EE101)

Module 1: DC Circuits

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.

Module 2: AC Circuits

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

Module 3: Transformers

Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

Module 4: Electrical Machines

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators.

Module 5: Power Converters

DC-DC buck and boost converters, duty ratio control. Single-phase and three-phase voltage source inverters; sinusoidal modulation.

Module 6: Electrical Installations

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Books

1. Ritu Sahdev, Basic Electrical Engineering, Khanna Book Publishing Co. (P) Ltd., Delhi.
2. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
3. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
4. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
5. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
6. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

BS-CH191: Chemistry-I Lab

Course Code : BS-CH191

Course Title : Chemistry-I Laboratory

L-T-P : 0-0-3

Category **:** Basic Science Courses

Semester : First/ Second

Credit **:** 1.5

Stream **:** B. Tech. (For EE and ECE).

Full Marks : 100 (40 for Continuous Evaluation; 60 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the learner will be able to:

COURSE OUTCOMES (COs)	
CODE	**DESCRIPTION**
BS-CH191.CO 1	Analyse sample by apply instruments like viscometer, pH-meter, Conductometer, Potentiometer *etc* to achieve high accuracy.
BS-CH191.CO 2	Analyse inorganic salts by semi-micro techniques
BS-CH191.CO 3	Analyse quantitative chemicals present in different samples

CO-PO Mapping

Co & PO Mapping BS-CH191 to PO attainment

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	2	2	-	3	2	1	1
CO2	1	3	3	3	-	1	2	-	3	2	2	2
CO3	3	3	3	3	3	2	1	1	2	2	2	2
Average	2.3	3	2.6	3	3	1.6	1.6	1	2.6	2	1.6	1.6

Syllabus

1. Conductometric titration for determination of the strength of a given HCl solution by titration against a standard NaOH solution
2. pH- metric titration for determination of strength of a given HCl solution against a standard NaOH solution

3. Determination of dissolved oxygen present in a given water sample.

4. To determine chloride ion in a given water sample by Argentometric method (using chromate indicator solution)

5. Determination of surface tension and viscosity

6. Thin layer chromatography

7. Ion exchange column for removal of hardness of water

8. Determination of the rate constant of a reaction

9. Determination of cell constant and conductance of solutions

10. Potentiometry - determination of redox potentials and emfs

11. Saponification/acid value of an oil

12. Chemical analysis of a salt

13. Determination of the partition coefficient of a substance between two immiscible liquids

14. Adsorption of acetic acid by charcoal

15. Use of the capillary viscosimeters to the demonstrate of the isoelectric pointas the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg

N.B.: **Choose 10 experiments from the above 15**

Books

- Advance Practical Chemistry by Subhas C Das, Sarat Book House
- A test book of Macro and Semimicro qualitative Inorganic Analysis by I. Vogel

BS-PH191: Physics Laboratory

Course Code : BS-PH191

Course Title : Physics-I Laboratory

L-T-P : 0-0-3

Category **:** Basic Science Courses

Semester : First

Credit **:** 1.5

Stream **:** B. Tech. (All branches except EE and ECE). Full Marks : 100 (40 for Continuous Evaluation; 60 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the learner will be able to:

COURSE OUTCOMES (COs)	
CODE	**DESCRIPTION**
BS-PH191.CO1	Ability to increase power of observation and reasoning and to think and work with precision and accuracy in daily life. Use Slide callipers and screw gauge, familiar with concept of Band gap of semiconductor and dielectric constant
BS-PH191.CO2	Get the opportunity to verify the validity of various laws taught in curriculum, Familiar with dispersive power of the material of a prism, Newton's ring, Planck constant
BS-PH191.CO3	Familiar with Hall coefficient of a semiconductor Electron spin resonance spectrometer, Young's modulus, Poiseulle's capillary flow method for viscosity measurement.

CO-PO Mapping

CO–PO Mapping BS-PH191 to PO attainment

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	3	3	3	1	2	-	-	2	1	2

1												
CO 2	3	3	3	3	3	1	2	-	-	2	1	2
CO 3	3	3	3	3	3	1	2	-	-	2	1	2

Syllabus

Experiments in Optics

1. Determination of dispersive power of the material of a prism
2. Determination of wavelength of a monochromatic light by Newton's ring
3. Determination of wavelength of a monochromatic light by Fresnel's bi-prism
4. Determination of wavelength of the given laser source by diffraction method

Electricity & Magnetism experiments

1. Determination of thermo electric power of a given thermocouple.
2. Determination of specific charge (e/m) of electron by J.J. Thompson's method.
3. Determination of dielectric constant of a given dielectric material.
4. Determination of Hall coefficient of a semiconductor by four probe method.
5. To study current voltage characteristics, load response, areal characteristic and spectral response of a photovoltaic solar cell.
6. Determination of resistance of ballistic galvanometer by half deflection method and study of variation of logarithmic decrement with series resistance.
7. Determination of unknown resistance using Carey Foster's bridge
8. Study of Transient Response in LR, RC and LCR circuits using expeyes
9. Generating sound from electrical energy using expeyes

Experiments in Quantum Physics

1. Determination of Stefan-Boltzmann constant.
2. Determination of Planck constant using photocell.
3. Determination of Lande-g factor using Electron spin resonance spectrometer.
4. Determination of Rydberg constant by studying Hydrogen spectrum.
5. Determination of Band gap of semiconductor.
6. To study current voltage characteristics, load response, areal characteristic and spectral response of a photovoltaic solar cell.

Miscellaneous experiments

1. Determination of Young's modulus of elasticity of the material of a bar by the method of flexure
2. Determination of bending moment and shear force of a rectangular beam of uniform cross-section
3. Determination of modulus of rigidity of the material of a rod by static method
4. Determination of rigidity modulus of the material of a wire by dynamic method
5. To determine the moment of inertia of a body about an axis passing through its centre of gravity and to determine the modulus of rigidity of the material of the suspended wire
6. Determination of coefficient of viscosity by Poiseulle's capillary flow method

ES-EE191: Basic Electrical Engineering

Course Code : ES-EE191

Course Title : Basic Electrical Engineering Laboratory

L-T-P : 0-0-2

Category **:** Engineering Science Courses

Semester : First

Credit 1

Stream **:** B. Tech.

Full Marks : 100 (40 for Continuous Evaluation; 60 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the student will be able to:

ESEE191.1	Demonstrate the characteristics of carbon, tungsten & florescent lamps.

ESEE191.2	Verifythe different electrical parameters obtained using network theorems.
ESEE191.3	Experiment on R-L-C series & parallel circuits

CO-PO Mapping

Co & PO Mapping ES-EE191 to PO attainment

SUBJECT CODE	COs	PROGRAM OUTCOMES(POs)											
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
ESEE 191	ESEE191.1	3	2	2	2	2	2	1	-	2	2	2	3
	ESEE191.2	3	2	2	2	2	2	1	-	2	2	2	3
	ESEE191.3	3	2	2	2	2	2	1	-	2	2	2	3
	AVERAGE	3	2	2	2	2	2	1	-	2	2	2	3

Syllabus (ES-EE191)

Name of the Experiment Performed:

1. First activity: Introduction to basic safety precautions and mentioning of the do's and Don'ts. Noting

down list of experiments to be performed, and instruction for writing the laboratory reports by the

students. Group formation. Students are to be informed about the modalities of evaluation.

2. Introduction and uses of following instruments :

(a) Voltmeter

(b) Ammeter

(c) Multimeter

(d) Oscilloscope

Demonstration of real life resistors, capacitors with colorcode , inductors and autotransformer.

3. Demonstration of cut-out sections of machines: DC machine, Induction machine, Synchronous

machine and single phase induction machine.

4. Calibration of ammeter and Wattmeter.

5. Determination of steady state and transient response of R-L, R-C and R-L-C circuit to a step change in

voltage.

6. Determination of steady state response of R-L and R-C and R-L-C circuit and calculation of

impedance and power factor.

7. Determination of resonance frequency and quality factor of series and parallel R-L-C circuit.

8. (a) Open circuit and short circuit test of a single-phase transformer

(b) Load test of the transformer and determination of efficiency and regulation

9. Demonstration of three phase transformer connections. Voltage and current relationship, phase shifts

between the primary and secondary side.

10. Measurement of power in a three phase unbalanced circuit by two wattmeter method.

11. Determination of Torque –Speed characteristics of separately excited DC motor.

12. Determination of Torque speed characteristics and observation of direction reversal by change of

phase sequence of connection of Induction motor.

13. Determination of operating characteristics of Synchronous generator.

14. Demonstration of operation of (a) DC-DC converter (b) DC-AC converter (c) DC-AC converter for

speed control of an Induction motor

15. Demonstration of components of LT switchgear

ES-ME191: Engineering Graphics & Design

Course Code : ES-ME191

Course Title : Engineering Graphics & Design

L-T-P : 1-0-4

Category **:** Engineering Science Courses

Semester : First

Credit 3

Stream **:** B. Tech.

Full Marks : 100 (60 for Continuous Evaluation; 60 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the student will be able to:

CO1	Learn basics of drafting and use of drafting tools which develops the fundamental skills of industrial drawings.
CO2	Know about engineering scales, dimensioning and various geometric curves necessary to understand design of machine elements.
CO3	Understand projection of line, surface and solids to create the knowledge base of orthographic and isometric view of structures and machine
CO4	Become familiar with computer aided drafting useful to share the design model to different section of industries as well as for research & development.

CO-PO-Mapping

Co & PO Mapping ES-ME191 to PO attainment

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1	2	-	1	2	1	1	1	-	1	-	-	1
CO 2	3	-	2	2	-	1	-	-	1	1	1	1
CO 3	2	2	2	1	-	1	1	1	1	-	-	1
CO 4	1	-	2	2	2	1	-	-	1	1	1	1

Syllabus (BS-M101)

INTRODUCTION TO ENGINEERING DRAWING
Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Different types of lines and their use; Drawing standards and codes.

LETTERING, DIMENSIONING, SCALES
Plain scale, Diagonal scale and Vernier Scales.

GEOMETRICAL CONSTRUCTION AND CURVES

Construction of polygons, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid, Involute, Archemedian Spiral.

PROJECTION OF POINTS, LINES, SURFACES

Principles of Orthographic Projections-Conventions - 1st and 3rd angle projection, Projections of Points and lines inclined to both planes; Projections of planes (Rectangle, pentagon, Hexagon etc.) inclined Planes - Auxiliary Planes.

PROJECTION OF REGULAR SOLIDS

Regular solids inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale (Cube, Pyramid, Prism, Cylinder, Cone).

COMBINATION OF REGULAR SOLIDS, FLOOR PLANS

Regular solids in mutual contact with each other like Spheres in contact with cones standing on their base. Floor plans that include: windows, doors, and fixtures such as

WC, bath, sink, shower, etc.

ISOMETRIC PROJECTIONS

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

SECTIONS AND SECTIONAL VIEWS OF RIGHT ANGULAR SOLIDS

Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only)

OVERVIEW OF COMPUTER GRAPHICS, C**USTOMISATION& CAD DRAWING**

listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids];

Set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

ANNOTATIONS, LAYERING & OTHER FUNCTIONS

Applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the

true shape of the sectioned surface; Drawing annotation, Computer aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;

DEMONSTRATION OF A SIMPLE TEAM DESIGN PROJECT
Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for

engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM)

Books

1. Pradeep Jain, Ankita Maheswari, A.P. Gautam, Engineering Graphics & Design, Khanna Publishing House
2. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
3. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
4. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
5. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers
6. Corresponding set of CAD Software Theory and User Manuals

ES-ME191: Workshop/ Manufacturing

Course Code : ES-ME192

Course Title : Workshop/ Manufacturing Practices

L-T-P : 1-0-4

Category **:** Engineering Science Courses

Semester : First

Credit 3

Stream **:** B. Tech.

Full Marks : 100 (40 for Continuous Evaluation; 60 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the student will be able to:

CO1	Gain basic knowledge of Workshop Practice and Safety useful for our daily living.
CO2	Identify Instruments of a pattern shop like Hand Saw, Jack Plain, Chisels etc and performing operations like such as Marking, Cutting etc used in manufacturing processes.
CO3	Gain knowledge of the various operations in the Fitting Shop using Hack Saw, various files, Scriber, etc to understand the concept of tolerances applicable in all kind of manufacturing.
CO4	Get hands on practice of in Welding and various machining processes which give a lot of confidence to manufacture physical prototypes in project works.

CO-PO Mapping

Co & PO Mapping ES-ME191 to PO attainment

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1	2	1	-	-	-	2	-	1	3	-	1	1
CO 2	2	2	1	1	1	1	1	2	1	1	-	-
CO 3	2	-	2	-	-	1	-	1	1	1	1	2
CO 4	1	1	1	2	1	3	1	3	2	-	-	1

Syllabus (BS-M101)

Detailed contents:

1. Manufacturing Methods- casting, forming, machining, joining,advanced manufacturing methods
2. CNC machining, Additive manufacturing
3. Fitting operations & power tools
4. Electrical &Electronics
5. Carpentry
6. Plastic moulding, glass cutting
7. Metal casting
8. Welding (arc welding & gas welding), brazing

(ii) Workshop Practice:

Machine shop

Typical jobs that may be made in this practice module: To make a pin from a mild steel rod in a lathe. To make rectangular and vee slot in a block of cast iron or mild steel in a shaping and / or milling machine.

Fitting shop

Typical jobs that may be made in this practice module: To make a Gauge from MS plate.

Carpentry

Typical jobs that may be made in this practice module: To make wooden joints and/or a pattern or like. **Welding shop**

Typical jobs that may be made in this practice module*:* ARC WELDING

To join two thick (approx 6mm) MS plates by manual metal arc welding.
GAS WELDING: To join two thin mild steel plates or sheets by gas welding

Casting

Typical jobs that may be made in this practice module:
One/ two green sand moulds to prepare, and a casting be demonstrated.

Smithy

Typical jobs that may be made in this practice module*:* A simple job of making a square rod from a round bar or like. **Plastic moulding & Glass cutting**

Typical jobs that may be made in this practice module*:* For plastic moulding, making at least one simple plastic component should be made. For glass cutting, three rectangular glass pieces may be cut to make a kaleidoscope using a black colour diamond cutter, or similar other components may be made. **Electrical & Electronics**

Familiarization with LT switchgear elements, making its sketches and noting down its specification. Kitkat fuse, Glass cartridge fuse, Plastic fuse holders (optional), Iron clad isolators, MCB style isolators, Single phase MCB, Single-phase wire, wiring cable. Demonstration of domestic wiring involving two MCB, two piano key switches, one incandescent lamp, one LED lamp and plug point. Simple wiring exercise to be executed to understand the basic electrical circuit. Simple soldering exercises to be executed to understand the basic process of soldering. Fabrication of a single-phase full wave rectifier with a step down transformer using four diodes and electrolytic capacitor and to find its volt-ampere characteristics to understand basic

electronic circuit fabrication.

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Books

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop
2. Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited,Mumbai.
3. 2. Kalpakjian S. and Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
4. Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology – I" Pearson Education,2008.

2st Semester

BS-CH201: Chemistry-I

Course Name: Chemistry-I

Course Code : BS-CH201 **Course**
Title : Chemistry-I **L-T-P** :
3-1-0
Category **:** Basic Science Courses
Semester : 2nd
Credit 4
Stream **:** B. Tech. (Other than EE and ECE).
Full Marks = 100 (30 for Continuous Evaluation; 70 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the learner will be

able to:

COURSE OUTCOMES (COs)	
CODE	**DESCRIPTION**
BS-CH201.CO1	Analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces and list major chemical reactions that are used in the synthesis of molecules
BS-CH201.CO2	Rationalise bulk properties and processes using thermodynamic considerations
BS-CH201.CO3	Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
BS-CH201.CO4	Rationalise periodic properties such as ionization potential, electronegativity, oxidation states andelectronegativity.

CO-PO Mapping

Co & PO Mapping BS-CH201 to PO attainment

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	3	3	2	3	2	1	2	1	1	2	2
CO2	3	3	3	2	3	3	-	1	1	-	-	3
CO3	3	3	3	3	2	2	2	1	2	3	3	1
CO4	3	3	3	3	1	3	1	-	1	-	1	1
Average	2.75	3	3	2.5	1.5	2.25	1.33	1.33	1.25	2.0	2.0	1.75

Syllabus

Unit I: Atomic and molecular structure

Schrodinger equation. Particle in a box solutions and their applications for simple sample. Molecular orbitals of diatomic molecules (e.g.H_2). Energy level diagrams of diatomic. π- molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

Unit II: Spectroscopic techniques and applications

Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications inmedicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magneticresonance and magnetic resonance imaging, surface characterisation techniques. Diffraction and scattering

Unit III: Intermolecular forces and potential energy surfaces

Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena.

Unit IV: Use of free energy in chemical equilibria

First and second laws of thermodynamics and thermodynamic functions: energy, entropy and free energy.

Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams.

Unit V: Periodic properties

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

Unit VI: Stereochemistry

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

Unit VII: Organic reactions and synthesis of a drug molecule

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

Books

Learning Resources:

- Engineering Chemistry, Satyaprakash, Khanna Book Publishing, Delhi
- Fundamentals of Molecular Spectroscopy, by C. N. Banwell
- Physical Chemistry, by P. W. Atkins
- Spectroscopy of Organic Compounds, by P.S.Kalsi, New Age International Pvt Ltd Publishers
- Physical Chemistry, P. C. Rakshit, Sarat Book House
- Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition

BS-PH101: Physics

Course Code : BS-PH201 **Course Title** :
Physics-I **L-T-P** : 3-1-0

Category **:** Basic Science Courses
Semester : 2nd
Credit 4
Stream **:** B. Tech. (All branches except EE and ECE). **Full Marks** : 100 (30 for Continuous Evaluation; 70 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the learner will be able to:

COURSE OUTCOMES (COs)	
CODE	**DESCRIPTION**
BS-PH201.CO1	Learn basic concepts of quantum physics, simple quantum mechanics calculations; Macrostate, Microstate, Density of states, Qualitative treatment of MB, FD and BE statistics.
BS-PH201.CO2	Solve problems including constraints & friction. Basic ideas of vector calculus and partial differential equations. Harmonic oscillator. Damped harmonic motion forced oscillations and Resonance. Motion of a rigid body.
BS-PH201.CO3	Learn the application of wave properties of light Interference, Diffraction and Polarization; Lasers: Principles and working of laser

BS-PH201.CO4	Learn Maxwell's equations. Polarization, Dielectrics; Magnetization, magnetic-hysteresis.

CO-PO Mapping

CO–PO Mapping BS-PH201 to PO attainment

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	2	2	1	2	-	-	2	1	2
CO 2	3	3	3	2	2	1	2	-	-	2	1	2
CO 3	3	3	3	3	2	1	2	-	-	2	1	2
CO 4	3	3	3	2	2	1	2	-	-	2	1	2

Syllabus

UNIT 1. Mechanics

Problems including constraints & friction. Basic ideas of vector calculus and partial

differential equations. Potential energy function F = -grad V, equipotential surfaces and meaning of gradient. Conservative and non-conservative forces. Conservation laws of energy & momentum. Non-inertial frames of reference. Harmonic oscillator; Damped harmonic motion forced oscillations and resonance. Motion of a rigid body in a plane and in 3D. Angular velocity vector. Moment of inertia.

UNIT 2. Optics

Distinction between interference and diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits (only the expressions for max;min, & intensity and qualitative discussion of fringes); diffraction grating(resolution formulae only), characteristics of diffraction grating and its applications.

Polarization: Introduction, polarization by reflection, polarization by double reflection, scattering of light, circular and elliptical polarization, optical activity.

Lasers: Principles and working of laser – population inversion, pumping, various modes, threshold population inversion with examples

UNIT 3. Electromagnetism and Dielectric Magnetic Properties of Materials

Maxwell's equations, Polarization, permeability and dielectric constant, polar and non-polar

Dielectrics, internal fields in a solid, Clausius-Mossotti equation (expression only), applications of dielectrics.

Magnetization: permeability and susceptibility, classification of magnetic materials, ferromagnetism, magnetic domains and hysteresis, applications.

UNIT 4. Quantum Mechanics

Introduction to quantum physics, black body radiation, explanation using the photon concept, Compton effect, de Broglie hypothesis, wave-particle duality, verification of matter waves, uncertainty principle, Schrodinger wave equation, particle in box, quantum harmonic oscillator, hydrogen atom.

UNIT 5. Statistical Mechanics

Macrostate, Microstate, Density of states, Qualitative treatment of Maxwell Boltzmann, Fermi-Dirac and Bose-Einstein statistics.

Books

Learning Resources:

1. Introduction to Electrodynamics, David J. Griffiths, Pearson Education India Learning Private Limited
2. Principles of Physics, 10ed, David Halliday, Robert Resnick Jearl Walker, Wiley
3. Electricity, Magnetism, and Light, Wayne M. Saslow, Academic Press
4. Engineering Mechanics (In SI Units) (SIE), S. Timoshenko, D.H. Young, J.V. Rao, Sukumar Pati , McGraw Hill Education
5. Classical mechanics, Narayan Rana, Pramod Joag, McGraw Hill Education
6. Introduction to Classical Mechanics, R Takwale, P Puranik, McGraw Hill Education
7. Engineering Mechanics, M.K. Harbola, Cengage India
8. An Introduction to Mechanics (SIE), David Kleppner, Robert Kolenkow, McGraw Hill Education
9. Principles of mechanics, John L. Synge and Byron A. Griffith, New York, McGraw-Hill
10. Mechanics (Dover Books on Physics) , J. P. Den Hartog , Dover Publications Inc.
11. Engineering Mechanics: Dynamics, L.G. Kraige J.L. Meriam, Wiley
12. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Robert Eisberg, Robert Resnick, Wiley
13. Introduction to Quantum Mechanics, J. Griffiths David , Pearson Education
14. Modern Quantum Mechanics, J. J. Sakurai, Cambridge University Press
15. Optics , Hecht, Pearson Education

16. Optics, Ghatak, McGraw Hill Education India Private Limited
17. Fundamentals of Statistical and Thermal Physics, Reif, Sarat Book Distributors
18. Statistical Mechanics , Pathria , Elsevier
19. Statistical Physics, L.D.Landau , E.M. Lifshitz, Butterworth-Heinemann

BS-M201: Mathematics - IIA

Course Code : BS-M201
Course Title : Mathematics - IIA
L-T-P : 3-1-0
Category **:** Basic Science Courses
Semester : First
Credit 4
Stream **:** B. Tech. (For CSE).
Full Marks : 100 (30 for Continuous Evaluation; 70 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the student will be able to:

COURSE OUTCOMES (COs)	
CODE	**DESCRIPTION**
BS-M 201.CO 1	Learn the ideas of probability and random variables, calculate probabilities using conditional probability, rule of total probability and Bayes' theorem.
BS-M 201.CO	Illustrate the Various discrete and continuous probability distribution with

2	their properties and their applications in physical and engineering environment.
BS-M 201.CO 3	Understand the basic ideas of statistics with different characterization of a univariate and bivariate data set.
BS-M 201.CO 4	Apply statistical tools for analyzing data samples and drawing inference on a given data set.

CO-PO Mapping

CO & PO Mapping BS-M201 to PO attainment

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	3	2	1	1	-	-	-	-	-	2
CO2	3	3	2	1	2	2	2	-	2	-	1	2
CO3	3	3	1	2	2	-	1	-	2	-	2	1
CO4	3	3	2	2	3	2	-	-	-	-	1	2
Average	3	3	2.67	2.33	2.67	1.67	1.5	-	2	-	1.33	1.75

Syllabus (BS-M201)

Syllabus

Module 1: Basic Probability [11L]

Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the Multinomial distribution, Poisson approximation to the Binomial distribution, infinite sequences of Bernoulli trials, sums of

independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality.

Module 2: Continuous Probability Distributions [4L]

Continuous random variables and their properties, Distribution functions and densities, Normal, Exponential and Gamma densities.

Module 3:Bivariate Distributions [5L]

Bivariate distributions and their properties, distribution of sums and quotients, Conditional densities, Bayes' rule.

Module 4: Basic Statistics [8L]

Measures of Central tendency, Moments, Skewness and Kurtosis, Probability distributions: Binomial, Poisson and Normal and evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation.

Module 5:Applied Statistics [8L]

Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.

Module 6: Small samples [4L]

Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.

Books

Learning Resources:

1. Reena Garg, Chandrika Prasad, Advanced Engineering Mathematics, Khanna Publishers.

2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons

3. S. Ross, A First Course in Probability, Pearson Education India

4. W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, Wiley.

5. John E. Freund, Ronald E. Walpole, Mathematical Statistics, Prentice Hall.

6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.

7. N.G. Das, Statistical Methods (Combined Volume), Tata-McGraw Hill.

BS-M202: Mathematics - IIB

Course Code : BS-M202
Course Title : Mathematics - IIB
L-T-P : 3-1-0
Category **:** Basic Science Courses
Semester : 2nd
Credit 4
Stream **:** B. Tech. (For Except CSE).
Full Marks : 100 (30 for Continuous Evaluation; 70 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the student will be able to:

COURSE OUTCOMES (COs)	
CODE	**DESCRIPTION**
BS-M 202.CO 1	Learn the methods for evaluating multiple integrals and their applications to different physical problems.
BS-M 202.CO 2	Understand different techniques to solve first and second order ordinary differential equations with its formulation to address the modelling of systems and problems of engineering sciences.
BS-M 202.CO 3	Learn different tools of differentiation and integration of functions of a complex variable that are used with various other techniques for solving engineering problems.

BS-M 202.CO 4	Apply different types of transformations between two 2-dimensional planes for analysis of physical or engineering problems.

CO-PO Mapping

CO & PO Mapping BS-M202 to PO attainment

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	3	2	2	2	2	-	-	1	2	2
CO2	3	3	2	2	2	2	-	-	2	-	1	2
CO3	3	3	1	1	2	-	2	-	2	1	-	1
CO4	3	3	2	2	3	2	-	-	-	-	2	2
Average	3	3	2	1.75	2.25	2	2	-	2	1	1.67	1.75

Syllabus (BS-M202)

Syllabus

Module 1: Multivariate Calculus (Integration) [11L]

Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, change of variables (Cartesian to Polar), Applications: Areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), Orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

Module 2: First order ordinary differential equations [5L]

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

Module 3: Ordinary differential equations of higher orders [9L]

Second order linear differential equations with constant coefficients, Use of D - operators, Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

Module 4: Complex Variable – Differentiation [6L]

Differentiation of complex functions, Cauchy-Riemann equations, Analytic functions, Harmonic functions, determination of harmonic conjugate, elementary analytic functions (exponential,

trigonometric, logarithmic) and their properties; Conformal mappings, Mobius transformations and their properties.

Module 5: Complex Variable – Integration [9L]

Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, Zeros of analytic functions, Singularities, Laurent's series; Residues, Cauchy residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

Books

Learning Resources:

1. Reena Garg, Chandrika Prasad, Advanced Engineering Mathematics, Khanna Publishers.

2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.

3. Michael Greenberg, Advanced Engineering Mathematics, Pearson.

4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.

5. Kanti B. Dutta, Mathematical Methods of Science and Engineering, Cenage Learning.

6. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, NewDelhi.

7. E. L. Ince, Ordinary Differential Equations, Dover Publications.

8. J. W. Brown and R. V. Churchill, Complex Variables and Applications, Mc-GrawHill

HMHU 201: ENGLISH

Course Code : HMHU201

Course Title : English

L-T-P : 2-0-0

Category **:** Humanities and Social Sciences including Management courses

Semester : Second

Credit 2

Stream **:** B. Tech. (ALL).

Full Marks : 100 (30 for Continuous Evaluation; 70 for End Semester Exam.)

Course Outcome (CO)

Student will be able to:

COURSE OUTCOMES (COs)	
CODE	**DESCRIPTION**
HMHU201.CO 1	Revise the basic grammar of English language.
HMHU 201.CO 2	Learn appropriate use of English language to enhance knowledge on building vocabulary and framing sentences.
HMHU 201.CO 3	Learn and incorporate sensible style in Technical writing.
HMHU201.CO 4	Acquire proficiency in English language for comprehensive excellence in reading, listening, writing and speaking.

CO-PO Mapping

Co & PO Mapping HMHU201 to PO attainment

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	2	-	-	-	-	-	-	1	3	-	2
CO2	-	2	-	1	-	1	-	-	2	3	-	2
CO3	-	2	-	1	-	1	1	2	1	3	-	2
CO4	-	2	-	1	-	1	1	1	2	3	1	2
Average	-	2	-	1	-	1	1	1.5	1.5	3	1	2

Syllabus (HMHU201)

Syllabus

MODULE I

Vocabulary Building 1.1

The concept of Word Formation: Compounding, Backformation, Clipping, Blending. 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 form derivatives. 1.4 Synonyms, antonyms, and standard abbreviations: Acronyms

MODULE II

2. Basic Writing Skills 2.1 Sentence Structures & Types: Simple, Compound, Complex 2.2 Use of phrases and clauses in sentences: Transformation of sentences, active, passive, narration2.3 Importance of proper punctuation 2.4 Creating coherence: Arranging paragraphs & Sentences in logical order
   2.5 Creating Cohesion: Organizing principles of paragraphs in documents 2.6 Techniques for writing precisely

MODULE III

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

MODULE IV

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

MODULE V

5. Writing Practices 5.1 Comprehension 5.2 Précis Writing 5.3 Essay Writing 5.4 Business Letter, Cover Letter & CV; E- mail

Books

Learning Resources:

(i) Kulbushan Kumar, R S Salaria,Effective Communication Skills, Khanna Publishing House, Delhi.
(ii) Practical English Usage. Michael Swan. OUP. 1995.
(iii) Remedial English Grammar. F.T. Wood. Macmillan.2007
(iv) On Writing Well. William Zinsser. Harper Resource Book. 2001
(v) Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
(vi) Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
(vii) Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press
(viii) Universal English Prof. Prasad Kataria Publications, 2019.
(ix) "Communication Skills for Professionals"-NiraKonar, Prentice Hall of India 2nd edition, NewDelhi,2011.
(x) Gajendra Singh Chauhan, SmitaKashiramka and L. Thimmesha. Functional English. Cengage, 2019.

ES-CS201: Programming for Problem Solving

Course Code : ES-CS201

Course Title : Programming for Problem Solving

L-T-P : 3-0-0

Category : Engineering Science Courses

Semester : 2nd

Credit 3

Stream : B. Tech.

Full Marks : 100 (30 for Continuous Evaluation; 70 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the student will be able to:

Course Name	COs	CO Statement
Basic Computation & Principles of Computer Programming (CS 201)	CS 201.1	Students will be able to *describe* the meaning of system of numbers, logic gates and the basic anatomy of a Computer.
	CS 201.2	Students will be able to *understand* the inherent meaning of the basic elements of C Programming Language like; constants, variables, operators, operator precedence etc., and *identify* the use of data types and C statements and *classify* the statements.
	CS 201.3	Students will be able to *organize* the statements in appropriate order to *prepare* a complete program that *solves* a specific problem and *analyze* a program to *point out* the bugs that might be present in it and change it to achieve the goal.
	CS 201.4	Students will be able to *construct* the final program and *create* the executable module for execution purpose.

CO-PO Mapping

Co & PO Mapping ES- CS 201 to PO attainment

Basic Computation & Principles of Computer Programming(CS201)

CO'S	PO'S											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CS 201.1	_	_	3	2	1	_	2	3	1	_	2	2
CS 201.2	1	3	2	2	_	2	_	3	2	3	2	2
CS 201.3	3	2	1	2	_	2	3	2	2	2	2	3
CS 201.4	3	2	3	3	2	2	2	1	2	2	3	_
Average	2.33	2.33	2.25	2.25	1.5	2.00	2.33	2.25	2.33	2.33	2.25	2.33

Syllabus (BS-M101)

Unit 1: Introduction to Programming

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.)

Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples.

From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code-

Unit 2: Arithmetic expressions and precedence

Unit 3: Conditional Branching and Loops

Writing and evaluation of conditionals and consequent branching

Unit 4: Arrays

Arrays (1-D, 2-D), Character arrays and Strings

Unit 5: Basic Algorithms

Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

Unit 6: Function

Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference

Books

Learning Resources:

1. R. S. Salaria, Computer Concepts and Programming in C, Khanna Publishers
2. 2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw- Hill
4. 4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall ofIndia

BS-PH291:Physics-I Lab

Course Code : BS-PH291

Course Title : Physics-I Laboratory

L-T-P : 0-0-3

Category **:** Basic Science Courses

Semester : Second

Credit **:** 1.5

Stream **:** B. Tech. (EE and ECE).

Full Marks : 100 (40 for Continuous Evaluation; 60 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the learner will be able to:

COURSE OUTCOMES (COs)	
CODE	**DESCRIPTION**
BS-PH291.CO1	Ability to increase power of observation and reasoning and to think and work with precision and accuracy in daily life. Use Slide callipers and screw gauge, familiar with concept of Band gap of semiconductor and dielectric constant

BS-PH291.CO2	Get the opportunity to verify the validity of various laws taught in curriculum, Familiar with dispersive power of the material of a prism, Newton's ring, Planck constant
BS-PH291.CO3	Familiar with Hall coefficient of a semiconductor Electron spin resonance spectrometer, Young's modulus, Poiseulle's capillary flow method for viscosity measurement.

CO-PO Mapping

CO–PO Mapping BS-PH291 to PO attainment

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	3	1	2	-	-	2	1	2
CO 2	3	3	3	3	3	1	2	-	-	2	1	2
C	3	3	3	3	3	1	2	-	-	2	1	2

O 3												

Syllabus

Experiments in Optics

1. Determination of dispersive power of the material of a prism
2. Determination of wavelength of a monochromatic light by Newton's ring
3. Determination of wavelength of a monochromatic light by Fresnel's bi-prism
4. Determination of wavelength of the given laser source by diffraction method

Electricity & Magnetism experiments

1. Determination of thermo electric power of a given thermocouple.
2. Determination of specific charge (e/m) of electron by J.J. Thompson's method.
3. Determination of dielectric constant of a given dielectric material.
4. Determination of Hall coefficient of a semiconductor by four probe method.
5. To study current voltage characteristics, load response, areal characteristic and spectral response of a photovoltaic solar cell.
6. Determination of resistance of ballistic galvanometer by half deflection method and study of variation of logarithmic decrement with series resistance.
7. Determination of unknown resistance using Carey Foster's bridge
8. Study of Transient Response in LR, RC and LCR circuits using expeyes
9. Generating sound from electrical energy using expeyes

Experiments in Quantum Physics

1. Determination of Stefan-Boltzmann constant.

2. Determination of Planck constant using photocell.
3. Determination of Lande-g factor using Electron spin resonance spectrometer.
4. Determination of Rydberg constant by studying Hydrogen spectrum.
5. Determination of Band gap of semiconductor.
6. To study current voltage characteristics, load response, areal characteristic and spectral response of a photovoltaic solar cell.

Miscellaneous experiments

1. Determination of Young's modulus of elasticity of the material of a bar by the method of flexure
2. Determination of bending moment and shear force of a rectangular beam of uniform cross-section
3. Determination of modulus of rigidity of the material of a rod by static method
4. Determination of rigidity modulus of the material of a wire by dynamic method
5. To determine the moment of inertia of a body about an axis passing through its centre of gravity and to determine the modulus of rigidity of the material of the suspended wire
6. Determination of coefficient of viscosity by Poiseulle's capillary flow method

BS-CH291: Chemistry-I Lab

Course Code : BS-CH291

Course Title : Chemistry-I Laboratory

L-T-P : 0-0-3

Category **:** Basic Science Courses

Semester : Second

Credit **:** 1.5

Stream **:** B. Tech. (Other than EE and ECE).

Full Marks : 100 (40 for Continuous Evaluation; 60 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the learner will be able to:

COURSE OUTCOMES (COs)	
CODE	**DESCRIPTION**
BS-CH291.CO 1	Analyse sample by apply instruments like viscometer, pH-meter, Conductometer, Potentiometer *etc* to achieve high accuracy.
BS-CH291.CO 2	Analyse inorganic salts by semi-micro techniques
BS-CH291.CO 3	Analyse quantitative chemicals present in different samples

CO-PO Mapping

Co & PO Mapping BS-CH291 to PO attainment

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	2	2	-	3	2	1	1

CO2	1	3	3	3	-	1	2	-	3	2	2	2
CO3	3	3	3	3	3	2	1	1	2	2	2	2
Average	2.3	3	2.6	3	3	1.6	1.6	1	2.6	2	1.6	1.6

Syllabus

1. Conductometric titration for determination of the strength of a given HCl solution by titration against a standard NaOH solution
2. pH- metric titration for determination of strength of a given HCl solution against a standard NaOH solution
3. Determination of dissolved oxygen present in a given water sample.
4. To determine chloride ion in a given water sample by Argentometric method (using chromate indicator solution)
5. Determination of surface tension and viscosity
6. Thin layer chromatography
7. Ion exchange column for removal of hardness of water
8. Determination of the rate constant of a reaction
9. Determination of cell constant and conductance of solutions
10. Potentiometry - determination of redox potentials and emfs
11. Saponification/acid value of an oil
12. Chemical analysis of a salt
13. Determination of the partition coefficient of a substance between two immiscible liquids
14. Adsorption of acetic acid by charcoal
15. Use of the capillary viscosimeters to the demonstrate of the isoelectric pointas the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg

N.B.: **Choose 10 experiments from the above 15**

Books

- Advance Practical Chemistry by Subhas C Das, Sarat Book House
- A test book of Macro and Semimicro qualitative Inorganic Analysis by I. Vogel

HMHU 291: ENGLISH

Course Code : HMHU291

Course Title : English

L-T-P : 0-0-2

Category **:** Humanities and Social Sciences including Management courses

Semester : Second

Credit 1

Stream **:** B. Tech. (ALL).

Full Marks : 100 (40 for Continuous Evaluation; 60 for End Semester Exam.)

Course Outcome (CO)

Student will be able to:

COURSE OUTCOMES (COs)	
CODE	**DESCRIPTION**
HMHU291.CO 1	Get introduced to professional application of English Language with emphasis on listening and speaking skills through language lab aids.
HMHU 291.CO 2	Practice sessions on pronunciation, intonation, voice modulation, stress, pitch and accent and developing communicative skills with special focus on Group Discussion.
HMHU 291.CO 3	Master effective reading and writing style through Language Lab aids.

HMHU291.CO 4	Ensure proficiency in reading, listening comprehension, technical writing and in speaking.

CO-PO Mapping

Co & PO Mapping HMHU291 to PO attainment

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	-	-	1	-	-	-	2	3	-	2
CO2	-	2	-	1	-	1	-	1	3	3	-	2
CO3	-	2	-	1	1	1	1	1	2	3	-	2
CO4	-	2	-	1	1	1	1	1	3	3	-	2
Average	-	2	-	1	1	1	1	1	2.5	3	-	2

Syllabus (HMHU291)

Syllabus

1) Honing ‘Listening Skill’ and its sub skills through Language Lab Audio device; 3P

2) Honing ‘Speaking Skill’ and its sub skills 2P

3) Helping them master Linguistic/Paralinguistic features (Pronunciation/Phonetics/ Voice modulation/ Stress/ Intonation/ Pitch &Accent) of connected speech 2P

4) Honing ‘Conversation Skill’ using Language Lab Audio –Visual input; Conversational Practice Sessions (Face to Face / via Telephone, Mobile phone &Role Play Mode) 2P

5) Introducing ‘Group Discussion’ through audio –Visual input and acquainting themwith key strategies for success 2P

6) G D Practice Sessions for helping them internalize basic Principles (turn- taking, creative intervention, by using correct body language, courtesies &other soft skills) of GD 4P

7) Honing ‘Reading Skills’ and its sub skills using Visual / Graphics/ Diagrams /Chart Display/Technical/Non Technical Passages Learning Global / Contextual / Inferential Comprehension; 2P8) Honing ‘Writing

Skill' and its sub skills by using Language Lab Audio –Visual input; Practice Sessions

ES-ME291: Engineering Graphics & Design

Course Code : ES-ME291

Course Title : Engineering Graphics & Design

L-T-P : 1-0-4

Category **:** Engineering Science Courses

Semester : First

Credit 3

Stream **:** B. Tech.

Full Marks : 100 (60 for Continuous Evaluation; 60 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the student will be able to:

CO1	Learn basics of drafting and use of drafting tools which develops the fundamental skills of industrial drawings.
CO2	Know about engineering scales, dimensioning and various geometric curves necessary to understand design of machine elements.
CO3	Understand projection of line, surface and solids to create the knowledge base of orthographic and isometric view of structures and machine
CO4	Become familiar with computer aided drafting useful to share the design model to different section of industries as well as for research & development.

CO-PO-Mapping

Co & PO Mapping ES-ME291 to PO attainment

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1	2	-	1	2	1	1	1	-	1	-	-	1
CO 2	3	-	2	2	-	1	-	-	1	1	1	1
CO 3	2	2	2	1	-	1	1	1	1	-	-	1
CO 4	1	-	2	2	2	1	-	-	1	1	1	1

Syllabus (ES-ME291)

INTRODUCTION TO ENGINEERING DRAWING
Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Different types of lines and their use; Drawing standards and codes.

LETTERING, DIMENSIONING, SCALES
Plain scale, Diagonal scale and Vernier Scales.

GEOMETRICAL CONSTRUCTION AND CURVES

Construction of polygons, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid, Involute, Archemedian Spiral.

PROJECTION OF POINTS, LINES, SURFACES

Principles of Orthographic Projections-Conventions - 1st and 3rd angle projection, Projections of Points and lines inclined to both planes; Projections of planes (Rectangle, pentagon, Hexagon etc.) inclined Planes - Auxiliary Planes.

PROJECTION OF REGULAR SOLIDS

Regular solids inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale (Cube, Pyramid, Prism, Cylinder, Cone).

COMBINATION OF REGULAR SOLIDS, FLOOR PLANS

Regular solids in mutual contact with each other like Spheres in contact with cones standing on their base. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.

ISOMETRIC PROJECTIONS

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

SECTIONS AND SECTIONAL VIEWS OF RIGHT ANGULAR SOLIDS

Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only)

OVERVIEW OF COMPUTER GRAPHICS, C**USTOMISATION& CAD DRAWING**

listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase

objects.; Isometric Views of lines, Planes, Simple and compound Solids]; Set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

ANNOTATIONS, LAYERING & OTHER FUNCTIONS

Applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers;

Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;

DEMONSTRATION OF A SIMPLE TEAM DESIGN PROJECT
Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form

and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM)

Books

1. Pradeep Jain, Ankita Maheswari, A.P. Gautam, Engineering Graphics & Design, Khanna Publishing House
2. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
3. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
4. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education

5. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers

6. Corresponding set of CAD Software Theory and User Manuals

ES-ME291: Workshop/ Manufacturing

Course Code : ES-ME292

Course Title : Workshop/ Manufacturing Practices

L-T-P : 1-0-4

Category **:** Engineering Science Courses

Semester : 2nd

Credit 3

Stream **:** B. Tech.

Full Marks : 100 (40 for Continuous Evaluation; 60 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the student will be able to:

CO1	Gain basic knowledge of Workshop Practice and Safety useful for our daily living.
CO2	Identify Instruments of a pattern shop like Hand Saw, Jack Plain, Chisels etc and performing operations like such as Marking, Cutting etc used in manufacturing processes.
CO3	Gain knowledge of the various operations in the Fitting Shop using Hack Saw, various files, Scriber, etc to understand the concept of tolerances applicable in all kind of manufacturing.
CO4	Get hands on practice of in Welding and various machining processes which give a lot of confidence to manufacture physical prototypes in project works.

CO-PO Mapping

Co & PO Mapping ES-ME291 to PO attainment

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1	2	1	-	-	-	2	-	1	3	-	1	1
CO 2	2	2	1	1	1	1	1	2	1	1	-	-
CO 3	2	-	2	-	-	1	-	1	1	1	1	2
CO 4	1	1	1	2	1	3	1	3	2	-	-	1

Syllabus (ES-ME291)

Detailed contents:

1. Manufacturing Methods- casting, forming, machining, joining,advanced manufacturing methods
2. CNC machining, Additive manufacturing
3. Fitting operations & power tools
4. Electrical &Electronics
5. Carpentry
6. Plastic moulding, glass cutting
7. Metal casting
8. Welding (arc welding & gas welding), brazing

(ii) Workshop Practice:

Machine shop

Typical jobs that may be made in this practice module: To make a pin from a mild steel rod in a lathe. To make rectangular and vee slot in a block of cast iron or mild steel in a shaping and / or milling machine.

Fitting shop

Typical jobs that may be made in this practice module: To make a Gauge from MS

plate.

Carpentry

Typical jobs that may be made in this practice module: To make wooden joints and/or a pattern or like. **Welding shop**

Typical jobs that may be made in this practice module: ARC WELDING

To join two thick (approx 6mm) MS plates by manual metal arc welding.
GAS WELDING: To join two thin mild steel plates or sheets by gas welding

Casting

Typical jobs that may be made in this practice module*:* One/ two green sand moulds to prepare, and a casting be demonstrated.

Smithy

Typical jobs that may be made in this practice module*:* A simple job of making a square rod from a round bar or like. **Plastic moulding & Glass cutting**

Typical jobs that may be made in this practice module*:* For plastic moulding, making at least one simple plastic component should be made. For glass cutting, three rectangular glass pieces may be cut to make a kaleidoscope using a black colour diamond cutter, or similar other components may be made. **Electrical & Electronics**

Familiarization with LT switchgear elements, making its sketches and noting down its specification. Kitkat fuse, Glass cartridge fuse, Plastic fuse holders (optional), Iron clad isolators, MCB style isolators, Single phase MCB, Single-phase wire, wiring cable. Demonstration of domestic wiring involving two MCB, two piano key switches, one incandescent lamp, one LED lamp and plug point. Simple wiring exercise to be executed to understand the basic electrical circuit. Simple soldering exercises to be executed to understand the basic process of soldering. Fabrication of a single-phase full wave rectifier with a step down transformer using four diodes and electrolytic capacitor and to find its volt-ampere characteristics to understand basic electronic circuit fabrication.

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

ES-CS291: Programming for Problem Solving

Course Code : ES-CS291

Course Title : Programming for Problem Solving

L-T-P : 0-0-4

Category **:** Engineering Science Courses

Semester : 2nd

Credit 2

Stream **:** B. Tech.

Full Marks : 100 (40 for Continuous Evaluation; 60 for End Semester Exam.)

Course Outcome (CO)

On successful completion of the learning sessions of the course, the student will be able to:

Course Name	COs	CO Statement
Basic Computation & Principles of Computer Programming(Lab) (CS291P)	CS 291.1	Students will be able to *define* the specifications like input and output relating to a particular problem and *describe* the algorithm that *solves* the problem.
	CS 291.2	Students will be able to *construct*each of the modules of aprogram by *restating* the steps of the algorithm using functions in the framework of C language.

	CS 291.3	Students will be able to *create* the program by using the functions and execute the program.
	CS 291.4	Students will be able to *point out* the bugs if any, and modify the program to *solve* the problem.

CO-PO Mapping

Co & PO Mapping ES- CS 291 to PO attainment

Basic Computation & Principles of Computer Programming(CS291)												
CO'S	PO'S											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CS 291.1	3	3	2	2	2	3	-	-	-	-	2	2
CS 291.2	2	2	-	2		2	2	2		1	2	2
CS 291.3	2	2	2	3	1	3	2	3	1	1	3	2
CS 291.4	1	1	-	1	1	2	-	1	1	1	1	2
Average	2	2	2	2	1.33	2.5	2	2	1	1	2	2

Syllabus (ES-CS291)

The laboratory should be preceded or followed by a tutorial to explain the approach or algorithm to be implemented for the problem given.

Tutorial 1: Problem solving using computers:

Lab1: Familiarization with programming environment

Tutorial 2: Variable types and type conversions: **Lab 2:** Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions:

Lab 3: Problems involving if-then-else structures

Tutorial 4: Loops, while and for loops:

Lab 4: Iterative problems e.g., sum of series

Tutorial 5: 1D Arrays: searching, sorting:

Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and Strings

Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value:

Lab 7: Simple functions

Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numerical integration):

Lab 8 and 9: Programming for solving Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls

Lab 10: Recursive functions

Tutorial 11: Pointers, structures and dynamic memory allocation

Lab 11: Pointers and structures

Tutorial 12: File handling: **Lab 12:** File operations

3rd Semester

BS- M301- Mathematics-III

Course Outcome (CO)

Student will be able to:

CO1	The ideas of probability and random variables, calculate probabilities using conditional probability, rule of total probability and Bayes' theorem.
CO2	Various discrete and continuous probability distribution with their properties and their applications in physical and engineering environment.
CO3	Students can apply statistical tools for analyzing data samples and drawing inference on a given data set.

Subject Code : BS-M301	**Category:** Basic Science course
Subject Name : **Mathematics III**	**Semester** : Third
L-T-P : **3-1-0**	**Credit:4**
Pre-Requisites: No-prerequisite	

Module No.	Description of Topic	Contact Hrs.
1	Definition of Partial Differential Equations, First order partial differential equations, solutions of first order linear PDEs; Solution to homogenous and non-homogenous linear partial differential equations of second order by complimentary function and particular integral method. Second-order linear equations and their classification, Initial and boundary conditions, D'Alembert's solution of the wave equation; Duhamel's principle for one dimensional wave equation. Heat diffusion and vibration problems, Separation of variables method to simple problems in Cartesian coordinates. The Laplacian in plane, cylindrical and spherical polar coordinates, solutions with Bessel functions and Legendre functions. One dimensional diffusion equation and its solution by separation of variable.	14
2	Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality. Continuous random varibales and their properties, distribution functions and densities, normal, exponential and gamma densities. Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.	12

3	Basic Statistics, Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation. Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, Tests for single mean, difference of means, and difference of standard deviations. Test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.	12

Textbooks/References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Chandrika Prasad & Reena Garg, Advanced Engineering Mathematics, Khanna PublishingHouse, 2019.
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications,Reprint, 2010.
4. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall,2003 (Reprint).
5. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
6. Ramana, Higher Engineering Mathematics, TMH
7. Sashtry, Advanced Engineering Mathematics, PHI

CO-PO Mapping

Mathematics III

(Course Code - BS-M301**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO 1	3	3	-	2	1	1	1	-	1	1	2	3	2	1	2
CO 2	3	3	1	1	1	2	1	1	1	-	1	3	1	2	1

CO 3	1	1	-	-	3	-	1	-	1	1	-	3	1	1	1

BS- BIO301- Biology

Course Outcome (CO)

Student will be able to:

CO1	Describe how biological observations of 18th Century that lead to major discoveries.
CO2	Convey that classification per se is not what biology is all about but highlight the underlying criteria, such as morphological, biochemical and ecological
CO3	Highlight the concepts of excessiveness and dominance during the passage of genetic material from parent to offspring
CO4	Convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine and classify enzymes and distinguish between different mechanisms of enzyme action.

Subject Code : BS-BIO301	**Category:** Basic Science course
Subject Name : Biology	**Semester** : Third
L-T-P : **3-0-0**	**Credit:3**
Pre-Requisites: No-prerequisite	

Module No.	**Description of Topic**	**Contact Hrs.**

1	**Introduction** *Purpose*: To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry. Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry.	2
2	**Classification** *Purpose*: To convey that classification per se is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted. Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilisation -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e) Habitataacquatic or terrestrial (e) Molecular taxonomy- three majorkingdoms of life. A given organism can come under different category basedon classification. Model organisms for the study of biology come from different groups. E.coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M.musculus	3
3	**Genetics** *Purpose*: To convey that "Genetics is to biology what Newton's laws are to Physical Sciences" Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.	4
4	**Biomolecules** *Purpose*: To convey that all forms of life has the same building blocks andyet the manifestations are as diverse as one can imagine	4
	Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids.	

5	**Enzymes** *Purpose*: To convey that without catalysis life would not have existed onearth. Enzymology: How to monitor enzyme catalysed reactions. How does an enzyme catalyse reactions? Enzyme classification. Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis.	4
6	**Information Transfer** *Purpose*: The molecular basis of coding and decoding genetic information is universal Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure-from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.	4
7	**Macromolecular analysis** *Purpose*: How to analyse biological processes at the reductionist level Proteins- structure and function. Hierarch in protein structure. Primarysecondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.	5
8	**Metabolism** *Purpose*: The fundamental principles of energy transactions are the same inphysical and biological world. Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergoinc reactions. Concept of Keq and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO_2 + H_2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO_2 and H_2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge	4
9	**Microbiology** Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics.	3

Learning Resources:

1. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman,
   S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd
2. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H.John Wiley and Sons

3. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman andCompany
4. Molecular Genetics (Second edition), Stent, G. S.; and Calender, R. W.H. Freeman andcompany, Distributed by Satish Kumar Jain for CBS Publisher
5. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. BrownPublishers
6. Biology for Engineers, Tata McGraw Hill (ISBN: 978-11-21439-931)

CO-PO Mapping

Biology

(Course Code - BS-BIO301**)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO 1	3	3	-	2	1	1	1	-	1	1	1	3	-	1	2
CO 2	3	2	1	1	1	2	2	1	1	-	1	3	-	-	1
CO 3	1	1	-	-	-	-	3	-	-	1	-	3	1	1	1
CO 4	3	2	1	1	-	1	1	2	2	2	-	3	-	1	3

ES-ECE301- Basic Electronics Engineering

Course Outcome (CO)

Student will be able to:

CO1	Understand the principles of semiconductor devices and their applications.
CO2	Design an application using Operational amplifier.

CO3	Understand the working of timing circuits and oscillators.
CO4	Understand logic gates, flip flop as a building block of digital systems.
CO5	Learn the basics of Electronic communication system.

Subject Code : ES-ECE301	**Category:** Engineering Science Courses
Subject Name : Basic Electronics Engineering	**Semester** : Third
L-T-P : **3-0-0**	**Credit:3**
Pre-Requisites: No-prerequisite	

Module No.	Description of Topic	Contact Hrs.
1	**Semiconductor Devices and Applications**: Introduction to P-N junction Diode and V-I characteristics, Half wave and Full-wave rectifiers, capacitor filter. Zener diode and its characteristics, Zener diode as voltage regulator. Regulated power supply IC based on 78XX and 79XX series, Introduction to BJT, its input-output and transfer characteristics, BJT as a single stage CE amplifier, frequency response and bandwidth.	7
2	**Operational amplifier and its applications:** Introduction to operational amplifiers, Op-amp input modes and parameters, Op-amp in open loop configuration, op-amp with negative feedback, study of practical op-ampIC 741, inverting and non-inverting amplifier Applications: summing and difference amplifier, unity gain buffer, comparator, integrator and differentiator.	6
3	**Timing Circuits and Oscillators:** RC-timing circuits, IC 555 and its applications as table and mono-stable multi-vibrators, positive feedback, Barkhausen's criteria for oscillation, R-Cphase shift and Wein bridge oscillator.	6
4	**Digital Electronics Fundamentals** :Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K- map, Logic ICs, half and full adder/sub tractor, multiplexers, De-multiplexers, flip-flops, shift registers, counters, Block diagram ofmicroprocessor/microcontroller and their applications.	7

5	**Electronic Communication Systems**: The elements of communication system, IEEE frequency spectrum, Transmission media: wired and wireless, need of modulation, AM andFM modulation schemes, Mobile communication systems: cellular concept and block diagram of GSM system.	6

CO-PO Mapping Basic Electronics Engineering (Course Code ES-ECE301)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	2	1	1	1	-	1	1	1	3	3	1	2
CO2	3	3	1	1	1	2	2	1	1	-	1	3	1	-	1
CO3	3	1	-	-	1	-	3	-	1	1	-	2	1	-	1
CO4	3	1	1	1	-	1	1	1	1	2	-	3	1	1	1
CO5	2	1	1	3	2	1	1	1	1	3	1	1	1	1	3

Learning Resources:

1. Floyd ," Electronic Devices" Pearson Education 9th edition, 2012.
2. R.P. Jain , "Modern Digital Electronics", Tata McGraw Hill, 3rd Edition, 2007.
3. S.Biswas, Basic Electronics, Khanna Publishing House, 2019
4. Frenzel, "Communication Electronics: Principles and Applications", Tata McGraw Hill, 3rdEdition, 2001
5. Shanti Ram Kal, Basic Electronics, PHI

ES-ME301- Engineering Mechanics

Course Outcome (CO)

Student will be able to:

CO1	Formulation and solve complex engineering problems by applying principles of engineering
CO2	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments
CO3	Development and conduct appropriate experimentation
CO4	An ability to acquire and apply new knowledge as needed

Subject Code : ES-ME301	**Category:** Engineering Science Courses
Subject Name : Engineering Mechanics	**Semester** : Third
L-T-P : **3-1-0**	**Credit:4**
Pre-Requisites: No-prerequisite	

Module No.	Description of Topic	Contact Hrs.
1	**Module 1:** *Introduction to Engineering Mechanics covering,* Force Systems: Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminancy.	3
2	**Module 2:** *Friction covering,* Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction,screw jack & differential screw jack.	4
3	**Module 3:** *Basic Structural Analysis covering,* Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines.	4

4	**Module 4***: Centroid and Centre of Gravity covering*, Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia-Definition, Momentof inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.	5
5	**Module 5***: Virtual Work and Energy Method*- Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.	5
6	**Module 6***: Review of particle dynamics*- Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law	5
	(rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy.Impulse-momentum (linear, angular); Impact (Direct andoblique).	
7	**Module 7:***Introduction to Kinetics of Rigid Bodies covering*, Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation.	5
8	**Module 8:***Mechanical Vibrations covering*, Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums.	5
9	**Tutorials** *from the above modules covering*, To find the various forces and angles including resultants in various parts of wall crane, roof truss, pipes, etc.; To verify the line of polygon on various forces; To find coefficient of friction between various materials on inclined plan; Free body diagrams various systems including block-pulley; To verify the principle of momentin the disc apparatus; Helical block; To draw a load efficiency curve for a screw jack.	12

Text /Reference Books:

1. M.P. Poonia & D.S. Bedi, Engineering Mechanics, Khanna Publishing House, 2019
2. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
3. R.S. Khurmi, Engineering Mechanics, S.Chand Publications, Delhi
4. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, –Dynamics, 9th Ed, Tata McGraw Hill
5. R. C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, PearsonPress.
6. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, OxfordUniversity Press
7. Shanes and Rao (2006), Engineering Mechanics, Pearson Education,
8. Hibler and Gupta (2010),Engineering Mechanics (Statics, Dynamics) by Pearson Education
9. Reddy Vijaykumar K. and K. Suresh Kumar(2010), Singer's Engineering Mechanics
10. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications
11. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications

CO-PO Mapping

Engineering Mechanics

(Course Code ES-ME301**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO 1	3	1	1	2	1	1	1	1	1	1	1	3	3	1	2
CO 2	3	3	2	1	3	2	1	1	1	-	1	3	3	1	2
CO 3	3	1	3	-	3	-	-	-	1	1	2	2	3	1	3
CO 4	3	1	1	1	2	1	1	-	1	2	2	3	1	-	1

PC-ME301- Thermodynamics

Course Outcome (CO)

Student will be able to:

CO1	Apply energy balance to systems and control volumes , insituations involving heat and work interactions
CO2	Evaluate changes in thermodynamic properties of substances
CO3	Evaluate the performance of energy conversion devices
CO4	differentiate between high grade and low grade energies.

Subject Code : PC-ME301	**Category:** Professional Core courses
Subject Name : Thermodynamics	**Semester** : Third
L-T-P : **3-1-0**	**Credit:4**
Pre-Requisites: No-prerequisite	

Module No.	Description of Topic	Contact Hrs.
1	Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work-Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work.	5
2	Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy.	5

3	Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables and R134a tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart.	8
4	First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume.	5
5	Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale.	5
6	Clausius inequality; Definition of entropy S ; Demonstration that entropy Sis a property; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of s from steam tables- Principle of increase of entropy; Illustration of processes in Ts coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles- Irreversibility and Availability, Availability function for	8

Learning Resources:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, *Fundamentals of Thermodynamics*, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, *Engineering Thermodynamics*, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, *Fundamentals of Engineering Thermodynamics*, John Wiley and Sons.
4. Nag, P.K, 1995, *Engineering Thermodynamics*, Tata McGraw-Hill Publishing Co. Ltd.
5. M.P. Poonia & S.C. Sharma, Basics of Mechanical Engineering, Khanna Publishing House, N. Delhi

CO-PO Mapping Thermodynamics (Course Code PC-ME301)														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO 1	1	1	1	2	1	1	1	1	1	1	1	3	3	1	2
CO 2	3	3	2	1	3	1	-	1	1	-	1	2	2	1	1
CO 3	3	1	3	-	1	-	-	-	1	1	2	2	3	1	3
CO 4	2	1	1	1	1	1	1	-	1	2	2	1	1	-	1

PC-ME302- Manufacturing Processes

Course Outcome (CO)

Student will be able to:

CO1	Interpret the casting processes
CO2	Recognize the principles of welding
CO3	Correlate the forming processes like forging

Subject Code : PC-ME302	**Category:** Professional Core courses
Subject Name : Manufacturing Processes	**Semester** : Third
L-T-P : **3-1-0**	**Credit:4**
Pre-Requisites: No-prerequisite	

Module No.	Description of Topic	Contact Hrs.
1	Conventional Manufacturing processes: Casting and moulding: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses.	10
2	Introduction to bulk and sheet metal forming, plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk forming(forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending) principles of powder metallurgy.	10
3	Machining: Single and multi-point machining; Orthogonal machining, cutting tool geometry of SPTT, milling cutter and drill, conversion of rake and clearance angles within ASA and ISO systems, various force components: Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, Cutting tool materials, Cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNC machining.	14
5	Joining/fastening processes: Physics of welding, brazing and soldering; design considerations in welding, Solid and liquid state joining processes;Adhesive bonding.	8

CO-PO Mapping

Manufacturing Processes

(Course Code PC-ME302**)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	1	1	1	2	1	1	1	1	1	1	1	3	3	1	2
CO 2	2	3	2	1	3	1	-	1	1	-	1	2	2	1	1
CO 3	3	1	1	-	1	-	-	-	1	1	2	2	3	1	3

Learning Resources:

1. Kalpakjian and Schmid, Manufacturing Processes for Engineering Materials (5th Edition)-Pearson India, 2014

2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, andSystems, Wiley Publication.
3. Degarmo, Black &Kohser, Materials and Processes in Manufacturing, Wiley Publication.
4. Mehta & Gaira, Manufacturing Process, Viva Books

PC-ME391- Practice of Manufacturing Processes

Course Outcome (CO)

Student will be able to:

CO1	The different conventional and unconventional manufacturing methods employed for making different products
CO2	Understand integral parts of conventional lathe, shaping and milling machines and various accessories and attachments used
CO3	Working fitting models according to drawings using hand tools- V-block, marking gauge, files, hack saw, Drills etc.
CO4	Perform machining operations like that plain shaping, inclined shaping, keyway cutting, Indexing and Gear cutting

Subject Code : PC-ME391	**Category:** Professional Core courses
Subject Name : Practice of Manufacturing Processes	**Semester** : Fourth
L-T-P : **0-0-3**	**Credit:3**
Pre-Requisites: No prerequisite	

Course Content:

It should include about 12 practicing modules (1 module= 3Hour class a week) covering:

1. Machine Shop: Taper turning, drilling, boring, shaping and milling operations- 3 modules
2. Pattern Making: 1 or 2 wooden patterns to make- 2 modules
3. Moulding: 1 module
4. Smithy Shop: 1 module

5. Welding Shop: Practicing SMAW, Gas Welding and/or GMAW- 2 modules
6. Fitting Shop: 2 modules
7. Sheet Metal Shop: 1 module

CO-PO Mapping Practice of Manufacturing Processes (Course Code PC-ME391)														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO 1	1	1	1	2	1	1	1	1	1	1	1	3	3	1	2
CO 2	2	3	2	1	3	1	-	1	1	-	1	2	2	1	1
CO 3	3	1	1	-	1	-	-	-	1	1	2	2	3	1	3
CO 4	2	1	1	1	1	1	1	-	1	2	2	1	1	-	1

4th Semester

ES ME 401- Materials Engineering

Course Outcome (CO)

Student will be able to:

CO1	Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.
CO2	To provide a detailed interpretation of equilibrium phase diagrams
CO3	Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

Subject Code : ES-ME401	**Category:** Engineering Science Courses
Subject Name : Materials Engineering	**Semester** : Fourth
L-T-P : **3-0-0**	**Credit:3**
Pre-Requisites: No prerequisite	

Module No.	Description of Topic	Contact Hrs.
1	Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; Dislocation strengthening mechanisms and slip systems, critically resolvedshear stress.	6
2	Mechanical Property measurement: Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength.	6
3	Static failure theories: Ductile and brittle failure mechanisms, Tresca, Von- mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr- Coulomb; Fracture mechanics: Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture withfatigue, Introduction to nondestructive testing (NDT)	8
4	Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binaryphase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstrctural aspects of ledeburite, austenite, ferrite and cementite, cast iron.	6
5	Heat treatment of Steel: Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys andmicrostructure development. Continuous cooling curves andinterpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening	6

6	Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titanium alloys	8

Learning Resources:

1. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition,Wiley India.
2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of IndiaPrivate Limited, 4th Indian Reprint, 2002.
3. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999.
4. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.

CO-PO Mapping

Materials Engineering

(Course Code ES-ME401**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO 1	3	2	1	2	1	1	1	-	1	1	1	3	3	1	2
CO 2	3	3	1	1	1	2	1	1	-	-	1	3	1	1	1
CO 3	3	1	-	-	1	-	1	-	1	1	1	2	3	2	1

PC ME 401- Applied Thermodynamics

Course Outcome (CO)

Student will be able to:

CO1	To learn about gas and vapor cycles and their first law and second law efficiencies
CO2	To understand about the properties of dry and wet air and the principles of psychrometry
CO3	To learn the about reciprocating compressors with and without intercooling
CO4	They will be able to understand phenomena occurring in high speed compressible flows

Subject Code : PC-ME401	**Category:** Professional Core courses
Subject Name : Applied Thermodynamics	**Semester** : Fourth
L-T-P : **3-1-0**	**Credit:4**
Pre-Requisites: No-prerequisite	

Module No.	Description of Topic	Contact Hrs.
1	Introduction to solid, liquid and gaseous fuels– Stoichiometry, exhaust gas analysis- First law analysis of combustion reactions- Heat calculations using enthalpy tables- Adiabatic flame temperature- Chemical equilibrium and equilibrium composition calculations using free energy.	8
2	Vapor power cycles Rankine cycle with superheat, reheat and regeneration, exergy analysis. Super-critical and ultra super-critical Rankine cycle- Gas power cycles, Air standard Otto, Diesel and Dual cycles- Air standard Braytoncycle, effect of reheat, regeneration and intercooling- Combined gas and vapor power cycles- Vapor compression refrigeration cycles, refrigerants and their properties.	12
3	Properties of dry and wet air, use of psychometric chart, processes involving heating/cooling and humidification/dehumidification, dew	4

	point.	
4	Basics of compressible flow. Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow- Flow of steam and refrigerant through nozzle, super saturation- compressible flow in diffusers, efficiency of nozzle and diffuser.	8
5	Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors.	5
6	Analysis of steam turbines, velocity and pressure compounding of steam turbines	3

Learning Resources:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, *Fundamentals ofThermodynamics*, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, *Engineering Thermodynamics*, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, *Fundamentals of Engineering Thermodynamics*, JohnWiley and Sons.
4. Nag, P.K, 1995, *Engineering Thermodynamics*, Tata McGraw-Hill Publishing Co. Ltd

CO-PO Mapping

Applied Thermodynamics

(Course Code PC-ME401**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO 1	3	2	1	2	1	1	1	-	1	1	1	3	3	1	2
CO 2	3	3	1	1	1	2	1	1	-	-	1	3	1	1	1
CO 3	3	1	-	-	1	-	1	-	1	1	1	2	3	2	1

CO 4	3	1	-	-	1	-	1	-	1	1	1	2	3	2	1

PC ME 402- Fluid Mechanics and Fluid Machines

Course Outcome (CO)

Student will be able to:

CO1	Understand the concept of fluid and its kinematic as well as dynamic properties.
CO2	Evaluate flow through pipes, orifices, V-notches, weirs, open channels.
CO3	Analyze and investigation on flow systems like Buckingham Pi theorem, Dimensionless numbers in fluid flow, submerged bodies, drag and lift, Boundary layer.
CO4	Demonstrate the concept of hydraulic turbine, reciprocating pumps and centrifugal pumps.

Subject Code : PC-ME402	**Category:** Professional Core courses
Subject Name : Fluid Mechanics & Fluid Machines	**Semester** : Fourth
L-T-P : **3-1-0**	**Credit:4**
Pre-Requisites: No-prerequisite	

Module No.	Description of Topic	Contact Hrs.
1	Definition of fluid, Newton's law of viscosity, Units and dimensions- Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume- applicationof continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications.	9

2	Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram.	9
3	Need for dimensional analysis – methods of dimension analysis – Similitude – types of similitude Dimensionless parameters – application ofdimensionless parameters – Model analysis.	6
4	Euler's equation – theory of Rotodynamic machines – various efficiencies –velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps- Reciprocating pump – working principle.	8
5	Classification of water turbines, heads and efficiencies, velocity triangles-Axial, radial andmixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube- Specific speed, unit quantities, performance curves for turbines – governing of turbines.	8

Learning Resources:

1. Fluid Mechanics & Hydraulic Machines, S.S. Rattan, Khanna Book Publishing Co., 2018
2. Fluid Mechanics and Machinery, R.K.Bansal, Laxmi Publication.
3. Introduction to Fluid Mechanics & Fluid Machines, Som and Biswas, TMH.
4. A Textbook on Fluid Mechanics and Machines, S.Pati, McGrawHill.
5. Fluid Mechanics and Machinery, C.S.P.Ojha, R. Berndtsson and P. N. Chadramouli, OxfordUniversity Press, 2010.
6. Hydraulics and Fluid Mechanics, P M Modi and S M Seth, Standard Book House.

CO-PO Mapping

Fluid Mechanics & Fluid Machines

(Course Code PC-ME402**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO 1	3	2	1	2	1	1	1	-	1	1	2	3	3	1	2
CO 2	3	3	1	1	1	2	1	1	1	-	1	3	1	-	1

CO 3	3	1	-	-	2	-	-	-	1	1	2	2	3	2	1
CO 4	2	1	2	1	1	-	1	-	1	1	1	2	3	2	1

PC ME 403- Strength of Materials

Course Outcome (CO)

Student will be able to:

CO1	Analyze various types of stresses & strains developed in a body against the application of external forces.
CO2	Determine shear force and bending moment for designing system components to meet desired characteristics from economic, environmental and social considerations.
CO3	Evaluate the beam stresses for a safe and sustainable design application and apply in constructive projects.
CO4	Understand the effect of torsion on beams and columns for a variety of loading conditions which boosts industrial skills.

Subject Code : PC-ME403	**Category:** Professional Core courses
Subject Name : Strength of Materials	**Semester** : Fourth
L-T-P : **3-1-0**	**Credit:4**
Pre-Requisites: No-prerequisite	

Module No.	Description of Topic	Contact Hrs.
1	Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses- elastic constants and their relations- volumetric, linearand shear strains- principal stresses and principal planes- Mohr's circle.	8

2	Beams and types transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution andneutral axis, shear stress distribution, point and distributed loads.	8
3	Moment of inertia about an axis and polar moment of inertia, deflection ofa beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems. Buckling of columns, Euler's theory, critical loads for different types ofconstraints.	10
4	Torsion, stresses and deformation in circular and hollow shafts, steppedshafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs.	8
5	Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure	8

Learning Resources:

1. D.S. Bedi, Strength of Materials, Sixth Edition, Khanna Publishing House, 2019
2. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
3. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
4. R.K. Bansal, Strength of Materials, Laxmi Publications
5. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, TataMcGraw Hill Publishing Co. Ltd., New Delhi 2005.
6. Debabrata Nag and Abhijit Chanda, Fundamentals of Strength of Materials, Wiley India.

CO-PO Mapping

Strength of Materials

(Course Code PC-ME403**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO 1	3	2	1	2	1	1	1	1	1	1	2	3	3	1	2

CO 2	3	2	2	1	1	2	1	1	1	-	1	3	1	1	1
CO 3	2	2	-	-	2	-	-	-	1	1	3	2	3	2	2
CO 4	2	1	2	1	1	1	1	-	1	1	1	2	3	1	1

PC ME 404- Metrology and Instrumentation

Course Outcome (CO)

Student will be able to:

CO1	Understand the working of linear and angular measuring instruments.
CO2	Know the fundamentals of limits and limit gauges, various methods for measurement of screw thread and surface roughness parameters and the working of optical measuring instruments.
CO3	Acquire an overview of mechanical measurement systems and principle of instruments for motion and dimension measurement.
CO4	Get basic idea about working principle and applications of devices for measurement of force and torque; strain and stress and temperature.

Subject Code : PC-ME404	**Category:** Professional Core courses
Subject Name : Metrology & Instrumentation	**Semester** : Fourth
L-T-P : **3-1-0**	**Credit:4**
Pre-Requisites: No-prerequisite	

Module No.	Description of Topic	Contact Hrs.
1	Concept of measurement:-Introduction to Metrology; Need for high precision measurements; Terminologies in Measurement- Precision, accuracy, sensitivity, calibration, resolution. Errors in Measurement, types of errors, Abbe's Principle. Basic standards of length- Line standard, End standards, Wavelength standard; Various Shop floor standards. Linear Measurement – Slip gauges, wringing, grades; Surface plate; Dial indicators; Height gauges and Vernier calliper; screw gauge. Comparators- mechanical, electrical, optical and pneumatic. Angular Measurement – Bevel protractor; Sine Bar, principle and use of sine bar, sine centre; Angle gauges. Sprit level; Angle Dekkor; Clinometers.	8
2	Limits and Limit gauges – Making to suit, selective assembly, systems of limits and fits; Types of fits; Hole basis system and Shaft basis system. Tolerance, allowance and deviation (as per BIS). Limit Gauges – GO and NO GO gauges; types of limit gauges. Gauge design - Taylor's principle of gauging; Gauge tolerance, disposition of gauge tolerance, wear allowance. Optical Measuring Instruments: - Benefits of light waves as standards; Monochromatic light; Principle of Interference. Interference band, optical flat, surface measurement. Interferometers – NPL, Pitter-NPL, auto collimator.	8
3	Screw thread measurement – Screw thread terminology; Measurement of major diameter; root diameter; pitch; effective diameter with two wire method and three wire method. Measurement of flank angle and form by profile projector and microscope. Measurement of surface texture –	8
	roughness and waviness; Analysis of surface traces, peak to valley height, R.M.S. value, Centre Line Average and Ra value, Rt, Rz etc. Methods of measuring surface roughness – Stylus probe, Tomlinson surface meter, Talysurf; surface roughness measurement – assessment length, roughness width cut-off, sampling length and evaluation length.	

4	Introduction to Digital Measurement– significance of Digital measurement; methods; Classification. Stages in generalized measuring system– Sensor- Transducer stage, Signal-Conditioning stage, Readout-Recording stage; Types of input quantities; Active and Passive transducers. Performance characteristic of measuring devices. Drift, Resolution, Threshold, Hysteresis, Static calibration. Dynamic characteristics- different order systems and their response-, Measuring lag, Fidelity, Dynamic error; Transducers– Working, Classification of transducers. Motion and Dimension measurement – LVDT – Principle, applications, advantages and limitations.	8
5	Strain and Stress Measurement- Electrical resistance strain gauge- Principle, operation. Measurement of Force and Torque– Strain-Gauge Load Cells, Hydraulic and Pneumatic load cells– force measurement using piezoelectric quartz crystal. Torque Measurement– Dynamometers– Mechanical, Hydraulic and Electrical. Vibration measurement– Vibrometers and Accelerometers. Temperature Measurement– Use of Thermal Expansion– Liquid-in-glass thermometers, Bimetallic strip thermometer, Pressure thermometers. Thermocouples– Resistance Temperature Detectors (RTD); Thermistors; Pyrometers.	8

CO-PO Mapping

Metrology & Instrumentation

(Course Code PC-ME404**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO 1	3	2	1	2	1	1	1	1	1	1	2	3	3	1	2
CO 2	3	2	2	1	1	2	-	1	1	-	2	3	1	1	2
CO 3	2	3	-	-	2	-	-	-	2	1	3	2	3	2	2
CO 4	2	2	2	1	1	2	1	-	1	1	1	2	2	-	1

MC 481- Environmental Science

Course Outcome (CO)

Student will be able to:

CO1	Gaining in-depth knowledge on natural processes that sustain life and govern economy.
CO2	Predicting the consequences of human actions on the web of life, global economy andquality of human life.
CO3	Developing critical thinking for shaping strategies (scientific, social, economic andlegal) for environmental protection and conservation of biodiversity, social equity andsustainable development.
CO4	Acquiring values and attitudes towards understanding complex environmental economic-social challenges, and participating actively in solving current environmental problems and preventing the future ones.
CO5	Adopting sustainability as a practice in life, society and industry.

Subject Code : MC481	**Category:** Mandatory courses
Subject Name : Environmental Science	**Semester** : Fourth
L-T-P : **0-0-2**	**Credit: 0**
Pre-Requisites: No-prerequisite	

(a) Awareness Activities:

I. Small group meetings about water management, promotion of recycle use,generation of less waste, avoiding electricity waste
II. Slogan making event
III. Poster making event
IV. Cycle rally
V. Lectures from experts

(b) Actual Activities:

I. Plantation
II. Gifting a tree to see its full growth
III. Cleanliness drive
IV. Drive for segregation of waste
V. To live some big environmentalist for a week or so to understand his work
VI. To work in kitchen garden for mess
VII. To know about the different varieties of plants

VIII. Shutting down the fans and ACs of the campus for an hour or so

CO-PO Mapping Environmental Science **(Course Code** MC481**)**															
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO 1	3	2	1	2	1	1	1	1	1	1	2	3	1	1	2
CO 2	2	1	2	1	1	2	-	1	1	-	2	3	-	1	1
CO 3	2	3	-	-	1	-	-	-	1	1	-	2	1	2	2
CO 4	2	2	2	1	1	2	1	-	1	1	1	2	2	-	1

PC ME 491- Practice of Manufacturing Processes and systems Laboratory

Course Outcome (CO)

Student will be able to:

CO1	Interpret the casting processes
CO2	Recognize the principles of welding
CO3	Correlate the forming processes like forging

Subject Code : PC-ME491	**Category:** Professional Core courses
Subject Name : Practice of Manufacturing Processes and Systems Laboratory	**Semester** : fourth
L-T-P : 0-0-3	**Credit:1.5**
Pre-Requisites: No prerequisite	

List of Experiments:

It should include about 12 experiments as outlined below:

i) Laboratory modules of pneumatics and/or electro-pneumatics
ii) Laboratory modules of hydraulics and/or electro-hydraulics
iii) Study of working of Logic Gates practically
iv) Simulation of designed pneumatics / hydraulics systems
v) Measurement of surface roughness
vi) Measurement of tapered objects using Sine Bar and using balls and rollers, etc.
vii) Measurement of threads using three wire method
viii) Measurement of gears
ix) Measurement of bore diameter using micrometer and gauges
x) Measurement of angles using bevel vernier protractor
xi) Statistical process control system to apply to measured dimension of samples
xii) Practicing different gauges to assess angles, thread, internal and external radius, etc.

CO-PO Mapping Practice of Manufacturing Processes and Systems Laboratory **(Course Code** PC-ME491**)**														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO 1	3	2	1	2	1	1	1	1	1	1	2	3	1	1	2
CO 2	2	3	2	1	1	2	-	1	1	1	2	3	3	3	1
CO 3	2	3	-	-	1	1	1	-	1	1	-	2	1	2	2

PC ME 492- Machine Drawing I

Course Outcome (CO)

Student will be able to:

CO1	Understand and apply the knowledge of machine drawing as a system of Communication in which ideas are expressed clearly and all information fully conveyed.
CO2	Understand the design a system, component or process to meet desired needs within, realistic constraints such as manufacturability, economic, environmental, safety & sustainability etc., to represent a part drawing and assembly drawings.
CO3	Identify, formulates, analyzes and solve Engineering Problems in Optimum time.

Subject Code : PC-ME492	**Category:** Professional Core courses
Subject Name :Machine Drawing I	**Semester** : fourth
L-T-P : 0-0-3	**Credit:1.5**
Pre-Requisites:	

Schematic product symbols for standard components in mechanical, electrical and electronic systems, welding symbols and pipe joints; Orthographic projections of machine elements, different sectional views- full, auxiliary sections; Isometric projection of components; Assembly and detailed drawings of a mechanical assembly, such as a plummer block, tool head of a shaping machine, tailstock of a lathe, simple gear box, flange coupling, welded bracket joined by stud bolt on to a structure, welded pipe joints indicating work parts before welding, etc.

Practicing AutoCAD or similar graphics softwares and making orthographic and isometric projections of different components.

CO-PO Mapping

Machine Drawing I

(Course Code PC-ME492**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	2	1	2	1	1	1	1	1	1	2	3	2	1	2
CO 2	2	3	2	1	1	1	-	1	1	1	2	3	3	3	1
CO 3	2	3	1	-	1	1	1	-	1	1	-	2	1	2	2

5th Semester

PC ME 501- Heat Transfer

Course Outcome (CO)

Student will be able to:

CO1	Formulate and analyze a heat transfer problem involving any of the three modes of heat transfer
CO2	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	Design devices such as heat exchangers and also estimate the insulation needed to reduce heat losses where necessary.

Subject Code : PC-ME501	**Category:** Professional Core Courses
Subject Name : Heat Transfer	**Semester** : Fifth
L-T-P : 3-1-0	**Credit: 4**
Pre-Requisites: Engineering Thermodynamics	

Module No.	Description of Topic	Contact Hrs.
1	Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heissler charts.	14

2	Heat convection, basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection-Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.	10
3	Interaction of radiation with materials, definitions of radioactive properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method.	9
4	Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and ε - NTU methods.	7
5	Boiling and Condensation heat transfer, Pool boiling curve.	4
6	Introduction to mass transfer, Similarity between heat and mass transfer.	4

Learning Resources:

1. A. Bejan, Heat Transfer, John Wiley, 1993
2. J.P. Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. F.P. Incropera and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, 6 th Edition,John Wiley,2007.
4. M. Kaviany, Principles of Heat Transfer, John Wiley, 2002
5. Y.A. Cengel, Heat Transfer: A Practical Approach, McGraw Hill, 2002

CO-PO Mapping

Heat Transfer

(Course Code - PC-ME501**)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO 1	2	3	-	2	1	1	1	-	1	1	2	3	2	1	2
CO 2	2	3	1	1	1	2	1	1	1	-	1	3	1	2	1
CO 3	1	1	-	-	3	-	1	-	-	2	-	1	1	1	1

PC ME 502- Solid Mechanics

Course Outcome (CO)

Student will be able to:

CO1	Learn about the elastic and plastic behavior of material and evaluate stress invariants,Principal stresses and their directions.
CO2	Determine strain invariants, principal strains and their directions.
CO3	Develop constitutive relationships between stress and strain for linearly elastic solid.
CO4	Analyze theories of failure and design components for safe operation.
CO5	Examine the properties of ideally plastic solid and apply the concepts of energy methods in solving structural

	problems.

Module No.	Description of Topic	Contact Hrs.
1	Introduction to Cartesian tensors, Strains: Concept of strain, derivation of small strain tensor and compatibility, Stress: Derivation of Cauchy relations and equilibrium and symmetry equations, principal stresses and directions	12
2	Constitutive equations: Generalized Hooke's law, Linear elasticity, Material symmetry; Boundary Value Problems: concepts of uniqueness and superposition.	10
3	Plane stress and plane strain problems, introduction to governing equations in cylindrical and spherical coordinates, axisymmetric problems.	10
4	Application to thick cylinders, rotating discs, torsion of non- circular cross-sections, stress concentration problems, thermo-elasticity, 2-D contact problems.	9
5	Solutions using potentials. Energy methods. Introduction to plasticity.	7

CO-PO Mapping

Solid Mechanics

(Course Code - PC-ME502**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO 1	3	3	-	2	1	1	1	-	1	1	2	3	2	1	2
CO 2	1	3	1	1	1	2	1	1	1	-	1	3	1	2	1
CO 3	1	1	-	-	1	-	-	-	-	2	-	1	1	-	1
CO 4	3	2	1	2	2	2	-	2	2	2	2	2	2	1	3
CO 5	2	1	2	3	3	1	-	-	3	1	3	3	1	-	1

Learning Resources:

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

PC ME 503- Kinematics and Theory of Machines

Course Outcome (CO)

Student will be able to:

CO1	Build up critical thinking and problem-solving capacity of various mechanical engineering problems related to kinematics of machines.
CO2	Asses various concepts of mechanisms like straight line motion mechanisms, Steering gear mechanisms and working principles of power elements (Gears, gear trains, Cams, Belt and Chain drives) and design related problems effectively.
CO3	Utilize analytical, mathematical and graphical aspects of kinematics of Machines for effective design.

Subject Code : PC-ME502	**Category:** Professional Core Courses
Subject Name : Solid Mechanics	**Semester** : Fifth
L-T-P : 3-1-0	**Credit: 4**
Pre-Requisites: Engineering Mechanics	

Module No.	Description of Topic	Contact Hrs.
1	Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain and slider crank chains. Limit positions- Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms.	6
2	Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamics- Coincident points- Corioli's component of acceleration- introduction to linkage synthesis- three position graphical synthesis for motion and path generation.	7

3	Classification of cams and followers- Terminology and definitions- Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of followermotions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers.	5
4	Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics**.**	6
5	Surface contacts- sliding and rolling friction- friction drives- bearings and lubrication, Friction clutches- Belt and Rope drives- Friction in brakes.	6
6	Vibrations– Free and forced vibration of undamped and damped Single DOF systems, Resonance, Transmissibility Ratio, Effect of damping, Vibration Isolation, Critical Speed of Shafts.	6
7	Balancing of Reciprocating and Rotating Masses- Staticbalancing, Unbalance of force or moment, Dynamic balancing of rotating masses- graphical and analytical methods; Swaying couple; Hammer blow.	4
8	Governors- Use and classification; Study and analysis of Porter, Proell and Wilson-Hartnell governors; Sensitiveness, stability, isochronism, hunting, effort and power of governors.	3
9	Flywheel- Inertia force and inertia torque in reciprocating engine, correction couple (torque), Turning moment diagram and flywheel design.	3
10	Gyroscope- Gyroscopic couple and precessional motion, Effect of gyroscopic couple on aeroplane and ship, Stability of two wheel and four wheel vehicles taking turn.	2

Learning Resources:

1. T. Bevan, Theory of Machines, 3rd Edition, CBS Publishers & Distributors, 2005.
2. A. Shariff, Theory of Machines, Dhanpat Rai Publication, New Delhi, 2000.
3. W.L. Cleghorn, Mechanisms of Machines, Oxford University Press, 2005.
4. R.L. Norton, Kinematics and Dynamics of Machinery, 1st Edition, McGraw Hill India, 2010.
5. A. Ghosh and A.K. Mallick, Theory of Mechanisms and Machines, Affiliated East-West Pvt.Ltd., New Delhi, 1988.

CO-PO Mapping Kinematics and Theory of Machines **(Course Code -** PC-ME 503)														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO 1	3	3	-	2	1	1	1	-	1	1	2	3	2	2	2
CO 2	2	3	1	1	3	3	1	1	1	-	1	3	3	2	1
CO 3	1	1	-	-	2	-	-	-	-	2	-	1	1	3	1

HM HU 501- Humanities I (Effective Technical Communication)

Course Outcome (CO)

Student will be able to:

CO1	Understand the dynamics of Verbal and Non Verbal aspects of technical communication
CO2	Practice multi-step writing process to plan, draft, and revise reports, correspondence, and presentations.
CO3	Illustrate and examine the knowledge of ethical aspects of engineering
CO4	Demonstrate and explain social and professional etiquettes
CO5	Plan self-development and practice self-assessment to function on multi-disciplinary teams.

Subject Code : PC-ME 503	**Category:** Professional Core Courses
Subject Name : Kinematics and Theory of Machines	**Semester** : Fifth
L-T-P : 3-1-0	**Credit: 4**
Pre-Requisites: Engineering Mechanics	

Module No.	Description of Topic	Contact Hrs.
1	Information Design and Development- Different kinds of technical documents, Information development life cycle, Organization structures, factors affecting information and document design, Strategies for organization, Information design and writing for print and for online media.	7
2	Technical Writing, Grammar and Editing- Technical writing process, forms of discourse, Writing drafts and revising, Collaborative writing, creating indexes, technical writing style and language. Basics of grammar,study of advanced grammar, editing strategies to achieve appropriate technical style. Introduction to advanced technical communication, Usability, Hunan factors, Managing technical communication projects, time estimation, Single sourcing, Localization.	8
3	Self Development and Assessment- Self assessment, Awareness, Perception and Attitudes, Values and belief, Personal goal setting, career planning, Self-esteem. Managing Time; Personal memory, Rapid reading, Taking notes; Complex problem solving; Creativity	6
4	Communication and Technical Writing- Public speaking, Group discussion, Oral; presentation, Interviews, Graphic presentation, Presentation aids, Personality Development. Writing reports, project proposals, brochures, newsletters, technical articles, manuals, official notes, business letters, memos, progress reports, minutes of meetings, event report.	8
5	Ethics- Business ethics, Etiquettes in social and office settings, Email etiquettes, Telephone Etiquettes, Engineering ethics, Managing time, Role and responsibility of engineer, Work culture in jobs, Personal memory, Rapid reading, Taking notes, Complex problem solving, Creativity.	7

Learning Resources:

1. D.F. Beer and D. McMurrey, Guide to Writing as an Engineer, John Willey, New York, 2004
2. D. Hacker, Pocket Style Manual, Bedford Publication, New York, 2003.
3. S. Khera, You Can Win, Macmillan Books, New York, 2003.
4. R. Sharma, Technical Communications, Oxford Publication, London, 2004.
5. D. Jungk, Applied Writing for Technicians, McGraw Hill, New York, 2004.
6. R. Sharma and K. Mohan, Business Correspondence and Report Writing, 5th Edition,McGraw Hill Education, 2017.
7. Xebec, Presentation Book, McGraw Hill Education India, New Delhi, 2000.

CO-PO Mapping

Humanities I (EffectiveTechnical Communication)

(Course Code - HM-HU501**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO
CO1	2	3	-	2	1	1	1	-	1	1	2	3	2	1	2
CO2	1	3	1	1	1	2	1	1	1	-	1	3	-	1	1
CO3	2	1	-	-	1	-	-	-	-	2	-	1	-	-	1
CO4	3	2	1	2	-	2	-	2	2	1	2	-	1	1	3
CO5	2	1	2	3	3	1	-	-	3	1	3	3	1	-	2

MC ME 501- Essence of Indian Knowledge Tradition

Course Outcome (CO)

Student will be able to:

CO1	Understand the concept of Traditional knowledge and its importance
CO2	Know the need and importance of protecting traditional knowledge.
CO3	Know the various enactments related to the protection of traditional knowledge.
CO4	Understand the concepts of Intellectual property to protect the traditional knowledge

Subject Code : HM-HU501	**Category:** Humanities and Social Sciences
Subject Name : Humanities I (Effective Technical Communication)	**Semester** : Fifth
L-T-P : 3-0-0	**Credit: 3**
Pre-Requisites: Basic English	

Module No.	Description of Topic	Contact Hrs.
1	Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge	5
2	Protection of traditional knowledge (TK): the need for protecting traditional knowledge Significance of TK Protection, value of TK inglobal economy, Role of Government to harness TK.	4

3	Legal frame work and TK: A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); B: The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indicators act 2003.	5
4	Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.	5
5	Traditional knowledge in different sectors: Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.	5

Learning Resources:

1. A. Jha, Traditional Knowledge System in India, 2009.
2. B.K. Mohanta and V.K. Singh, Traditional Knowledge System and Technology in India,Pratibha Prakashan, 2012.
3. K. Kapoor and M. Danino, Knowledge Traditions and Practices of India, Central Board ofSecondary Education, 2012.
4. E-Resources: http://nptel.ac.in/courses/121106003/

CO-PO Mapping

Humanities I (Essence of Indian Knowledge Tradition)

(Course Code - MC ME501**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO 1	2	1	-	-	1	3	1	3	1	1	2	3	2	1	2
CO 2	1	-	1	1	1	2	1	1	-	-	-	1	-	1	1
CO 3	-	-	-	-	1	1	1	2	-	2	-	1	-	-	-
CO 4	1	2	1	2	-	2	2	2	2	2	2	-	1	1	-

PC ME 591- Mechanical Engineering Laboratory (Thermal)I

Course Outcome (CO)

Student will be able to:

CO1	Calculate the mean effective pressure and air standard efficiency of different gas power cycles.
CO2	Calculate the performance test on IC engines.
CO3	Sketch the velocity diagrams of single and multi-stage turbines.
CO4	Explain the classification and working principle of various types of air compressors.
CO5	Calculate properties of moist air and COP of vapor refrigeration systems by using refrigeration table and chart.

Subject Code : PC-ME591	**Category:** Professional Core Courses
Subject Name : Mechanical Engineering Laboratory (Thermal) I	**Semester** : Fifth
L-T-P : 0-0-3	**Credit: 1.5**
Pre-Requisites: Engineering Thermodynamics and Fluid Mechanics and Fluid Machines	

Course Contents

1. Measurement of coefficient of discharge of given Orifice and Venturimeters
2. Determination of the density & viscosity of an oil and friction factor of oil flow in a pipe
3. Determination of the performance characteristics of a centrifugalpump
4. Determination of the performance characteristics of Pelton Wheel
5. Determination of the performance characteristics of a Francis Turbine
6. Determination of the performance characteristics of a Kaplan Turbine
7. Determination of the thermal conductivity and specific heat of givenobjects
8. Determination of the calorific value of a given fuel and its flash & fire points
9. Determination of the p-V diagram and the performance of a 4-stroke dieselengine
10. Determination of the convective heat transfer coefficient for flow over a heated plate
11. Determination of the emissivity ofa given sample

CO-PO Mapping

Mechanical Engineering Laboratory (Thermal) I

(Course Code- PC-ME591**)**

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

PC ME 592- Machine Drawing-II

Course Outcome (CO)

Student will be able to:

CO1	Calculate the mean effective pressure and air standard efficiency of different gas power cycles.
CO2	Calculate the performance test on IC engines.
CO3	Sketch the velocity diagrams of single and multi-stage turbines.
CO4	Explain the classification and working principle of various types of air compressors.
CO5	Calculate properties of moist air and COP of vapor refrigeration systems by using refrigeration table and chart.

Subject Code: PC-ME592	**Category:** Professional Core Courses
Subject Name: Machine Drawing-II	**Semester**: Fifth
L-T-P: **0-0-3**	**Credit: 1.5**
Pre-Requisites: Engineering Drawing	

The contents should include about 10 assignments with the focus given as outlined below:

UNIT - I Projection and Isometric Drawing of Machine components

Fasteners: Drawings of various views of Screw threads, metric and BSW threads, Square thread and multi start threads. Nut bolts, Washers, Setscrew, Locknuts and foundation bolts. Riveted joints: Forms and proportions of river heads, Different views of different types of riveted Lapand Butt joints.

Drawings of various views of Shaft joints: Cotter joint and Knuckle joint. Keys & Shaft coupling: Muff, Flanged, Flexible, Universal and Oldhams coupling.

UNIT - II Assignments using graphic software

Assembly and detailed drawings: Tool head of a shaping machine; Engine parts: Eccentric, Piston, Cross head and Connecting rod; Valves: Steam stop valve, Anyone of safety, relief and non-return valves; Solid modeling of Plummer block

Learning Resources:

1. N.D.Bhatt, Machine Drawing, 46th Edition, Charotar Publishing House, India, 2011.
2. P.S. Gill, Machine Drawing, 18th Edition, S.K. Kataria & Sons, Delhi, 2013.
3. T. Jones, Machine Drawing, John Heywood Ltd, Manchester, UK, 2012.

CO-PO Mapping

Machine Drawing-II

(Course Code- PC-ME592**)**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	1	1	1	-	1	1	2	3	2	1	2
CO2	3	3	1	1	1	1	2	1	1	-	2	3	3	3	2
CO3	2	1	1	2	1	-	-	-	-	2	1	1	3	1	1

PW ME 581- Project-I

Course Outcome (CO)

Student will be able to:

CO1	Develop the ability to solve a specific problem right from its identification.
CO2	Literature review till the successful solution of the same
CO3	To gather some exposure on some projects, maybe designing some innovative ideas, fabricating and / or demonstrating an innovative machine or product etc.

Subject Code : PW-ME581	**Category:** Project (Summer internship)
Subject Name : Project-I	**Semester** : Fifth
L-T-P : 0-0-2	**Credit: 1**
Pre-Requisites: Nil	

CO-PO Mapping

Project-I

(Course Code- PW-ME581**)**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	1	1	1	-	1	1	3	3	2	1	2
CO2	3	3	1	-	1	1	2	1	1	1	3	3	3	3	2
CO3	2	1	2	2	-	-	-	-	-	2	1	2	3	1	3

6th Semester

PC ME 601- Manufacturing Technology

Course Outcome (CO)

Student will be able to:

CO1	Understand all machines and related tools for manufacturing various components.
CO2	Understand the relationship between process and system in manufacturing domain.
CO3	Analyze the experiment on CNC machine tools.
CO4	Demonstration rapid prototyping methods.

Subject Code : PC-ME601	**Category:** Professional Core Courses
Subject Name : Manufacturing Technology	**Semester**: Sixth
L-T-P: **4-0-0**	**Credit: 4**
Pre-Requisites: Primary Manufacturing Processes	

Module No.	Description of Topic	Contact Hrs.
1	Tooling for conventional and non-conventional machining processes: Mould and die design, Press tools, Cutting tools; Holding tools: Jigs and fixtures, principles, applications and design; Press tools: Configuration, design of die and punch; principles of forging die design.	12
2	Metrology: Metrology in tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as micro-scale machining, Inspection and workpiece quality.	8
3	Assembly practices: Manufacturing and assembly, process planning, selective assembly, Material handling and devices.	6

4	**NC/CNC Machine Tools and Systems** Types of automation: Fixed (or hard) and programmable (or flexible); need, advantages and applications of flexible automation over fixed automation. **Components and Their Functions in NC/CNC Machines** MCU, DPU and CLU, Feed drives using stepper/ servo motors and recirculating ball screw-nut system, Automatic Tool Changers- Tool Turret and Tool Magazine, Automatic pallet Changer. **Basic systems of NC and CNC machines** Coordinate system, Control– open loop and closed loop, Dimensioning– absolute and incremental, Point–to–point and contour motion, Linear and circular Interpolation. **CNC Machine Tools and Integrated Automation** Structure and working principle of CNC lathe, milling machine,	8
	Examples and use of CNC machines, Machining Centre (Vertical and Horizontal), Integrated Automation systems (DNC- Direct and Distributed or BTR and Dedicated system, FMS- FFMS, FMC and FMM)– characteristics and applications.	
5	**Part Programming for CNC machines** Manual Part Programming using ISO G and M Codes in CNC lathe and milling machine for simple jobs, Canned cycle. Computer Aided Part Programming using MACRO statements in APT for simple jobs in CNC lathe and milling machine.	8
6	**Rapid Prototyping** Overview of Rapid Prototyping, Basic Process- CAD Model Creation, Conversion to STL format, Slicing the STL File, Layer by layer construction. Use of CMM and 3-D Camera for making virtual model. Principles, systems, relative advantages and applications of the common RP methods, such as Stereo lithography (SLG), Selective laser sintering (SLS), Fused deposition modelling (FDM), Laminated objects manufacturing (LOM), 3-D Printing.	6

Learning Resources:

1. S. Kalpakjian and S.R. Schmid, Manufacturing Processes for Engineering Materials, 5thEdition, Pearson India, 2014.
2. R.K. Jain, Engineering Metrology, 21st Edition, Khanna Publication, New Delhi, 1984.
3. P.N. Rao, N.K. Tewari and T.K. Kundra, Computer Aided Manufacturing, McGraw Hill,2017.
4. Y. Koren, Computer Control of Manufacturing Systems, McGraw Hill, 1986.
5. M.P. Grover, Fundamentals of Modern Manufacturing, 3rd Edition, Wiley.
6. M.P. Groover, Automation, Production Systems and CIM, Prentice Hall.
7. A. Ghosh & A.K. Mullick, Manufacturing Science, EW Press.

A. Ghosh, Rapid Prototyping, EW Press

CO-PO Mapping Manufacturing Technology **(Course Code -** PC-ME601**)**														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	2	3	1	1	-	1	1	2	3	2	1	2
CO2	2	3	1	1	2	2	1	1	1	-	1	3	3	3	3
CO3	1	1	-	-	2	-	-	-	-	-	-	1	2	2	1
CO4	2	2	1	2	2	3	-	1	2	1	2	2	2	1	3

PC ME 602- Design of Machine Elements

Course Outcome (CO)

Student will be able to:

CO1	Correlate the design procedure and selection of material for a specific application.
CO2	Understand and apply failure theories in evaluating strength of machine element
CO3	Analyze machine components subjected to static and variable loads
CO4	Design machine elements like Riveted and welded joints, Bolted joints, Keys, cotters and knuckle joints, shafts and their couplings and springs.

Subject Code : PC-ME602	**Category:** Professional Core Courses
Subject Name : Design of Machine Elements	**Semester** : Sixth
L-T-P : 3-1-0	**Credit: 4**
Pre-Requisites: Strength of materials, Machine Drawing	

Module No.	Description of Topic	Contact Hrs.
1	Objective and scope of Mechanical Engineering Design; Design considerations; Review and selection of materials andmanufacturing processes; codes and standards;	4
2	Modes of failure; Design/allowable stress; Factor of safety (FoS); Theories of failure – maximum normal stress theory, maximum shear stress theory, Distortion energy theory. Choice of Failure criteria; Design for stability : buckling analysis – Johnson and Euler columns	4
3	Fatigue in metals; S-N curve; Endurance limit and fatigue strength; Stress concentration factors – effect of discontinuity, fillets and notches; Effect of size, surface finish, stress concentration and degree of reliability on endurance limit; Design for finite and infinite life; Goodman, modified Goodman and Soderberg diagrams with respect to fatigue failure under variable stresses; Cumulative fatigue damage – Miner's equation.	5
4	Design of (i) Cotter joint; (ii) Knuckle joint and (iii) Fillet Welded joint of brackets under different types of loading.	6
5	Bolted joints : Metric thread, standard sizes, use of lock nuts and washers; Applications in structures including brackets, turn buckle; Pre-stressed bolts; Riveted joints : Unwin's formula; Brief discussion on single, double and triple row lap joints, butt joints with single or double strap / cover plate; simple strength design; joint efficiencies.	6
6	Design of : (i) Solid and hollow shafts, strength design of shafts, design based on torsional rigidity; (ii) Shaft coupling-rigid, pin-bush and geared flexible type, alignment of coupling; **(iii)** Belt drives-geometrical relations, derivation of torque and power transmission by flat and V-belt drives, selection of belt from manufacturers' catalogues, **pulley** (iv) **Chain drives – roller chains, polygonal effect, power rating, sprocket wheel, silent chain**	10
7	Design of: (i) Transmission screw, Screw jack, (ii) Helical compression spring - stress and deflection equations, stiffness, curvature effect : Wahl'sfactor, springs in parallel and series; **(iii) Multi-leaf springs : load-stress and load-deflection equations, Nipping**	8
8	Analysis and design of sliding and rolling contact bearings, Design of transmission elements: spur, helical, bevel and worm gears; Analysis of clutches and brakes	5

Learning Resources:

1. J.E. Shigley and C.R. Mischke, Mechanical Engineering Design, 5th Edition, McGraw HillInternational, 1989.
2. D. Deutschman, W.J. Michels and C.E. Wilson, Machine Design Theory and

Practice,Macmillan, 1992.
3. R.C. Juvinal, Fundamentals of Machine Component Design, John Wiley, 1994.
4. M.F. Spottes, Design of Machine elements, Prentice-Hall India, 1994.
5. R. L. Norton, Mechanical Design– An Integrated Approach, Prentice Hall, 1998.
6. V. B. Bhandari, Design of Machine Elements by, McGraw Hill Publishing Co. Ltd., 2007.

P. Kannaiah, Machine Design, 2nd Edition, Scitech Publications

CO-PO Mapping

Design of Machine Elements

(Course Code - PC-ME602**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	2	3	1	1	-	1	1	2	3	2	1	2
CO2	2	3	1	1	2	2	1	1	1	-	1	3	3	3	3
CO3	3	1	-	2	2	-	-	-	-	-	-	2	2	2	1
CO4	2	2	1	2	2	3	-	1	2	1	2	2	2	1	3

HM-HU601 Humanities II (Operations Research)

Course Outcome (CO)

Student will be able to:

CO1	Apply forecasting methods for predicting demands.
CO2	Make decisions under certainty, uncertainty and conflicting situations.
CO3	Apply linear programming tools for optimal utilization of resources in various types of industries.
CO4	Solve transportation problems to minimize cost and understand the principles of assignment of jobs and recruitment polices.
CO5	Understand the basic elements of a Queuing model

Subject Code: HM-HU601	**Category:** Humanities and Social Sciences including Management Courses
Subject Name: Humanities II (Operations Research)	**Semester**: Sixth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites:	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to Operations Research:** Introduction, Historical Background, Scope of Operations Research, Features of Operations Research, Phases of Operations Research, Types of Operations Research Models, Operations Research Methodology, Operations Research Techniques and Tools, Structure of the Mathematical Model, Limitations of Operations Research	2
2	**Linear Programming:** Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Case Studies of LPP, Graphical Methods to Solve Linear Programming Problems, Applications, Advantages, Limitations. Graphical Analysis of Linear Programming Problems: Introduction, Graphical Analysis, Some Basic Definitions, Graphical Methods to Solve LPP, Some Exceptional Cases, Important Geometric Properties of LPP. Simplex Method: Introduction, Standard Form of LPP, Fundamental theorem of LPP, Solution of LPP - Simplex Method, The Simplex Algorithm, Penalty Cost Method or Big M-method, Two Phase Method, Solved Problems on Minimisation. Duality in Linear Programming Problem: Introduction, Importance of Duality Concepts, Formulation of Dual Problem, Economic Interpretation of Duality, Sensitivity Analysis.	8
3	**Transportation Problem:** Introduction, Formulation of Transportation Problem (TP), Transportation Algorithm (MODI Method), the Initial Basic Feasible Solution, Moving Towards Optimality.	3
4	**Assignment Problem:** Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Travelling Salesman Problem	3

5	**Project Management Using CPM-PERT:** Project Scheduling and PERT-CPM: Introduction, Basic Difference between PERT and CPM, PERT/CPM Network Components and Precedence Relationship, Project Management – PERT, Float calculation and its importance. Cost reduction by Crashing of activity	5
6	**Queuing Theory:** Basis of Queuing theory, elements of queuing theory, Operating characteristics of a queuing system, Queue discipline, Service Mechanism, Classification of Queuing models, [M/M/1]:{//FCFS} Queue System, numerical	3
7	**Inventory Management:** Inventory classification, Different costs associated to Inventory, Inventory models with deterministic demands (EOQ, EPQ and price discount models), inventory classification systems	4
8	**Job Sequencing:** Introduction to sequencing and scheduling models: n job two machines problem, n job 3 machines problem	2
9	**Decision Theory:** Introduction, Decision under certainty, Decision under risk, Decision under uncertainty: Laplace criterion, MaxiMin criterion, MiniMax criterion, savage MiniMax regret criterion, Hurwicz criterion, Decision tree	3
10	**Replacement Theory:** Introduction, Replacement of capital equipment which depreciated withtime, replacement by alternative equipment, Group and individual replacement policy.	3

Learning Resources

1. F.S. Hillier, G.J. Lieberman, B. Nag and P. Basu, Introduction to Operation Research, 10th Edition, McGraw Hill, 2017.
2. C. Mohan and K. Deep, Optimization Techniques, New Age, 2009.
3. N.D. Vohra, Quantitative Techniques in Management, 5th Edition, McGraw-Hill.
4. K.V. Mittal and C. Mohan, Optimization Methods in Operations Research and SystemsAnalysis, New Age, 2003.
5. H.A. Taha, Operations Research - An Introduction, 7th Edition, Prentice Hall, 2002.
6. A. Ravindran, D.T. Phillips and J.J. Solberg, Operations Research: Principles and Practice,2nd Edition, John Willey and Sons, 2009.
7. K. Bedi, Production and Operations Management, Oxford University Press, 2004.
8. S.J. Chandra and A. Mehra, Numerical Optimization with Applications, Narosa, 2009.
9. J.K. Sharma, Operation Research: Theory and Applications, 5th Edition, Macmillan Pub.,2013.
10. L.W. Wayne, Operations Research Applications and Algorithms, 4th Edition, Brooks/Cole,USA.

CO-PO Mapping Humanities II (Operations Research) **(Course Code -** HM-HU601**)**														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	3	1	1	-	2	1	2	3	2	1	2
CO2	1	3	1	1	2	1	1	1	1	-	2	3	3	3	3
CO3	3	2	1	2	3	-	-	-	2	-	-	3	1	2	1
CO4	2	2	1	2	2	1	-	1	2	1	2	1	2	2	3
CO5	2	2	1	2	2	1	-	1	2	1	2	2	2	2	3

MC601- Constitution of India

Course Outcome (CO)

Subject Code : MC601	**Category:** Mandatory Courses
Subject Name : Constitution of India	**Semester** : Sixth
L-T-P : 0-2-0	**Credit: 0**
Pre-Requisites:	

Module No.	**Description of Topic**	**Contact Hrs.**
1	Introduction to the Constitution of India, The Making of the Constitution and Salient features of the Constitution. Preamble to the Indian Constitution Fundamental Rights & its limitations.	4
2	Directive Principles of State Policy & Relevance of Directive Principles State Policy Fundamental Duties. Union Executives – President, Prime Minister Parliament Supreme Court of India.	5
3	State Executives – Governor, Chief Minister, State Legislature High Court of State. Electoral Process in India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th & 91st Amendments.	5

4	Special Provision for SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions. Human Rights –Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India Powers and functions of Municipalities, Panchyats and Co - Operative Societies.	5
5	Special Provision for SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions. Human Rights –Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India Powers and functions of Municipalities, Panchyats and Co - Operative Societies.	5

Learning Resources:

1. D.D. Basu, Introduction to the Constitution on India, 19th/ 20th Students Edition, PrenticeHall EEE, 2001.
2. C.E. Haries, M.S. Pritchard and M.J. Robins, Engineering Ethics, Thompson Asia, 2003.
3. M.V. Pylee, An Introduction to Constitution of India, Vikas Publishing, 2002.
4. M. Govindarajan, S. Natarajan and V.S. Senthilkumar, Engineering Ethics, Prentice Hall ofIndia Pvt. Ltd., New Delhi, 2004.
5. B.K. Sharma, Introduction to the Constitution of India, PHI Learning, New Delhi, 2011.

Latest Publications, Indian Institute of Human Rights, New Delhi

CO-PO Mapping

Humanities II (Constitution of India)
(Course Code - MC601**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	1	1	2	-	1	3	1	2	2	1	2	3	1	1	2
CO 2	1	2	-	1	1	2	1	1	1	2	2	3	1	-	2
CO 3	1	2	1	-	2	1	-	1	2	-	-	3	-	1	-
CO 4	2	2	-	-	-	3	-	2	2	2	2	1	-	-	3

PE ME 601A- Internal Combustion Engines and Gas Turbines

Course Outcome (CO)

Student will be able to:

CO1	know about the systems of Refrigeration, Air-Conditioning and Ventilation.
CO2	learn about different components of these systems.
CO3	know about designing a Refrigeration and Air-Conditioning system.
CO4	Classified the essential components of gas turbine along with its performance improving methods.
CO5	Illustrated the working principle of different types of Jet propulsive engines and Rockets.

Subject Code: A	**Category:** Professional Elective Courses
Subject Name: Internal Combustion Enginesand Gas Turbines	**Semester**: Sixth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Thermodynamics, Heat Transfer	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Basic Engine components and Nomenclature, Classification of Engines, The working principle of Engines, Comparison of 2-Stroke and 4-Stroke Engines; CI, and SI Engines, Ideal and Actual Working Cycles and their analysis, Valve timing Diagram. **Fuels:** Fossil fuels, Chemical structure of Petroleum, Properties of SI and CI Engine Fuels, Fuel Ratings; Octane Number, Cetane Number.	6

2	**Carburetors & Fuel Injection:** Air Fuel Mixture Requirements, Construction and Working of Simple Carburetor, Calculation of Air-Fuel Ratio, Parts of Carburetor. Requirement of Injection Systems, Classification of Injection Systems, Fuel Feed pump, Injection Pumps, Working principles of Governors, Nozzles and Fuel Injector, Injection in SI and CI Engines. **Combustion and Ignition Systems in SI and CI Engines:** Normal and Abnormal Combustion in SI and CI Engines, Stages of Combustion, Detonation and Knocking.	7
3	**Performance parameters for IC Engines:** Engine Power, Engine Efficiencies, Performance Characteristics, Variables Effecting Performance Characteristics, Methods of Improving Engine Performance, Heat Balance. **Modern Automotive Engines:** Changes in Fuel injection Methods in S.I and C.I engines, Common Rail Direct Injection System, Gasoline Direct Injection, Variable Valve Technology, A brief review of Design changes to achieve high efficiency.	7
5	**Alternate Fuels For IC Engines:** Need for use of alternate fuels. Use of alcohol fuels. Biodiesel.	3
	Biogas and Hydrogen in engines.	
6	**Gas Turbine:** Introduction to Gas Turbines, Development, Classification and Application of Gas Turbines, Ideal and Actual Cycles; Effect of Inter cooling, Reheating, Regeneration, Combined cycle and Cogeneration.	6
7	**Gas Turbine Cycles for Aircraft Propulsion:** Criteria of performance, Intake, and propelling nozzle efficiencies, Simple Turbojet Cycle, The turboprop engine, Thrust augmentation, Gas turbine combustion systems, Combustion chamber designs, Gas Turbine Emissions.	7

Learning Resources:

1. V. Ganesan, I.C. Engines, McGraw Hill, 2017.
2. V. Ganesan, Gas Turbines, McGraw Hill, 2004.
3. C.R. Ferguson and A.T. Kirkpatrick, Internal Combustion Engines, Wiley, 2015.
4. H.N. Gupta, Fundamentals of Internal Combustion Engines, PHI, 2012.
5. H. Cohen, H.I.H. Saravanamuttoo, G.F.C. Rogers, P. Straznicky and A.C. Nix, Gas TurbineTheory, Pearson, 2019.
6. J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill Co., 1988.
7. W.W. Pulkrabek, Engineering Fundamentals of IC Engine, PHI Pvt. Ltd., 2002.

CO-PO Mapping Internal Combustion Enginesand Gas Turbines **(Course Code -** PE-ME601A**)**															
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	3	3	2	1	1	-	1	2	1	1	2	2	3	2	2
CO 2	3	1	3	1	-	-	-	1	-	3	1	3	1	1	1
CO 3	1	2	2	1	2	1	-	-	2	-	2	2	2	-	1
CO 4	1	2	1	-	-	1	2	2	1	2	3	1	1	1	3
CO 5	3	2	1	2	-	1	2	2	1	2	3	1	3	3	3

PE ME 601B- Refrigeration and Air Conditioning

Course Outcome (CO)

Student will be able to:

CO1	know about the systems of Refrigeration, Air-Conditioning and Ventilation.
CO2	learn about different components of these systems.
CO3	know about designing a Refrigeration and Air-Conditioning system.

Subject Code: B	**Category:** Professional Elective Courses
Subject Name: Refrigeration & Air Conditioning	**Semester**: Sixth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Thermodynamics, Heat Transfer	

Module No.	Description of Topic	Contact Hrs.
1	Introduction: Concepts of Refrigeration and Air-Conditioning. Unit of refrigeration, Refrigerants– Desirable Properties, Nomenclature	02
2	Simple Vapour Compression Refrigeration System (Simple VCRS): Vapour compression cycle on p-h and T-s diagrams. Cycles with subcooling and superheating, their effects; Effect of changes in evaporator pressure and condenser pressure on the performance of a simple VCRS; dry compression and wet compression of refrigerant; actual Vapour Compression Cycle.	05
3	Air Refrigeration System (ARS): Bell-Coleman refrigerator. COP determination, actual air-refrigeration cycle.	03
4	Vapour Absorption Refrigeration System (VARS): Advantages of VARS over VCRS. Working principle of simple VARS, practical VARS. Limitations of VARS, maximum COP of a VARS, Lithium bromide-water System; Aqua-ammonia systems.	04
5	Equipment and Control: Major Refrigeration Equipment-Compressors: Types; reciprocating, rotary & centrifugal, volumetric efficiency, Condensers: types used in refrigeration systems; Evaporators: expansion devices: capillary tubes and thermostatic expansion valves.	06
6	Ventilation– Definition & Requirement, Natural & Mechanical Ventilation, Ventilation Load Calculation.	03
7	Basic definitions and principles related to Psychometry; Psychometric Charts & Their Uses; Heating, Cooling, Heating & Humidification & Cooling & Dehumidification processes. Adiabatic Saturation, Cooling Coils, By-pass Factor.	05
8	Sensible Heat Factors. Heat Load estimation: Simple cases of Coolingand Dehumidification. Duct Sizing & Design. Air-conditioning equipment: Air handling units, Cooling Towers.	8

Learning Resources:

1. W.F. Stocker and J.W. Jones, Refrigeration and Air Conditioning, McGraw Hill, 2014.
2. C.P. Arora, Refrigeration and Air Conditioning, McGraw Hill India, 2017.
3. P.L. Ballaney, Refrigeration and Air Conditioning, Khanna Publication, New Delhi, 1972.
4. R.C. Arora, Refrigeration and Air Conditioning, PHI, 2010.
5. S.C. Arora and S. Domkundwar, Refrigeration and Air Conditioning, Dhanpat Rai Publication, 2018.

CO-PO Mapping Refrigeration & Air Conditioning **(Course Code** - PE-ME601B**)**															
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	3	3	2	-	1	-	1	2	1	1	2	2	3	2	2
CO 2	2	3	3	1	-	2	-	1	-	3	1	3	1	1	1
CO 3	1	2	-	1	2	1	-	-	2	-	2	2	3	1	1

PE ME 601C- Turbo Machinery

Course Outcome (CO)

Student will be able to:

CO1	know basic characteristics of compressible and incompressible flow machines.
CO2	learn how to derive dimensionless numbers using dimensional analysis.
CO3	know about the method of testing and performance analysis of turbo machines.

Subject Code: C	**Category:** Professional Elective Courses	
Subject Name: Turbo Machinery	**Semester**: Sixth	
L-T-P: **3-0-0**	**Credit: 3**	
Pre-Requisites: Fluid Mechanics and Fluid Machinery		
Module No.	**Description of Topic**	**Contact Hours**

1	**Introduction:** Classification: Incompressible and compressible flow machines; Radial, axial and mixed flow machines; Turbines vs pumps, fans and compressors. Applications: Water supply, ventilation, power generation, propulsion.	2
2	**Incompressible- Flow Machines:** i) Hydraulic Turbines: Headrace, penstock, nozzle, runner, draft tube and tail race; Gross head and net head; Velocity diagrams for impulse and reaction turbines; Discharge, head, power and efficiencies.	8
3	ii) Pumps: Reservoir, foot valve, suction line, pump, delivery line and overhead tank; Static head and losses; Velocity diagrams; Discharge, head, power and efficiencies.	8
4	**Compressible-Flow Machines:** Static and stagnation states; Isentropic and adiabatic expansion and compression processes; Nozzle, diffuser and rows of stationary andmoving blades; Efficiencies.	8
5	**Dimensional Analysis:** Similarity laws, volume-flow, mass-flow head and power coefficients, pressure ratio, enthalpy ratio, Reynolds number, Machnumber; Specific speed and machine selection.	4
6	**Testing and Performance Analysis:** Measurement devices; affinity laws and unit quantities. Set up and operating characteristics of pumps, turbines; fans and turbo-compressors. Cavitation– cause of cavitation and definition of Thoma's cavitationparameter, surge and choking.	6

Learning Resources:

1. S.M. Yahya, Turbine, Compressors and Fans, 4th Edition, McGraw Hill Education, 2017.
2. J. Lal, Hydraulic Machines, Metropolitan Book Co., New Delhi, 6th Edition, 2016.
3. S.K. Som, G. Biswas and S. Chakraborty, Introduction to Fluid Mechanics & FluidMachines, McGraw Hill, 2017.
4. M.M. Das, Fluid Mechanics & Turbo Machines, PHI, 2010.
5. R.K. Bansal, Fluid Mechanics & Machinery, Laxmi Publications, 2018.
6. C. Ratnam, A.V. Kothapalli, Fluid Mechanics & Machinery, I.K. International PublishingHouse Ltd, 2010.
7. C.S.P. Ojha, R. Berndtsson and P.N. Chandramouli, Fluid Mechanics & Machinery, OxfordUniversity Press, 2008.

CO-PO Mapping Turbo Machinery **(Course Code -** PE-ME601C**)**															
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	3	3	2	1	1	-	1	2	1	1	2	2	3	2	2
CO 2	3	1	3	1	-	-	-	1	-	3	1	3	1	1	1
CO 3	2	2	2	1	2	1	-	-	2	-	2	2	2	2	1

PE ME 601D- Fluid Power Control

Course Outcome (CO)

Student will be able to:

CO1	know about different types of fluid power control systems and their applications.
CO2	learn working principles of different components of a pneumatic and hydraulic system.
CO3	learn about drawing fluid power control circuits to suit an application.

Subject Code: D	**Category:** Professional Elective Courses
Subject Name : Fluid Power Control	**Semester**: Sixth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Fluid Mechanics and Fluid Machinery	

Module No.	Description of Topic	Contact Hrs.
1	Fluid power; Applications and advantages; Components of a hydraulic and pneumatic system. Desired properties of a hydraulic fluid; advantage of mineral oil over water; definition of terms like pressure, head, force, density, specific gravity, kinematic and absolute viscosity, compressibility and incompressibility. Pascal's law; analysis of simple hydraulic jack, Mechanical advantage; continuity equation; hydraulic power of a cylinder.	5
2	Hydraulic Pumps: positive displacement pumps; constructional features, working principle and volumetric capacity of external gearpump, vane pump, axial piston pump and radial piston pump.	6
3	Hydraulic Actuators : Constructional features of single acting and double acting hydraulic cylinders; mounting of cylinders, cushioning of cylinder; different application of cylinder through mechanical linkages; force, velocity and power from a cylinder. Hydraulic motors; torque, power and flow rate in a hydraulic motor.	4
4	Hydraulic Valves: Direction control valves – operation and graphical symbol of 3 way and 4 way valves; different modes of activation of valves. Operation and graphical symbols of check valves, pressure relief valve pressure reducing valve, unloading valve and flow control valve.	4
5	Representation of hydraulic components through ANSI symbols. Analysis of hydraulic circuits for single and double acting cylinder control, regenerative circuit, pump unloading circuit, double pump hydraulic system, cylinder synchronization circuit, speed control of a hydraulic motor, circuit to lift and hold heavy load, automatic sequencing of two cylinders.	7
6	Advantages & disadvantages of pneumatic system compared to hydraulic system; constructional details and operation of a reciprocating compressor; working principle and use of filter, pressure regulator, lubricator and silencer; symbols of different pneumatic components; compressed air distribution system in a plant; drawing pneumatic circuits for different operations.	6
7	Use of electrical devices for controlling fluid circuits; function of electrical devices like push-button switches, limit switches, pressure switches, solenoids, relays and timers and their symbols; concept of ladder diagram; study of circuits using electrical control devices such as control of a solenoid actuated cylinder using one limit switch, reciprocation of a cylinder using pressure or limit switches, and two cylinder sequencing circuit using two limit switches.	4

Learning Resources:

1. S. Ilango and V. Soundararajan, Introduction to Hydraulics and Pneumatics, PHI, 2011.
2. A. Esposito, Fluid Power with Applications, Pearson, 2003.
3. S.R. Majumdar, Pneumatic Systems: Principles and Maintenance, McGraw Hill, 1999.
4. E.C. Fitch Jr., Fluid Power and Control Systems, McGraw Hill, New York,1966.

D.S. Banks and D.D. Banks, Industrial Hydraulics, Prentice Hall, 1988

CO-PO Mapping

Fluid Power Control
(Course Code - PE-ME601D**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	3	3	2	1	1	-	1	2	1	1	2	2	2	2	2
CO 2	3	2	3	2	-	-	-	1	-	2	1	3	3	1	2
CO 3	2	2	2	1	2	1	-	-	2	-	1	2	2	1	1

PE ME 601E- Advanced Fluid Mechanics

Course Outcome (CO)

Student will be able to:

CO1	Know about compressible fluid flow.
CO2	Learn about ideal fluid flow.
CO3	Understand about free surface flow.
CO4	Know about unsteady flow.

Subject Code : E	**Category:** Professional Elective Courses
Subject Name: Advanced Fluid Mechanics	**Semester :** Sixth
L-T-P : 3-0-0	**Credit:** 3
Pre-Requisites: Fluid Mechanics	

Module No.	Description of Topic	Contact Hrs.
1	Compressible Flow: review of thermodynamic principles for perfect gases, adiabatic and isentropic relations; steady flow energy equation; speed of propagation of a small disturbance through a compressible fluid, sonic velocity, Mach number, mach cone and Mach wave; isentropic flow, stagnation properties of a compressible flow, isentropic pressure, temperature and density ratios; compressibility correction factor in the measurement of air speed; area– velocity relationship for compressible flow through a variable area duct, mass flow rate through a duct, critical condition and choking; flow through convergent-divergent nozzle, over expansion and under expansion, performance of propulsive nozzles; normal shock, normal shock relations, wave drag.	12

2	Ideal Fluid Flow: rotation of a fluid particle, vorticity, rotational and irrotational motion; velocity potential function, circulation, stream function, flownet; governing equation for two dimensional irrotational motion, simple two dimensional irrotational flows like uniform flow, plane source, plane sink etc; superimposition of simple irrotational flows, combination of a source and a sink, combination of uniform flow and a source (Rankine half body), combination of a uniform flow and a source-sink pair (Rankine oval), doublet and its strength, superimposition of an uniform flow and a doublet (flow past a stationary cylinder); vortex motion– free and forced vortex, strength of a vortex; combination of a uniform flow, a doublet and a free vortex (flow over a rotating cylinder), Magnus effect, Kutta-Joukowski's theorem.	12
3	Free Surface Flow: flow in open channel, Chezy's equation, Manning's equation, economical cross section, specific energy,	8
	hydraulic jump.	
4	Unsteady flow– water hammer.	4

Learning Resources:

1. R.K. Bansal, A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publication,New Delhi, 2010.
2. S.K. Som, G. Biswas and S. Chakraborty, Introduction to Fluid Mechanics and FluidMachines, McGraw-Hill, 2012.

CO-PO Mapping

Advanced Fluid Mechanics
(Course Code - PE-ME601E**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	3	3	2	1	1	-	1	2	2	1	2	2	3	2	2
CO 2	2	2	3	2	-	-	1	1	-	2	1	3	2	2	1
CO 3	2	2	3	1	1	1	-	-	1	-	1	2	2	1	2

PE ME 601F- Composite Materials

Course Outcome (CO)

Student will be able to:

CO1	Identify, describe and evaluate the properties of fibre reinforcements, polymer matrix materials and commercial composites.
CO2	Develop competency in one or more common composite manufacturing techniques, and be able to select the appropriate technique for manufacture of fibre-reinforced composite products.
CO3	Analyse the elastic properties and simulate the mechanical performance of composite laminates; and understand and predict the failure behaviour of fibre-reinforced composites
CO4	Apply knowledge of composite mechanical performance and manufacturing methods to a composites design project
CO5	Critique and synthesise literature and apply the knowledge gained from the course in the design and application of fibre-reinforced composites.

Subject Code: F	**Category:** Professional Elective Courses
Subject Name: Composite Materials	**Semester**: Sixth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Materials Engineering	

Module No.	Description of Topic	Contact Hrs.
1	Definition and applications of composite materials, Fibres- glass, carbon, ceramic and aramid fibres; Matrices- polymer, graphite, ceramic and metal matrices; characteristics of fibres and matrices. Lamina- assumptions, macroscopic viewpoint, generalized Hooke's law, reduction of homogeneous orthotropic lamina, isotropic limit case, orthotropic stiffness matrix, commercial material properties, rule of mixtures, transformation matrix, transformed stiffness.	12
2	Manufacturing of composite materials, bag moulding, compression moulding, pultrusion, filament welding, other manufacturingprocesses	8

3	Basic assumptions of laminated anisotropic plates, symmetric laminates, angle ply laminates, cross ply laminates, laminate structural moduli, evaluation of lamina properties, determination oflamina stresses, maximum stress and strain criteria, von Mises Yield criterion for isotropic materials, generalized Hill's criterion for anisotropic materials, Tsai-Hill's criterion for composites, prediction of laminate failure, thermal analysis of composite laminates.	8
4	Analysis of laminated plates- equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies.	8

Learning Resources:

1. R.F. Gibson, Principles of Composite Material Mechanics, 2nd Edition, McGraw Hill, 1994.
2. M.W. Hyer, Stress Analysis of Fiber-Reinforced Composite Materials, McGraw Hill, 1998.
3. K.K. Chawla, Composite Materials- Science and Engineering, Springer InternationalPublishing, 2019.
4. M. Mukhopadhyay, Mechanics of Composite Materials and Structures, University Press,2013.

CO-PO Mapping

Composite Materials
(Course Code - PE-ME601F**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	3	3	2	1	1	-	1	2	2	1	2	2	3	2	2
CO 2	2	2	3	2	-	-	1	1	-	2	1	3	2	2	1
CO 3	2	2	3	-	1	1	-	-	1	-	1	2	2	-	2
CO 4	3	2	2	1	2	1	-	-	-	-	2	2	3	1	3
CO 5	2	3	3	1	1	2	-	-	1	1	1	2	2	1	2

PE ME 601G- Mechatronics

Course Outcome (CO)

Student will be able to:

CO1	Model and analyze mechatronic systems for an engineering application
CO2	Identify sensors, transducers and actuators to monitor and control the behavior of process or product.
CO3	Develop PLC programs for an engineering application.
CO4	Evaluate the performance of mechatronic systems.

Subject Code: G	**Category:** Professional Elective Courses
Subject Name: Mechatronics	**Semester**: Sixth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Fluid Mechanics and Fluid Machinery, Kinematics and Theory of Machines, Basic Electrical Engineering, Basic Electronics Engineering	

Module No.	Description of Topic	Contact Hrs.
1	Introduction to Mechatronics: Definition, Mechatronics in design and manufacturing, Comparison between Traditional and Mechatronic approach; Concurrent engineering	3
2	Review of fundamentals of electronics: Logic gates and their operations, Signal processing devices, Data conversion devices, Inputand output devices. Sensors and Transducers, Actuators, Limit switches, Relays	6
3	Control Systems: Open loop and closed loop control, block diagrams, transfer functions, Laplace transforms.	3
5	Electrical Drives: Stepper motors, servo drives.	2
6	Mechanical Drives: Different mechanisms, Ball screws, Linear motion bearings, Transfer systems.	3
7	Pneumatic and Hydraulic Drives: Elements of pneumatic and hydraulicdrives, comparison between them. Design of pneumatic and hydraulic circuits, symbolic representations of such circuits	4

	indicating different valves, actuators, etc.	
8	Basics of 8085 microprocessor, programmable register architecture, buses, memory mapping, clock pulse and data transfer operations, and simple assembly and mnemonic programming on 8085 microprocessor.	5
9	Use of On-Off, PI and PID controllers to control different drives, Programming in PLC controller using Ladder diagram.	4
10	Mathematical modeling of physical systems, such as spring-mass vibration system, linear and rotory motion and its Laplace Transform.	2
11	Basics of time domain analysis, Introduction to discrete-time systems and Z-transform.	2
12	Introduction to Mechatronic systems, such as automatic brake, door	2
	closing and opening, robot, CNC machine, AGV, etc.	

Books:

1. W. Bolton, Mechatronics, 5th Edition, Addison Wesley Longman Ltd., 2010.
2. D. Shetty and R. Kolk, Mechatronics System Design, 3rd Edition, PWS Publishing, 2009.
3. D.G. Alciatore & M.B. Histand, Introduction to Mechatronics and Measurement systems, 4thEdition, McGraw Hill, 2006.
4. A. Smaili and F. Arnold, Applied Mechatronics, Oxford University Press, Indian Edition,2007.
5. M.D. Singh and J.G. Joshi, Mechatronics, Prentice Hall of India, 2006.
6. K.K. Appu Kuttan, Introduction to Mechatronics, Oxford University Press, New Delhi,2007.

CO-PO Mapping

Mechatronics

(Course Code - PE-ME601G**)**

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

PE ME 601H- Robotics

Course Outcome (CO)

Student will be able to:

CO1	To familiarize the Basics of robots Control system.
CO2	To familiarize the end effectors, Sensor technology and Industrial application of robot.
CO3	Elucidate the need and implementation of related Instrumentation & control in robotics
CO4	Illustrate the movement of robotic joints with computers/microcontrollers.

Subject Code: H	**Category:** Professional Elective Courses
Subject Name: Robotics	**Semester:** Sixth
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Manufacturing Technology	

Module No.	Description of Topic	Contact Hrs.
1	Introduction: Basic concepts- Robot anatomy- Manipulators- kinematics: Forward and inverse kinematics- Precision movement, robot specifications and Work volume, Types of Robot drives- Basic robot motions- Point to point control, continuous path contour.	8
2	End Effectors: End effectors- classification- mechanical, magnetic, vacuum and adhesive gripper- gripper force analysis and design. Robot control- Unit control system concept- servo and non-servo control of robot joints, adaptive and optimal control.	7
3	Sensors: Sensor devices, Types of sensors- contact, position and displacement sensors, Force and torque sensors- Proximity and range sensors- acoustic sensors- Robot vision systems- Sensing and digitizing- Image processing and analysis.	6
4	Robot Programming: Robot language classification- programming methods- off and on line programming- Lead through method- Teach pendent method- VAL systems and language, simple program.	8

5	Industrial Application: Application of robots- Material handling- Machine loading and unloading, Assembly, Inspection, Welding, Spray painting, Mobile robot, Microbots- Recent developments in robotics- safety consideration.	7

Learning Resources:

S.R. Deb, Robotics technology and flexible automation, McGraw Hill publishing companylimited, New Delhi, 1994

CO-PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	1	1	1	2	2	-	1	-	3	1	2
CO2	3	3	2	2	1	-	-	1	-	1	3	2
CO3	3	1	1	-	3	1	1	2	2	2	3	1
CO4	3	1	-	-	3	-	-	-	1	2	1	2
Average	**3**	**1.5**	**1.333333**	**1.5**	**2.25**	**1.5**	**1**	**1.333333**	**1.5**	**2**	**2**	**1.75**

PE ME 601I- Material Handling

Course Outcome (CO)

Student will be able to:

CO1	Understand the basic roles of the different materials handling equipment.
CO2	Recognize the importance of safety issues in the areas of warehouse and material handling.
CO3	Evaluate their abilities in Key areas such as Purchase Management, Inventory Control, Logistics,
CO4	Analyze in handling legal aspects of business, employment laws and to deal with public andgovernment.

Subject Code: I	**Category:** Professional Elective Courses
Subject Name: Material Handling	**Semester**: Sixth
L-T-P : **3-0-0**	**Credit: 3**
Pre-Requisites: Kinematics and Theory of Machines	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Definition, importance and scope of material handling (MH); classification of materials; codification of bulk materials ; utility of following principles of MH– (i) materials flow, (ii) simplification, (iii) gravity, (iv) space utilization, (v) unit size, (vi) safety, (vii) standardization, (viii) dead-weight, (ix) idle time, (x) motion.	4
2	**Unit load**: Definition; advantages & disadvantages of unitization; unitization by use of platform, container, rack, sheet, bag and self contained unit load; descriptive specification and use of pallets, skids, containers, boxes, crates and cartons; shrink and stretch wrapping. **Classification of MH Equipment**: Types of equipment– (i) industrial trucks & vehicles, (ii) conveyors, (iii) hoisting equipment, (iv) robotic handling system and (v) auxiliary equipment; Independent equipment wise sub classification of each of above type of equipment.	6

3	**Industrial trucks & vehicles**: Constructional features and use of the following equipment – (i) wheeled hand truck, (ii) hand pallet truck, (iii) fork lift truck; Major specifications, capacity rating and attachments of fork lift truck.	5
4	**Conveyors:** Use and characteristics of belt conveyor, constructional features of flat and troughed belt conveyor; Use and constructional features of chain conveyors– (i) apron, car and trolley type; Construction of link-plate chains; Dynamic phenomena in chain drive; Use and constructional features of roller conveyors; Gravity and powered roller conveyor; Pneumatic conveyor-use and advantages; Positive, negative and combination system of pneumatic conveyors; constructional feature, application and conveying capacity of screw conveyor.	8
5	**Hoisting Equipment**: Advantage of using steel wire rope over chain; constructional features of wire ropes; Rope drum design; Pulley system-simple vs. multiple pulley; Load handling attachments : hooks, grabs, tongs, grab bucket; Arrangement of hook suspension with cross piece and pulleys (sheaves); Use and constructional features of (i) hand operated trolley hoist , (ii) winch; (iii) bucket elevator, (iv) Jib crane, (v) overhead traveling crane and (vi) wharf crane; Level luffing system of a wharf crane; Utility of truck mounted and crawler crane.	8
6	**Robotic handling**: Materials handling at workplace; Major components of a robot; Applications of robotic handling.	2
7	**Auxiliary Equipment:** Descriptive specification and use of (i) Slideand trough gates, (ii) belt, screw and vibratory feeders, (iii) Chutes, (iv) positioners like elevating platform, ramps, universal vice; (v) ball table.	3

Learning Resources:

1. S. Ray, Introduction to Materials Handling, New Age International Pub., 2017.
2. T.K. Ray, Mechanical Handling of Materials, Asian Books Pvt. Ltd., 2005.
3. T.H. Allegri, Materials Handling: Principles and Practices, CBS Publishers and Distributors,2018.
4. J.M. Apple, Material Handling System Design, John Wiley & Sons, 1972.

CO-PO Mapping

Material Handling **(Course Code -** PE-ME601 I**)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	1	1	-	1	2	2	1	2	2	3	2	2
CO 2	3	2	3	2	1	-	1	1	-	2	1	3	3	2	2
CO 3	1	2	1	-	1	1	-	-	1	-	1	1	1	-	2
CO 4	3	3	1	1	-	1	-	-	-	-	1	2	1	1	3

PE ME 601J- Principles and Practices of Management

Course Outcome (CO)

Student will be able to:

CO1	Understand the evolutionary development of management thought and general principles of management.
CO2	Understand the management functions in an organization.
CO3	To understand the concept of organization
CO4	Demonstrate the ability to directing, leadership and communicate effectively
CO5	To analysis isolate issues and formulate best control methods.

Subject Code: J	**Category:** Professional Elective Courses
Subject Name: Principles & Practices of Management	**Semester:** Sixth
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Basic Engineering Concept	

Module No.	Description of Topic	Contact Hrs.
1	**Management:** Definition, nature, importance, evolution of management thoughts– pre & post scientific era, contributions made by Taylor, Fayol, Gilbreth, Elton Mayo, McGregor, Maslow– Covering Time & Motion Study, Hawthrone Experiments; Is management a science or art? Functions of manager, ethics in managing and social responsibility of managers.	5
2	**Planning & Control:** Why Management process starts with planning, steps in planning, planning premises, types of planning, barriers to effective planning, operational plan, strategic planning, Mckinsey's 7's Approach, SWOT analysis, Controlling- concept, Planning- control relationship, process of control, human response to control, dimensions of control, MBO.	5

3	**Decision Making & Organizing:** Nature, process of decision making, decision making under Certainty and Uncertainty, decision-tree, group-aided decision, brain-storming; Organizing – concept, nature and process of organizing, authority and responsibility, delegation and empowerment, centralization and decentralization, concept of departmentation.	6
4	**Staffing & Motivation:** Concept, Manpower planning, Job design, recruitment & selection, training anddevelopment, performance appraisal, motivation, motivators and satisfaction, motivating towards organizing objectives, morale building.	5
5	**Leadership & Communication:** Defining leadership and its role, should managers lead, leadership style, leadership development, Leadership behavior. Communication- Process, Bridging gap-using tools of communication, electronic media in Communication.	5
6	**Financial Management:** Financial functions of management, Financial Planning, Management of Working Capital, Sources of	5
	Finance.	
7	**Marketing Management:** Functions of Marketing, Product Planning & Development, Marketing Organization, Sales Organization, Sales Promotion, Consumer Behaviour, Marketing Research and Information.	5

Learning Resources:

1. S. Robbins and M. Culter, Management, Pearson, 2016.
2. J.R. Schermerhorn, Introduction to Management, Wiley India Edition, 2011.
3. C.J. O'Donnel and H. Koontz, Principles of Management, McGrew Hill, 1995.
4. R.L. Daft, New Era of Management, Cengage Learning, 2008.

J.A.F. Stoner, R. Freeman and D.R. Gilbert. Jr., Management, Prentice Hall of India, 1985

CO-PO Mapping

Principles & Practices of Management **(Course Code -** PE-ME601J**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	3	3	2	1	1	-	1	2	2	1	2	2	3	2	2
CO 2	3	2	3	2	-	-	1	1	-	2	3	3	2	1	-

CO 3	1	2	1	1	1	1	-	-	1	-	-	1	2	1	2
CO 4	3	1	1	1	-	1	-	-	-	-	1	2	2	1	3
CO 5	2	3	3	1	1	2	-	-	1	1	1	2	2	2	2

PC ME 691- Mechanical Engineering Laboratory (Design)II

Course Outcome (CO)

Student will be able to:

CO1	Demonstrate the knowledge of basic machine elements to withstand loads and deformations for a given application, while considering additional specifications
CO2	Formulate and solve engineering problems based on design of spur gears with respect to tooth bending strength and surface strength specifications
CO3	Analyze the design of bearings using design charts and custom software and select appropriate bearings for an application using printed and electronic catalog data.
CO4	Design shafts, brakes and clutches subjected to static or dynamic loads and present their designs orally

Subject Code : PC-ME691	**Category:** Professional Core Courses
Subject Name : Mechanical Engineering Laboratory (Design) II	**Semester** : Sixth
L-T-P : 0-0-3	**Credit: 1.5**
Pre-Requisites:	

Course Contents

1. Uniaxial tension test on mild steel rod
2. Torsion test on mild steel rod
3. Impact test on a metallic specimen
4. Brinnell/ Vickers and Rockwell hardness tests on metallic specimens
5. Bending deflection test on beams
6. Strain measurement using Rosette strain gauge, or like.
7. Microscopic examination of heat-treated and untreated metallic samples
8. Determination of velocity ratios of simple, compound, epicyclic and differential gear trains
9. Studying kinematics of four bar, slider crank, crank rocker, double crank, doublerocker and oscillating cylinder mechanisms

10. Studying kinematics of typical mechanisms like pantograph, some straight line motionmechanisms, wiper, drafter, etc.
11. Motion studies of different cams & followers
12. Single degree of freedom Spring-mass-damper system: determination of natural frequency and damping coefficient
13. Determination of torsional natural frequency of single and double rotor systems-undamped and damped natural frequencies
14. Studying machine vibration using sensor
15. Solving simple balancing problems experimentally

CO-PO Mapping

Mechanical Engineering Laboratory(Design) II
(Course Code - PC-ME691**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	3	3	2	1	1	2	1	2	2	1	2	3	3	2	2
CO 2	3	2	3	1	1	-	-	1	1	3	1	3	3	2	2
CO 3	2	3	1	1	2	1	-	-	1	-	-	3	2	1	1
CO 4	3	2	1	2	-	2	2	2	2	2	3	1	2	3	3

PW ME 681- Project-II

Course Outcome (CO)

Student will be able to:

CO1	To develop the ability to conduct investigations of complex engineering problems using research knowledge, methods and other modern engineering tools.
CO2	To analyze a situation or mechanical system and identify possible ideas for practical implementation.
CO3	To train the students in preparing project reports.
CO4	To train the students to face review and viva voice examination.

Subject Code : PW-ME681	**Category:** Project (Summer Internship)
Subject Name : Project-II	**Semester** : Sixth
L-T-P : 0-0-4	**Credit: 2**
Pre-Requisites:	

CO-PO Mapping

Mechanical Engineering Laboratory(Design) II
(Course Code - PC-ME691**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	3	3	2	1	1	-	1	2	3	1	2	2	3	2	2
CO 2	3	1	3	1	-	-	-	1	2	3	1	3	3	2	2
CO 3	2	3	2	1	2	1	-	-	3	-	2	2	2	2	1
CO 4	3	2	1	2	-	2	2	2	2	2	3	1	3	3	3

MC 601- Constitutions of India

Course Outcome (CO)

Student will be able to:

CO1	Have general knowledge and legal literacy and thereby to take up competitive examinations.
CO2	Understand state and central policies, fundamental duties.
CO3	Understand Electoral Process, special provisions.
CO4	Understand powers and functions of Municipalities, Panchayats and Co-operative Societies,

Subject Code : MC601	**Category:** Mandatory Courses
Subject Name : Constitution of India	**Semester** : Sixth
L-T-P : 0-2-0	**Credit: 0**
Pre-Requisites:	

Module No.	Description of Topic	Contact Hrs.
1	Introduction to the Constitution of India, The Making of the Constitution and Salient features of the Constitution. Preamble to the Indian Constitution Fundamental Rights & its limitations.	4
2	Directive Principles of State Policy & Relevance of Directive Principles State Policy Fundamental Duties. Union Executives – President, PrimeMinister Parliament Supreme Court of India.	5
3	State Executives – Governor, Chief Minister, State Legislature High Court of State. Electoral Process in India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th & 91st Amendments.	5
4	Special Provision for SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions. Human Rights –Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India Powers and functions of Municipalities, Panchyats and Co - Operative Societies.	5

5	Special Provision for SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions. Human Rights –Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India Powers and functions of Municipalities, Panchyats and Co - Operative Societies.	5

Learning Resources:

1. D.D. Basu, Introduction to the Constitution on India, 19th/ 20th Students Edition, PrenticeHall EEE, 2001.
2. C.E. Haries, M.S. Pritchard and M.J. Robins, Engineering Ethics, Thompson Asia, 2003.
3. M.V. Pylee, An Introduction to Constitution of India, Vikas Publishing, 2002.
4. M. Govindarajan, S. Natarajan and V.S. Senthilkumar, Engineering Ethics, Prentice Hall ofIndia Pvt. Ltd., New Delhi, 2004.
5. B.K. Sharma, Introduction to the Constitution of India, PHI Learning, New Delhi, 2011.

Latest Publications, Indian Institute of Human Right.

CO-PO Mapping
Humanities II (Constitution of India)
(Course Code - MC601**)**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	1	1	2	-	1	3	1	2	2	1	2	3	1	1	2
CO 2	1	2	-	1	1	2	1	1	1	2	2	3	1	-	2
CO 3	1	2	1	-	2	1	-	1	2	-	-	3	-	1	-
CO 4	2	2	-	-	-	3	-	2	2	2	2	1	-	-	3

7th Semester

PC ME 701- Advanced Manufacturing Technology

Course Outcome (CO)

Student will be able to:

CO1	understand non- traditional machining processes and the effect of process parameters
CO2	To differentiate the various non-traditional machining processes
CO3	To demonstrate micromachining technology

Subject Code: PC-ME701	**Category:** Professional Core Courses
Subject Name: Advanced Manufacturing Technology	**Semester**: Seventh
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Manufacturing Processes, Manufacturing Technology	

Module No.	Description of Topic	Contact Hrs.
1	**Mechanical Advanced Machining Processes:** Need and classification of nontraditional machining processes – Material removal in traditional and nontraditional machining processes - considerations in process selection. Ultrasonic machining – Working principle, mechanism of metal removal – Theory of Shaw, elements of the processes, tool feed mechanism, effect of parameters, applications and numerical. Abrasive jet machining, Water jet machining and abrasive water jet machine - Basic principles, equipments, process variables, mechanics of metal removal, MRR, application and limitations.	6

2	**Electro–Chemical Processes:** Principle of ECM process, chemistry of the ECM processes, Parameters of the process, determination of the metal removal rate, dynamics of ECM process, polarization, tool design, advantages and disadvantages, application, electrochemical grinding, electrochemical honing, electrochemical deburring, Application of ECM for deep hole drilling - electrostream drilling and shaped tube electrolytic machining. Chemical machining - Fundamental principle, types of chemical machining, maskants, etchants, advantages, disadvantages, applications	6
3	**Electric Discharge Machining:** Working principle of EDM, Power circuits for EDM - RC pulse generator and controlled pulse generator– Analysis of R-C Circuits – Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, surface finish and machining accuracy, characteristics of spark eroded surface and recent development in EDM. Wire EDM – Working principle, process variables, process characteristics and applications. Electric discharge grinding and electric discharge diamond grinding - working principle, process capabilities and applications.	6

4	**Laser, Electron Beam, Ion Beam and Plasma Arc Machining:** General working principle of laser beam machining – Generation of Laser, types of Lasers, process characteristics and applications. Electron Beam Machining - Equipment for production of Electron Beam, theory of EBM, thermal and non-thermal type, process characteristics and applications. Ion Beam Machining - Mechanism of metal removal and associated equipments, process characteristics and applications. Plasma Arc Machining - Metal removal mechanism, process parameters, process characteristics, types of torches, applications.	6
5	**Advanced Finishing Processes:** Abrasive flow Machining (AFM)- working principle, AFM system, process variables, process performance and applications. Magnetic abrasive finishing (MAF)- working principle, MAF system, material removal and surface finish, process variables and applications. Chemomechanical polishing, working principle, material removal and surface finish and applications.	6
6	**Micro-Machining:** Need- evolution- fundamentals and trends in micro technologies- Consequences of the technology and society- challenges to manufacturing technology- evolution of precision in manufacturing, tooling and current scenario, requirements and applications Theory of micromachining- Chip formation- Size effect in micromachining- microturning- microdrilling.	6

CO-PO Mapping
Advanced Manufacturing Technology
(Course Code – PC ME 701**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO
CO1	3	3	2	-	2	-	1	-	-	3	-	2	3	-	1
CO2	3	3	-	3	1	-	-	2	1	-	2	2	1	2	-
CO3	3	3	-	3	2	1	-	-	-	1	1	3	3	-	2

Learning Resources:

1. A. Ghosh and A.K. Mallik, Manufacturing Science, Affiliated East west Press Ltd, 2001.
2. V.K. Jain, Advanced Machining Processes, Allied Publishers Pvt. Ltd. 2002
3. H. El-Hofy, Advanced Machining Processes, McGraw-Hill, New York, 2005.
4. G.F. Benedict, Nontraditional Machining Processes, Marcel Dekker Inc., New York, 1987.
5. J.A. McGeough, Advanced Machining Methods, Chapman and Hakk, London, 1988.
6. M. Adithan, Modern Machining Methods, Khanna Publishers, New Delhi, 2008.
7. P.K. Mishra, Nonconventional Machining, The Institution of Engineers (India) Text BookSeries, Narosa Publishing House, New Delhi, 1997

PE ME 701A/702A- Automobile Engineering

Course Outcome (CO)

Student will be able to:

CO1	Understand and demonstrate the various systems in automobile and also its working principle
CO2	Explain the working of various parts like engine, transmission, clutch, brakes
CO3	Student shall apply design knowledge of different types of elements used in the automobile
CO4	Develop a strong base for understanding future developments in the automobile industry

Subject Code : A	**Category:** Professional Elective Courses
Subject Name : Automobile Engineering	**Semester**: Seventh
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Thermodynamics, Kinematics & Theory of Machines	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** History & Development of Automobile. Various sub systems ofAutomobile.	1
2	**Prime Mover:** Engine for Two-Wheeler & Three-Wheeler vehicles, Engine for passenger cars, commercial and other vehicle, Fuel system for carburetted engine, MPFI engine and Diesel engine, Lubrication and cooling system.	5
3	**Auto Electrical:** Electric Motor as prime mover, Battery, generator, Ignition system, Starting system, lighting & signaling	6
4	**Steering System:** Devis steering & Ackerman steering system. Rack & pinion, cam & lever, worm & sector system.	3

5	**Transmission System:** Flywheel & clutch. Gearbox sliding and constant mesh type, Automatic Transmission, Universal joint, Propeller shaft.	6
6	**Differential & Axle:** Construction & function of differential, Different types of front & rear axles.	3
7	**Suspension System:** Conventional and independent suspension system, application.	3
8	**Brake System:** Disc & drum brake, Hydraulic brake, Parking brake. Stopping distance.	3
9	**Power Requirement:** Various resistances such as air resistance, gradient resistance, rolling resistance. Tractive effort. Torque- Speed curve. Horse power calculation.	3
10	**Automotive air conditioning:** Ventilation, heating, air condition,refrigerant, compressor and evaporator. **Wheels and tyres:** Wheel quality, assembly, types of wheels, wheel rims. Construction of tyres and tyre specifications. **Automotive Restraint Systems:** Seat belt, automatic seat belt tightener system, collapsible steering column and air bags.	3

Learning Resources:

1. K. Newton, W. Steed and T.K. Garrette, Motor Vehicle, 2nd Edition, Butterworth, 1989.
2. A.K. Babu, Automobile Mechanics, Khanna Publishing House, 2019.
3. A. De, Automobile Engineering, Revised Edition, Galgotia Publication Pvt. Ltd., 2010.
4. W.H. Crouse and D.L. Anglin, Automotive Mechanics, McGraw Hill, New Delhi, 2005.
5. J. Heitner, Automotive Mechanics, Affiliated South West Press, New Delhi, 2000.
6. G.B. Narang, Automobile Engineering, Khanna Publishers, New Delhi, 2001.
7. K. Ramakrishna, Automobile Engineering, PHI Learning Pvt. Ltd., New Delhi, 2012.

CO-PO Mapping
Automobile Engineering
(Course Code – PE ME 701A/702A)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	-	2	-	1	-	-	3	-	2	3	-	1
CO2	3	3	1	3	1	-	-	2	1	-	2	2	1	2	-
CO3	3	3	-	3	2	1	-	-	-	1	1	3	3	-	2
CO3	3	3	1	3	2	1	1	-	1	1	2	3	3	1	2

PE ME 701B702B- Gas Dynamics and Jet Propulsion

Course Outcome (CO)

Student will be able to:

CO1	Understand basic concepts of gas dynamics and describe the basic fundamental equations of one dimensional flow of compressible fluid and isentropic flow of an ideal gas.
CO2	Analyze the steady one-dimensional is entropic flow, frictional flow and isothermal flow and express the concepts of steady one dimensional flow with heat transfer.
CO3	Explain the effect of heat transfer on flow parameters.
CO4	Illustrate the jet propulsion engines
CO5	Describe the basic concepts of rocket propulsion

Subject Code: B	**Category:** Professional Elective Courses
Subject Name: Gas Dynamics and Jet Propulsion	**Semester**: Seventh
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Thermodynamics, Heat Transfer	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to Gas Dynamics:** Control volume and system approaches acoustic waves and sonic velocity– Mach number– classification of fluid flow based on mach number– Mach cone-compressibility factor– general features of one dimensional flow of a compressible fluid– continuity and momentum equations for a control volume.	3
2	**Isentropic Flow of an Ideal Gas:** Basic equation- stagnation enthalpy, temperature, pressure and density- stagnation, acoustic speed- critical speed of sound- dimensionless velocity- governing equations for isentropic flow of a perfect gas- critical flow area.	6

3	**Steady One Dimensional Isentropic Flow**: Nozzles- area change effect on flow parameters- chocking- convergent nozzle- performance of a nozzle under decreasing back pressure- Delavel nozzle- optimum area ratio- effect of back pressure- nozzle discharge coefficients- nozzle efficiencies. **Simple Frictional Flow:** Governing equations for Adiabatic flow with friction in a constant area duct- fannoline limiting conditions- effect of wall friction flow properties in an Isothermal flow with friction in a constant area duct governing equations- limiting conditions, numerical problems.	7
4	**Steady One Dimensional Flow with Heat Transfer:** Governing equations- Rayleigh line entropy change caused by heattransfer- conditions of maximum enthalpy and entropy. **Effect of Heat Transfer on Flow Parameters:** Intersection of Fanno and Rayleigh lines. Shock waves in perfect gas- properties of flow across a normal shock- governing equations- Rankine Hugoniat equations- Prandtl's velocity relationship-	8
	converging diverging nozzle flow with shock thickness- shock strength.	
5	**Jet Propulsion Aircraft propulsion:** Types of jet engines- thrust equation, Effect of pressure, velocity and temperature changes of air entering compressors, thrust augmentation methods, Performance of turbo propeller engines, ramjet and pulsejet, scramjet engines.	6
6	**Rocket Propulsion:** Rocket engines, Basic theory of equations- thrust equation- effective jet velocity- specific impulse-rocket engine performance- solid and liquid propelant rockets- comparison of various propulsion systems.	6

Learning Resources:

1. J.D. Anderson, Modern Compressible flow, McGraw Hill, 2003.
2. H.W. Liepman and A. Roshko, Elements of gas dynamics, Wiley, New York, 1957.
3. H. Cohen, G.E.C. Rogers and Saravanamutto, Gas Turbine Theory, Longman Group Ltd.-1980.
4. S.M. Yahya, Fundamentals of Compressible Flow, New Age International (P) Limited-1996.
5. N.J. Zucrow, Principles of Jet Propulsion and Gas Turbines, John Wiley, New York,-1970.
6. S.M. Yahya, Fundamentals of compressible flow with aircraft and rocket propulsion, NewAge International (P) Ltd., 2007.
7. M.J. Zucrow, Aircraft & Missile Propulsion, Wiley, New York, 2013.

CO-PO Mapping
Gas Dynamics and Jet Propulsion

(Course Code – PE ME 701B/702B**)**

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

PE ME 701C/702C- Computational Fluid Dynamics

Course Outcome (CO)

Student will be able to:

CO1	Understand the differential equations for flow phenomena and numerical methods for their solution.
CO2	Analyze different mathematical models and computational methods for fluid flow and heat transfer simulations.
CO3	Formulate computational problems related to fluid flows and heat transfer.
CO4	Estimate the accuracy of a numerical solution by comparison to known solutions of simple test problems and by mesh refinement studies.
CO5	Evaluate forces in both internal and external flows.

Subject Code: C	**Category:** Professional Elective Courses
Subject Name: Computational Fluid Dynamics	**Semester**: Seventh
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Fluid Mechanics and Fluid Machines, Engineering Mathematics	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** History and Philosophy of computational fluid dynamics, CFD as a design and research tool, Applications of CFD in engineering, Programming fundamentals, MATLAB programming, Numerical Methods	2
2	**Governing equations of fluid dynamics:** Models of the flow, The substantial derivative, Physical meaning of the divergence of velocity, The continuity equation, The momentum equation, The energy equation, Navier-Stokes equations for viscous flow, Euler equations for inviscid flow, Physical boundary conditions, Forms of the governing equations suited for CFD, Conservation form of the equations, shock fitting and shock capturing, Time marching and space marching.	4

3	**Mathematical behavior of partial differential equations:** Classification of quasi-linear partial differential equations, Methods of determining the classification, General behavior of Hyperbolic, Parabolic and Elliptic equations.	2
4	**Basic aspects of discretization:** Introduction to finite differences, Finite difference equations using Taylor series expansion and polynomials, Explicit and implicit approaches, Uniform and unequally spaced grid points.	3
5	**Grids with appropriate transformation:** General transformation of the equations, Metrics and Jacobians, The transformed governing equations of the CFD, Boundary fitted coordinate systems, Algebraic and elliptic grid generation techniques, Adaptive grids.	4
6	**Parabolic partial differential equations:** Finite difference formulations, Explicit methods - FTCS, Richardson and DuFort- Frankel methods, Implicit methods - Lasonen, Crank-Nicolson	4
	and Beta formulation methods, Approximate factorization, Fractional step methods, Consistency analysis, Linearization.	
7	**Stability analysis:** Discrete Perturbation Stability analysis, von Neumann Stability analysis, Error analysis, Modified equations, Artificial dissipation and dispersion.	3
8	**Scalar representation of Navier-Stokes equations:** Equations of fluid motion, numerical algorithms: FTCS explicit, FTBCS explicit, Dufort-Frankel explicit, McCormack explicit and implicit, BTCS and BTBCS implicit algorithms, applications.	4
9	**Grid generation:** Algebraic Grid Generation, Elliptic Grid Generation, Hyperbolic Grid Generation, Parabolic Grid Generation	3
10	**Finite volume method for unstructured grids:** Advantages, Cell Centered and Nodal point Approaches, Solutionof Generic Equation with tetrahedral Elements, 2-D Heat conduction with Triangular Elements.	3
11	**CFD Solution Procedure:** Problem setup – creation of geometry, mesh generation, selection of physics and fluid properties, initialization, solution control and convergence monitoring, results reports and visualization. **Case Studies:** Benchmarking, validation, Simulation of CFD problems by use of general CFD software, Simulation of coupled heat, mass and momentum transfer problem.	4

Learning Resources:

1. P.S. Ghosdastidar, Computer Simulation of Flow and Heat Transfer, McGraw-Hill, 1998.
2. K. Muralidhar and T. Sundararajan, Computational Fluid Flow and Heat

Transfer, NarosaPublishing House, 1995.
3. J.D. Anderson Jr., Computational Fluid Dynamics, McGraw-Hill Book Company, 1995.
4. P. Niyogi, S.K. Chakrabarty and M.K. Laha, Introduction to Computational Fluid Dynamics,Pearson Education, 2006.

CO-PO Mapping

Computational Fluid Dynamics

(Course Code – PE ME 701C/702C**)**

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

PE ME 701D/702D- Elements of Atmospheric Fluid Dynamics

Course Outcome (CO)

Student will be able to:

CO1	know about the general structure of the atmosphere and its behaviour.
CO2	learn about various types of atmospheric circulations.
CO3	know about the effects of earth's rotation and friction on wind movements.
CO4	know about the structure of atmospheric boundary layer and turbulence.
CO5	learn about smoke dispersion patterns and chimney height determination.
CO6	know about the similarity analysis and scaling and wind tunnel simulation & testing

Subject Code : D	**Category:** Professional Elective Courses
Subject Name : Elements of Atmospheric Fluid Dynamics	**Semester**: Seventh
L-T-P : 3-0-0	**Credit: 3**
Pre-Requisites: Fluid Mechanics, Thermodynamics	

Module No.	Description of Topic	Contact Hrs.
1	General structure of the atmosphere; elements of meteorology- lapse rate of temperature, temperature inversions, isotherms & isobars.	6
2	Atmospheric circulation, vertical convection, centrifugal effects, stability of the atmosphere.	6
3	Effect of earth's rotation, effect of friction. Atmospheric motions; wind scales.	6
4	Atmospheric boundary layer, governing equations; Ekman spiral; logarithmic and power laws; atmospheric turbulence.	6

5	Effect of wind on smoke dispersion; determination of chimney height.	5
6	Basic similarity requirements; dimensional analysis; basic scaling considerations; wind tunnel simulations of atmospheric flows; windtunnel testing.	7

Learning Resources:

1. E. Simiu and R.H. Scanlan, Wind Effects on Structures– Fundamentals and Applications toDesign, John Wiley & Son, 1996.
2. S. Eskinazi, Fluid Mechanics and Thermodynamics of Our Environment, Academic Press,1975.

CO-PO Mapping

Elements of Atmospheric Fluid Dynamics

(Course Code – PE ME 701D/702D**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1	-	-	-	2	2	-	3	1	3	-
CO2	3	2	2	2	2	-	1	-	-	1	1	2	1	2	2
CO3	2	1	1	2	-	-	1	-	1	1	-	3	3	-	-
CO4	3	3	2	1	1	-	1	-	2	-	-	3	1	3	1
CO5	3	3	-	-	2	-	-	-	-	-	-	3	3	-	2
CO6	3	1	1	1	1	-	-	-	2	2	-	3	-	3	-

PE ME 701E/702E- Selection and Testing of Materials

Course Outcome (CO)

Student will be able to:

CO1	To understand importance of engineering materials.
CO2	To choose materials for engineering applications.
CO3	To identify the material properties.
CO4	To identify suitable testing technique to inspect industrial component.
CO5	To use different techniques and know its applications and limitations.

Subject Code: E	**Category:** Professional Elective Courses
Subject Name: Selection and Testing of Materials	**Semester**: Seventh
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Materials Engineering, Design of Machine Elements	

Module No.	Description of Topic	Contact Hrs.
1	**Engineering Materials** Introduction – classification of engineering materials – selection ofmaterials for engineering purposes –selection of materials and shape –classification metal and alloys, polymers, ceramics and glasses, composites, natural materials,-non metallic materials- smart materials - physical, metrical properties of metals.	5
2	**Material Properties** Mechanical properties - fatigue strength - fracture Toughness - Thermal Properties - Magnetic Properties - Fabrication Properties - electrical, optical properties - Environmental Properties, Corrosion properties - shape and size - Material Cost and Availability– failure analysis.	3

3	**Materials Selection Charts and Testing** Ashby material selection charts-Testing of Metallic Materials - Selection of Materials for Biomedical Applications - Medical Products - Materials in Electronic Packaging - Advanced Materials in Sports Equipment - Materials Selection for Wear Resistance - Advanced Materials in Telecommunications - Using Composites - Manufacture and Assembly with Plastics, fiber and Diamond Films	6
4	**Mechanical Testing** Introduction to mechanical testing, Hardness test (Vickers, Brinell, Rockwell), Tensile test, Impact test (Izod, Charpy) - Principles, Techniques, Methods, Advantages and Limitations, Applications. Bend test, Shear test, Creep and Fatigue test - Principles, Techniques, Methods, Advantages and Limitations, Applications.	6
5	**Non Destructive Testing** Visual inspection, Liquid penetrant test, Magnetic particle test, Thermography test – Principles, Techniques, Advantages and Limitations, Applications. Radiographic test, Eddy current test, Ultrasonic test, Acoustic emission- Principles, Techniques, Methods, Advantages and Limitations, Applications.	6
6	**Material Characterization Testing** Macroscopic and Microscopic observations, Optical and Electron microscopy (SEM and TEM) - Principles, Types, Advantages and Limitations, Applications. Diffraction techniques, Spectroscopic Techniques, Electrical and Magnetic Techniques- Principles, Types, Advantages and Limitations, Applications.	6
7	**Other Testing** Thermal Testing: Differential scanning calorimetry, Differential thermal analysis. Thermomechanical and Dynamic mechanical analysis: Principles, Advantages, Applications. Chemical Testing: X-Ray Fluorescence, Elemental Analysis by Inductively Coupled Plasma-Optical Emission Spectroscopy and Plasma-Mass Spectrometry.	4

Reference Books:

1. L. Gladius, Selection of Engineering Materials, Prentice Hall Inc. New Jersey, USA, 1995.
2. J.A. Charles and F.A.A. Crane, Selection and Use of Engineering Materials, 3rd Edition,Butterworths, London, UK, 1996.
3. M.F. Ashby, Materials Selection in Mechanical Design, 3rd Edition, Elsevier, 2005.
4. B. Raj, T. Jayakumar and M. Thavasimuthu, Practical Non-Destructive Testing, NarosaPublishing House, 2009.
5. ASM Metals Handbook, Non-Destructive Evaluation and Quality Control, AmericanSociety of Metals, Metals Park, Ohio, USA

CO-PO Mapping Selection and Testing of Materials (Course Code – PE ME 701E/702E)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	3	-	1	2	-	2	-	-	3	2	-	1
CO2	3	-	2	-	-	1	-	-	-	-	3	2	1	1	2
CO3	3	2	-	1	1	1	-	-	-	-	3	1	-	1	1
CO4	-	2	-	3	1	-	-	-	-	-	-	3	2	1	1
CO5	2	1	1	2	-	-	1	-	1	1	-	3	3	-	-

PE ME 701F/702F- Mechanical Vibration

Course Outcome (CO)

Student will be able to:

CO1	Understand the causes and effects of vibration in mechanical systems.
CO2	Demonstrate schematic models for physical systems and formulate governing equations of motion.
CO3	Explain the role of damping, stiffness and inertia in mechanical systems
CO4	Analyze rotating and reciprocating systems and compute critical speeds.
CO5	Evaluate and design machine supporting structures, vibration isolators and absorbers.

Subject Code : F	**Category:** Professional Elective Courses
Subject Name : Mechanical Vibration	**Semester**: Seventh
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Kinematics & Theory of Machines	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Causes and effects of vibration, Classification of vibrating system, Discrete and continuous systems, degrees of freedom, Identification of variables and Parameters, Linear and nonlinear systems, linearization of nonlinear systems, Physical models, Schematic models and Mathematical models.	6
2	**SDF systems**: Formulation of equation of motion: Newton -Euler method, De Alembert's method, Energy method, Undamped Free vibration response and Damped Free vibration response, Case studies on formulation and response calculation.	6

3	**Forced vibration response:** Response to harmonic excitations, solution of differential equation of motion, Vector approach, Complex frequency response, Magnification factor Resonance, Rotating/reciprocating unbalances, Force Transmissibility, Motion Transmissibility, Vehicular suspension, Vibration measuring instruments, Case studies on forced vibration,	6
4	**Two degree of freedom systems:** Introduction, Formulation of equation of motion: Equilibrium method,Lagrangian method, Case studies on formulation of equations of motion. Free vibration response, Eigen values and Eigen vectors, Normal modes and mode superposition, Coordinate coupling, decoupling of equations of motion, Natural coordinates, Response to initial conditions, free vibration response case studies, Forced vibration response, undamped vibration absorbers, Case studies on undamped vibration absorbers.	7
5	**Multi degree of freedom systems:**	7

	Introduction , Formulation of equations of motion, Free vibration response, Natural modes and mode shapes, Orthogonally of model vectors, normalization of model vectors, Decoupling of modes, modelanalysis, mode superposition technique, Free vibration response through model analysis, Forced vibration analysis through model analysis, Model damping, Rayleigh's damping, Introduction to experimental model analysis.	
6	**Continuous systems**: Introduction to continuous systems, Exact and approximate solutions, free vibrations of strings, bars and beams.	4

Reference Books:

1. L. Meirovich, Elements of Vibration analysis, 2nd Edition, Mc-Graw Hill, 2007.
2. S.S. Rao, Mechanical Vibrations. 4th Edition, Pearson Education, 2011.
3. W.T. Thompson, Theory of Vibration, CBS Publishers, 2002.
4. C.W. de Silva, Vibration: Fundamentals and Practice, CRC Press, 2000.
5. G.K. Grover, Mechanical Vibrations, 8th Edition, Nemchand & Bros, Roorkee, 2009.
6. F.S. Tse, I.E. Morse and R.T. Hinke, Mechanical Vibrations, 2nd Edition, Chapman and Hall,1991.
7. V.P. Singh, Mechanical Vibrations, 3rd Edition, Dhanpat Rai & Co., 2006.

CO-PO Mapping

Mechanical Vibration

(Course Code – PE ME 701F/702F**)**

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

PE ME 701G/702G- Finite Element Analysis

Course Outcome (CO)

Student will be able to:

CO1	Apply finite element method to solve problems in solid mechanics and heat transfer.
CO2	Formulate and solve problems in one dimensional structures including trusses, beams and frames.
CO3	Formulate FE characteristic equations for two dimensional elements and analyse plain stress, plain strain, and axi-symmetric and plate bending problems.
CO4	To learn and apply finite element solutions to structural, thermal, fluid mechanics problem
CO5	To develop the knowledge and skills needed to effectively evaluate finite element analyses

Subject Code: G	**Category:** Professional Elective Courses
Subject Name: Finite Element Analysis	**Semester**: Seventh
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Engineering Mechanics, Strength of Materials, Mathematics	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Historical background, Relevance of FEA/FEM to design problems, Application to the continuum– Discretization, Matrix approach, Matrix algebra– Gaussian elimination, Governing equations for continuum, Classical Techniques in FEM, Weighted residual method, Ritz method, Galerkin method	6
2	**One dimensional problems:** Finite element modeling– Coordinates and shape functions, Potential energy approach– Element matrices and vectors, Assembly for global equations, Boundary conditions, Higher order elements- Shapes functions, Applications to axial loadings of rods– Extension to plane trusses, Bending of beams– Finite element formulation of stiffness matrix and load vectors, Assembly to Global equations, boundary conditions, Solutions and Post processing, Example Problems.	6

3	**Two dimensional problems– scalar variable problems:** Finite element modeling– CST element, Element equations, Load vectors and boundary conditions, Assembly, Application to heat transfer, Examples	3
4	**Two dimensional problems– vector variable problems**: Vector Variable problems, Elasticity equations–Plane Stress, Plane Strain and Axisymmetric problems, Formulation, element matrices, Assembly, boundary conditions and solutions Examples	7
5	**Isoparametric elements for two dimensional problems:** Natural coordinates, Isoparametric elements, Four node quadrilateral element, Shape functions, Element stiffness matrix and force vector, Numerical integration, Stiffness integration, Displacement and Stress calculations, Examples.	6

6	**Numerical Integration and 2-D problems of Elasticity:** Introduction to numerical integration, two dimensional integrals, plane stress, plane strain, axisymmetric, plate bending problems. **Thermal Applications:** Two- dimensional heat conduction analysis, formulation of functional, element matrices and case studies. **Fluid Mechanics Applications:** Stream function formulation, velocity potential formulation and torsional analysis of a prismatic bar. **Computer implementation:** Pre-processor, Processor, Post-processor. Discussion about finite element packages.	8

Text Books:

1. P. Seshu, Textbook of Finite Element Analysis, Prentice Hall of India, 2009.
2. J. N. Reddy, Finite Element Method in Engineering, McGraw Hill, 2009.
3. O.C. Zienkiewicz, R.L. Taylor and J.Z. Zhu, The Finite Element Method for Solid andStructural Mechanics, 4th Edition, Elsevier 2007.
4. R.D. Cook, D.S. Malkus and M.E. Plesha, Concepts and Applications of Finite ElementAnalysis, Wiley, 2001.
5. T.R. Chandrupatla and A.D. Belegundu, Introduction to Finite Elements in Engineering,Pearson, 2012.
6. C.S. Krishnamoorthy, Finite Element Analysis, McGraw Hill, 1994.
7. K.J. Bathe, Finite Element Procedures, Prentice Hall of India, 1982.

CO-PO Mapping

Finite Element Analysis

(Course Code – PE ME 701G/702G**)**

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

PE ME 701H/702H- Advanced Welding Technology

Course Outcome (CO)

Student will be able to:

CO1	To familiarize different types of welding processes.
CO2	To familiarize the basic mechanism behind weld joint and influencing factors.
CO3	To impart the knowledge different tests to judge soundness of the weld joint.

Subject Code: H	**Category:** Professional Elective Courses
Subject Name: Advanced Welding Technology	**Semester:** Seventh
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Manufacturing Processes	

Module No.	Description of Topic	Contact Hrs.
1	Review of welding processes, joint design.	3
2	Descriptions and Parametric influences on Welding processes: Arc Welding- SMAW, Stud Arc welding, SAW, GMAW, GMAW-P,FCAW, GTAW, GTAW-P. Resistance Welding processes- Spot, Butt, Seam, Projection. Solid State Welding processes- Forge welding, Friction welding, Friction Stir welding, Diffusion welding, Roll welding.	6
3	Arc Welding- Different types of equipment, Power sources, Choiceof Polarity, Arc characteristics, Modes of Metal Transfer, Welding Positions, Electrode selection.	5
4	Critical and Precision Welding processes- USW, PAW, LBW, EBW. Underwater Welding- Wet Welding and Dry Welding: Hyperberic and Cavity. Welding of Plastics- Hot Gas Welding, Hot Tool Welding, Hot Press Welding, Friction Welding, Ultrasonic Welding. Joining of Ceramics and Composites.	8

5	Welding Metallurgy, HAZ, Effect of different process parameters onthe characteristics of weldment. Weldability of Plain Carbon Steel, Stainless Steel, Cast Iron, Aluminium and its Alloys.	8
6	Welding Defects- Types, Causes, Inspection and Remedial Measures.Testing of Welded Joints- Visual Inspection, Dye-Penetration (DP) Test, Ultrasonic Test and Radiography Test.	3
7	Welding Fixtures, Welding Automation and Robotic Welding. Safe Practices in Welding.	3

Learning Resources:

1. O.P. Khanna, A Text Book of Welding Technology, Dhanpat Rai & Sons, 2015.
2. R.S. Parmar, Welding Engineering and Technology, Khanna Publishers, 2013.
3. M. Bhattacharyya, Weldment Design, The Association of Engineers, India Publication,Kolkata, 1991.
4. J.C. Lippold and D.J. Kotecki, Welding Metallurgy and Weldability of Stainless Steels,Wiley India (P) Ltd., New Delhi, 2011.
5. H. Udin, E.R. Funk and J. Wulf, Welding for Engineers, John Wiley and Sons, 1954.
6. J.L. Morris, Welding Process and Procedures, 2nd Edition, Prentice Hall, 1955.
7. J. F. Lancaster, The Metallurgy of Welding, 6th Edition, William Andrew Publishing, 1999.
8. B. Raj, V. Shankar, A.K. Bhaduri (Editors), Welding Technology for Engineers, NarosaPublishing House, 2006.

CO-PO Mapping

Advanced Welding Technology

(Course Code – PE ME 702H**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	1	-	-	-	-	-	-	-	2	1	-	-	-
CO2	2	2	2	-	-	-	-		-	-	2	1	-	2	1
CO3	3	-	2	1	-	-	-	1	-	-	2	-	1	-	-

PE ME 701I/702I- Quantity Production Method

Course Outcome (CO)

Student will be able to:

CO1	Gather knowledge about different quantity production methods practised in industry.
CO2	Understand planning and scheduling methods usually used in industry to have high productivity and to enhance quality.
CO3	Understand production method and size of production.

Subject Code: I	**Category:** Professional Elective Courses
Subject Name: Quantity Production Method	**Semester:** Seventh
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Manufacturing Technology	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Engineering Production; aim and objectives history of progress, definition and requirements. Levels of production; piece, batch, lot, mass and quantity production. Mechanisation and Role of automation in industrial production; need, degree and types of automation.	4

2	**Quantity Production Methods- Concept:** Broad classification of engineering production methods: Major sequential steps in industrial production; Preforming, semi finishing, heat treatment, finishing, assembly and inspection. Quantity production (methods) of common items: (i) shafts and spindles, (ii) automobile parts, engine block, piston, connecting rods and crank shaft, (iii) metallic wires, rods, tubes, bars, plates and sheets, (iv) various types of gears and bearings. Methods of quantity production of cutting tools, tool inserts and tool holders. Small size products: Pins, clips, needles, metallic caps, washers, utensils, chains springs, paste tubes and coins. Large scale production of bolts and nuts. Quantity production by spinning, bulging, magneto forming, hydro forming and explosive forming. Production by powder metallurgical process.	16
3	**Planning and Scheduling:** 3.1 Process planning and scheduling for quantity production using (i) semi-automatic and automatic lathes, (ii) transfer machines (iii) CNC machining systems (including machining centres, DNC	6
	and FMS) 3.2 Design and use of jigs and fixtures for batch production inmachine shops	
4	**Productivity and Quality Enhancement in Quantityproduction:** Group technology; concept and application in large scaleproduction. Inspection and quality control in quantity production. Computerisation and robotization in quantity production.	4
5	**Non-Conventional Manufacturing of Products in Quantity:** Quantity production by non-traditional processes; EDM, Wire-Cut EDM, ECM, AJM, AWJM, WJM, USM, CHM, EBM and PAM. Regenerative Manufacturing; Rapid Prototyping, Rapid Tooling and Rapid Manufacturing. Quantity Production of Ceramic and Polymer Products.	6

Learning Resources:

1. M.P. Groover, Fundamentals of Modern Manufacturing, Wiley Pub, 2009.
2. S. Kalpakjian, Manufacturing Engineering and Technology, Pearson, 2002.
3. S.D.El Wakil, Processes and Design for Manufacturing, CRC Press, 2019.
4. R.A. Lindberg, Process and Materials of Manufacture, Pearson 2015.
5. E.P. DeGarmo, J.T. Black and R.A. Kosher, Materials and Processes in Manufacturing,Prentice Hall, 1997.

6. C. Donaldson, Tool Design, 4th Edition, McGraw Hill Publication, 2012.
7. G.C. Sen and A. Bhattacharyya, Principles of Machine Tools, New Central Agency Publication, Kolkata, 2015

CO-PO Mapping

Quantity Production Method

(Course Code – PE ME 701I/702I**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	-	-	-	1	-	-	3	1	1	1
CO2	3	2	2	1	2	-	-	-	2	-	-	3	2	3	1
CO3	3	3	3	2	1	2	1	-	1	-	2	3	-	1	-

PE ME 701J/702J- CAD/CAM

Course Outcome (CO)

Student will be able to:

CO1	To familiarize the basics of computer aided design- geometric modeling, stress analysis.
CO2	To familiarize the basics of computer aided manufacturing.
CO3	To familiarize the components of computer aided manufacturing system including application of robot and control systems.

Subject Code: J	**Category:** Professional Elective Courses
Subject Name: CAD/CAM	**Semester:** Seventh
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Manufacturing Technology, Elements of Mechanical Design, Mathematics	

Module No.	Description of Topic	Contact Hrs.
1	Fundamentals of CAD- Design process, benefits of computer aided design, graphics standards.	3
2	Geometric modeling- wire-frame, surface and solid modeling Transformation- translation and rotation exercise problems and programming. Stress analysis- basics of FEM, formation of stiffness matrix fortwo elements.	6
3	Introduction to computer aided manufacturing (CAM) systems, basic building blocks of computer integrated manufacturing (CIM).	4
4	Toolings of CNC machines, tool and work handling systems involving robot, AGV, RTV, AS/RS, ATC, APC.	3
5	Robotics; types, anatomy, drives and applications.	3
6	Computer aided production planning and control, Manufacturingfrom product design- CADCAM interface, concept of group technology (GT), CAPP.	6

7	Control systems, Process monitoring, Adaptive control systems, etc.	2
8	Automatic inspection systems, use of CMM, Reverse Engineering.	1

Learning Resources:

1. P.N. Rao, N.K. Tewari and T.K. Kundra, Computer Aided Manufacturing, McGraw-HillPublication, 2017.
2. M.P. Groover and E.W. Zimmers Jr., CAD/CAM, Prentice Hall of India, 1983.
3. P. Radhakrishnan, S. Subramanyan and V. Raju, CAD/CAM/CIM, New Age InternationalPublishers, 2007.
4. P.N. Rao, CAD/CAM, McGraw Hill Publication, 2010.
5. M.P. Groover, Automation, Production Systems, and Computer- Integrated Manufacturing,Prentice Hall of India, 2016.
6. I. Zeid, CAD/CAM- Theory and Practice, McGraw-Hill Publishing Co. Ltd., New Delhi,1991.
7. S.R. Deb and S. Deb, Robotics Technology and Flexible Automation, McGraw-HillPublication, 2010.
8. S.K. Saha, Introduction to Robotics, McGraw-Hill Publication, 2008.
9. P.B. Mahapatra, Computer-Aided Production Management, Prentice Hall of India, 2010.

CO-PO Mapping

CAD/CAM

(Course Code – PE ME 701 J/702 J**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	2	1	2	1	3	2	2	-	3	2	2	-	1
CO2	1	1	1	-	-	2	2	1	1	2	3	1	1	1	3
CO3	3	-	1	2	-	1	2	1	1	2	3	1	3	-	3

OE ME 701A- Industrial Engineering

Course Outcome (CO)

Student will be able to:

CO1	Understand the concepts of Industrial Engineering.
CO2	Explain production systems and their characteristics.
CO3	Understand the role of productivity in streamlining a production system.
CO4	Describe different aspects of work system design and facilities design pertinent to manufacturing industries
CO5	Apply forecasting and scheduling techniques to production systems.
CO6	Apply the inventory management tools in managing inventory

Subject Code: A	**Category:** Open Elective Courses
Subject Name: Industrial Engineering	**Semester:** Seventh
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Basic Engineering Knowledge	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to Industrial Engineering and Productivity:** Definition and Functions of Industrial Engineering, Origin and development of factory system, Contribution of Taylor and Gilbreth Productivity: Definition of productivity, Factors Influencing Productivity, Causes of Low Productivity, Productivity Measurement Models, Productivity Improvement Techniques.	3

2	**Work Study**: Basic Concept, Steps Involved in Work Study, Techniques of Work Study, Human Factors in the Application of Work Study. Method Study: Basic Concept, Steps Involved in Method Study, Recording Techniques, Operation Process Charts, Flow Process Charts, Two-Handed-Process Charts, Multiple Activity Charts, Flow Diagrams. String Diagrams, Principles of Motion Economy, Micro-Motion Study, Therbligs, SIMO Charts. Work Measurement: Basic Concept, Techniques of Work Measurement, Steps Involved in Time Study, Time Study Equipment, Performance Rating, Basic concept and Procedure of Work Sampling Study.	10
3	**Facility Layout and Planning:** Nature, Significance and Scope of Facility layout and design; Steps in facility layout planning, Assembly Line Balancing. Material Handling: Definition, Objective and Principles of Material Handling, Classification of Material Handling Devices.	10
4	**Production Planning and Control:** Introduction to Production Systems, Types of production systems, Need and functions of PPC. Forecasting: Definition and Functions of Forecasting, Forecasting	4
	techniques: linear regression, moving average, exponentialsmoothing; Analysis of forecast error. Aggregate production planning, Capacity Planning, ERP, Master Production Schedule. Basic sequencing and scheduling techniques.	
5	**Introduction to Inventory Management:** Importance and areas of materials management, Introduction to Inventory: Definitions, Need for inventory, Types of inventory, Inventory costs; Structure of inventory models, Deterministic models; safety stock, inventory control systems; Selective inventory management. MRP and JIT-based production systems, Concept of zero inventory, Fundamental concepts of purchasing, storing, distribution, and value analysis & engineering.	9

Learning Resources:

1. S.C. Sharma, Industrial Engineering and Management, Khanna Book Publication, 2016.
2. O.P. Khanna, Industrial Engineering and Management, Dhanpat Rai Publication, 1980.
3. M.T. Telsang, Industrial Engineering and Production Management, S. Chand

Publishing,2018.
4. K.B. Zandin and H.B. Maynard, Maynard's Industrial Engineering Hand Book, McGrawHill Education, 2001.
5. ILO, Introduction to Work Study, Oxford and IBH Publishing, 1992.
6. B. Mahadevan, Operations Management: Theory and Practice, Pearson, 2010.
7. S.N. Chary, Production and Operations Management, McGraw-Hill Education, 2019.
8. K. Bedi, Production and Operations Management, Oxford University Press, 2004.
9. A. Tompkins, J.A. White, Y.A. Bozer, and J.M.A. Tanchoco, Facilities Planning, Wiley,2005.

CO-PO Mapping

Industrial Engineering

(Course Code – OE ME 701A**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	3	2	2	-	1	-	-	2	2	3	3	1	-
CO2	3	3	-	2	-	1	1	-	1	2	1	2	3	-	3
CO3	-	3	3	3	2	-	-	1	3	1	3	-	1	-	3
CO4	1	3	3	3	2	2	2	1	3	1	3	2	1	3	3
CO5	2	2	-	2	-	1	1	-	-	1	1	2	2	2	-
CO6	3	-	-	-	2	2	3	-	--	-	3	3	3	-	2

OE ME 701B- Project Management

Course Outcome (CO)

Student will be able to:

CO1	Understand the concept of projects and its phases.
CO2	Analyze project from marketing, operational and financial perspective.
CO3	Develop network diagrams for planning and execution of a given project.

Subject Code: B	**Category:** Open Elective Courses
Subject Name: Project Management	**Semester:** Seventh
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Basic Engineering Knowledge	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Introduction to Project Management, History of Project Management, Types & Characteristics of Projects, Project Life Cycle.Project Identification and Screening.	4
2	**Project Analysis:** Facets of Project Analysis, Strategy and Resource Allocation, Market and Demand Analysis, Technical Analysis, Economic and Ecological Analysis. Cash flows for project appraisal- Investment evaluation using capital budgeting techniques, net present value, profitability index, internal rate of return, payback period, accounting rate of return.	12
3	**Network Technique for Project Management:** Development of Project Network, Time Estimation, Determination of the Critical Path, PERT Model, CPM Model.	10
4	**Optimisation in Project Management:** Time and Cost trade-off in CPM, Crashing procedure, Scheduling when resources are limited.	5
5	**Organization systems for project implementation:** Work Breakdown, coordination and control, Project Management Softwares.	5

Learning Resources:

1. P. Chandra, Project: A Planning Analysis, McGraw Hill Book Company, New Delhi, 2017.
2. C.F. Grey, E.W. Larson and G.V. Desai, Project Management the Managerial Process,McGraw Hill Education (India), New Delhi, 1990.
3. K. Harold, Project Management: A Systems Approach to Planning, Scheduling andControlling, Wiley Student Edition, 2013.
4. J.D. Wiest and F.K. Levy, A Management Guide to PERT/ CPM with PERT/ PDM/ DCPMand Other Networks, PHI Learning Private Limited, 1970.
5. A. Kanda, Project Management: A Life Cycle Approach, PHI, 2010.

CO-PO Mapping

Project Management

(Course Code – OE ME 701B**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	1	3	-	-	1	3	2	-	1	2
CO2	2	-	-	1	2	2	3	-	--	2	1	3	-	-	2
CO3	1	-	-	-	2	1	3	-	-	2	2	3	1	-	1

OE ME 701C- Introduction to Product Design and Development

Course Outcome (CO)

Student will be able to:

CO1	Identify and analyse the product design and developmentprocesses industry.
CO2	Define the components and their functions of product design and development processes
CO3	Analyse, evaluate and apply the methodologies for product design, development and management.
CO4	Undertake a methodical approach to the management of product development to satisfy customer needs.
CO5	Carry out cost and benefit analysis through various cost models.

Subject Code : C	**Category:** Open Elective Courses
Subject Name: Introduction to Product Design and Development	**Semester**: Seventh
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Elements of Machine Design, Basics of Management Principles	

Module No.	Description of Topic	Contact Hrs.
1	Introduction to product design, design and development process, sequential engineering design method, product planning and project selection.	10
2	Identifying customer needs– interpreting raw data;Product specifications– establishing target specifications, settingfinal specifications.	9
3	Concept generation– activities of concept generation, clarifying problem, exploring the output; Concept selection– concept screeningand concept scoring, methods of selection.	9
4	Concept testing– qualitative and quantitative methods including survey, measurement and customer's response; Design forenvironment– basic concepts.	8

Learning Resources:

1. K.T. Ulrich and S.D. Eppinger, Product Design and Development, 7th Edition, McGraw-Hill,2019.
2. B. Gupta, Concepts in Engineering Design, Dhanpat Rai & Co., New Delhi, 2016.

A.C. Chitale and R.C. Gupta, Product Design and Manufacture, Prentice-Hall, 6th Edition, 2014.

CO-PO Mapping

Introduction to Product Design and Development

(Course Code – OE ME 701C**)**

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

OE ME 701D- Non-conventional Energy Sources

Course Outcome (CO)

Student will be able to:

CO1	know about the energy scenario at present and the need of using renewable energy for sustainability.
CO2	know specifically the use of solar energy for heating as well as photovoltaic generation.
CO3	Explore the concepts involved in wind energy conversion system by studying its components, types and performance.
CO4	Illustrate ocean energy and explain the operational methods of their utilization.
CO5	Acquire the knowledge on Geothermal energy

Subject Code : D	**Category:** Open Elective Courses
Subject Name: Non-Conventional Energy Resources	**Semester**: Seventh
L-T-P : 3-0-0	**Credit:** 3
Pre-Requisites: Thermodynamics, Fluid Dynamics and Heat Transfer	

Module No.	Description of Topic	Contact Hrs.
1	Principles of Renewable Energy: The history of energy scene, energy of the future: sustainable energy, development and role of renewableenergy, Scientific Principles of renewable energy.	4
2	Review of principles of thermodynamics, fluid dynamics and heat transfer.	1
3	Solar Radiation: i) Sun-Earth geometry, ii) Extraterrestrial Solar Radiation, iv) Measurement and estimation of solar radiation.	4
4	Solar Water Heating: i) Flat Plate Collectors: Heat Transfer analysis, Testing ii) Evacuated Tube Collectors	5

5	Other Solar Thermal Applications: i) Air heaters, ii) WaterDesalination, iii) Space Cooling, iv) Solar Concentrators, v) Solar ponds	3
6	Photovoltaic Generation: i) Photon absorption at Silicon p-n junction, ii) Solar Cell, iii) Application and Systems.	4
7	Wind Power: i) Turbine types & terms, ii) Mechanical & Electrical Power from Wind Turbines.	3
8	Biomass & Biofuels: i) Use of Biomass, ii) Classification & Use of Biofuels.	3
9	Wave Power & Tidal Power: Basic Concepts	3
10	Ocean Thermal Energy Conversion, Geothermal Energy. Energy Storage	6

Learning Resources:

1. G. Boyle, Renewable Energy, 2nd Edition, Oxford University Press, 2010.
2. J. Twidell and T. Weir, Renewable Energy Resources, 2nd Edition, Taylor & Francis, 2006.
3. B.H. Khan, Non Conventional Energy Resources, McGraw Hill, 2010.
4. G.D. Rai, Non Conventional Energy Sources, Khanna Publishers, New Delhi, 2017.
5. Ashish Chandra, Non-Conventional Energy Sources, Khanna Publishers, New Delhi, 2019

CO-PO Mapping

Non-conventional Energy Resources

(Course Code – OE ME 701D**)**

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

OE ME 701E- Biomechanics and Biomaterials

Course Outcome (CO)

Student will be able to:

CO1	Understand dynamics of human motion with the knowledge of musculoskeletal anatomy and biomaterial interfaces.
CO2	Understand fundamental characteristics and properties of biomaterials and their testing techniques.
CO3	Apply knowledge about biomaterials and human biomechanics to critically analyse the fitness for purpose and predict the performance of biomedical devices in selected clinical applications
CO4	Apply standards, regulations and ethical responsibilities in the process of developing biomaterials and medical devices, and design strategies to deal with possible hurdles in bringing a product to market.

Subject Code : E	**Category:** Open Elective Courses
Subject Name : Biomechanics and Bio materials	**Semester** : Seventh
L-T-P : **3-0-0**	**Credit: 3**
Pre-Requisites: Biology, Engineering Mechanics	

Module No.	Description of Topic	Contact Hrs.
1	**Musculoskeletal Anatomy**: Basic Statics and Joint Mechanics (elbow, shoulder, spine, hip, knee, ankle)	6
2	**Basic Dynamics to Human Motion**: Review of linear and angular kinematics; Kinetic equations of motion; Work & energy methods; Momentum methods; Examples in biomechanics; Modern kinematic measurement techniques; Applications of human motion analysis Structure, Function, and Adaptation of Major Tissues and Organs.	6

3	**Fundamental Strength of Materials in Biological Tissues**: Introduction to Viscoelasticity. **Fundamentals of biomaterials science**. Concept of biocompatibility. Classes of biomaterials used in medicine, basic properties, medical requirements and clinical significance. Disinfection and sterilizationof biomaterials.	6
4	**Physico-Chemical Properties of Biomaterials**: mechanical (elasticity, yield stress, ductility, toughness, strength, fatigue, hardness, wear resistance), tribological (friction, wear, lubricity), morphology and texture, physical (electrical, optical, magnetic, thermal), chemical and biological properties.	6
5	**Elements in Contact with the Surface of a Biomaterial**: Blood composition, plasma proteins, cells, tissues. **Phenomena at the Biointerfaces**. Molecular and cellular processes with living environment, blood-materials interaction, short and long term reactions to the body.	6

6	**Testing of Biomaterials**: in vitro, in vivo preclinical and in vivo clinical tests. Technologies of biomaterials processing, as implants and medical devices; improvement of materials biocompatibility by plasma processing.	6

Learning Resources:

1. D.V. Knudson, Fundamentals of Biomechanics, Springer, 1999.
2. N. Ozkaya, M. Nordin, D. Goldsheyder and D. Leger, Fundamentals of Biomechanics:Equilibrium, Motion, and Deformation, Springer, 2012.
3. Y.C. Fung, Biomechanics: Mechanical Properties of Living Tissues, Springer, 1981.
4. M. Nordin and V.H. Frankel, Basic Biomechanics of the Musculoskeletal System, Barnes &Noble, 2011.
5. B.D. Ratner and A.S. Hoffman (Eds.), Biomaterials Science, An Intoduction to Materials inmedicine, 3rd Edition, Academic Press, New York, 2012

CO-PO Mapping

Biomechanics and Biomaterials **(Course Code –** OE ME 701E**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	2	-	1	1	-	1	2	1	2	3	-	3
CO2	-	3	3	3	2	-	-	1	3	1	3	-	1	-	3
CO3	1	3	3	3	2	2	2	1	3	1	3	2	1	3	3

CO4	3	-	-	-	2	2	3	-	--	-	3	3	3	-	2

OE ME 701F- Computational Methods in Engineering

Course Outcome (CO)

Student will be able to:

CO1	understand the concept of truncation and round off errors; fixed and floating point arithmetic and propagation of error and interpolation or extrapolation.
CO2	integrate different functions numerically and understand the error expressions.
CO3	solve systems of linear, algebraic and ordinary differential equations.
CO4	apply Laplace and Fourier transformation techniques.
CO5	use linear and non-linear regression techniques and do analysis of variance (ANOVA).

Subject Code : F	**Category:** Open Elective Courses
Subject Name : Computational Methods in Engineering	**Semester** : Seventh
L-T-P : **3-0-0**	**Credit: 3**
Pre-Requisites: Mathematics- IB, Mathematics- IIB, Mathematics- III	

Module No.	Description of Topic	Contact Hrs.
1	**Approximations:** Accuracy and precision, round off and truncation errors, error propagation.	3
2	**Linear algebraic equations:** Formulation and solution of linear algebraic equations, Gauss elimination, LU decomposition, iterationmethods– convergence, Eigen values and Eigen vectors.	4
3	**Interpolation methods**: Newton's divided difference, interpolation polynomials, Lagrange interpolation polynomials.	5
4	**Differentiation and Integration:** High accuracy integration formula, extrapolation, derivatives of unequally spaced data, Gauss quadrature and integration.	5
5	**Numerical solution of Algebraic equation:** Bisection method, Regula-Falsi method, Newton-Raphson method.	4
6	**Transform techniques**: Continuous Fourier series, frequency and time domains, Laplace transform, Fourier integral and transform, Discrete Fourier Transform, fast Fourier Transform.	6
7	**Differential Equations:** Initial and boundary value problems, eigen value problems, solutions to elliptical and parabolic equations, partial differential equations.	5
8	**Regression methods**: Linear and non-linear regression, multiple linear regression, general linear test squares. **Statistical methods**: Statistical representation of data, modelling and analysis of data, ANOVA, test of hypotheses.	4

Learning Resources:

1. S.K. Gupta, Numerical Methods for Engineers, New Age International, 2005.
2. S.C. Chapra and R.P. Canale, Numerical Methods for Engineers, McGraw Hill, 1989.
3. R.J. Schilling and S.L. Harris, Applied Numerical Methods for Engineering using MATLABand C, Brooks/Cole Pub., 2000.
4. W.W. Hines and Montgomery, Probability and Statistics in Engineering and ManagementStudies, John Wiley, 1990.

CO-PO Mapping Computational Methods in Engineering **(Course Code –** OE ME 701F**)**															
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	3	3	2	-	1	-	-	2	2	3	3	1	-
CO2	3	-	-	3	-	1	1	-	-	-	1	2	-	-	-
CO3	-	-	3	3	2	-	-	1	-	1	3	-	1	-	3
CO4	1	3	3	3	2	-	-	-	-	1	3	2	-	2	-
CO5	2	2	3	2	-	1	-	-	-	1	1	2	2	2	-

OE ME 701G- Artificial Intelligence (AI)

Course Outcome (CO)

Student will be able to:

CO1	Build intelligent agents for search and games.
CO2	Solve AI problems through programming with Python.
CO3	Learning optimization and inference algorithms for model learning.
CO4	Design and develop programs for an agent to learn and act in a structured environment.

Subject Code: G	**Category:** Open Elective Courses
Subject Name: Artificial Intelligence (AI)	**Semester:** Seventh
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Basic Programming in Python, Data Structures	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Concept of AI, history, current status, scope, agents,environments, Problem Formulations, Review of tree and graph structures, State space representation, Search graph and Search tree.	2
2	**Search Algorithms**: Random search, Search with closed and openlist, Depth first and Breadth first search, Heuristic search, Best first search, A* algorithm, Game Search.	7
3	**Probabilistic Reasoning:** Probability, conditional probability, Bayes Rule, Bayesian Networks- representation, construction and inference, temporal model, hidden Markov model.	10
4	**Markov Decision process:** MDP formulation, utility theory, utility functions, value iteration, policy iteration and partially	10

	observableMDPs.	
5	**Reinforcement Learning:** Passive reinforcement learning, direct utility estimation, adaptive dynamic programming, temporaldifference learning, active reinforcement learning- Q learning.	7

Learning Resources:

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 3rd Edition, PrenticeHall, 2009.
2. E. Rich, K. Knight and K. Knight, Artificial Intelligence, McGraw Hill, 1991.
3. M.C. Trivedi, A Classical Approach to Artificial Intelligence, Khanna Publishing House,New Delhi, 2018.
4. S. Kaushik, Artificial Intelligence, Cengage Learning India, 2011.
5. D. Poole and A. Mackworth, Artificial Intelligence: Foundations for Computational Agents,Cambridge University Press, 2010.
6. Websites for reference: https://nptel.ac.in/courses/106105077
7. Websites for reference: https://nptel.ac.in/courses/106106126
8. Websites for reference: https://aima.cs.berkeley.edu

CO-PO Mapping

Artificial Intelligence(AI)

(Course Code – OE ME 701G)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	-	1	2	1	-	2	2	3	2	2
CO2	3	1	3	1	-	-	-	1	-	-	1	3	1	1	1
CO3	2	-	2	1	2	-	-	-	-	-	2	2	2	-	1
CO4	1	2	1	-	-	1	-	1	1	-1	3	1	1	1	3

OE ME 701H- Machine Learning

Course Outcome (CO)

Student will be able to:

CO1	Distinguish between, supervised, unsupervised and semi-supervised learning
CO2	Apply the appropriate machine learning strategy for any given problem
CO3	Suggest supervised, unsupervised or semi-supervised learning algorithms for any given problem
CO4	Design systems that uses the appropriate graph models of machine learning
CO5	Modify existing machine learning algorithms to improve classification efficiency

Subject Code : H	**Category:** Open Elective Courses
Subject Name : Machine Learning	**Semester** : Seventh
L-T-P : **3-0-0**	**Credit: 3**
Pre-Requisites: Mathematics- IB, Mathematics- IIB, Mathematics- III	

Module No.	Description of Topic	Contact Hrs.
1	Introduction: Learning– Types of Machine Learning– Supervised Learning– The Brain and the Neuron– Design a Learning System– Perspectives and Issues in Machine Learning– Concept Learning Task– Concept Learning as Search– Finding a Maximally Specific Hypothesis– Version Spaces and the Candidate Elimination Algorithm– Linear Discriminants– Perceptron– Linear Separability– Linear Regression.	8
2	Linear Models: Multi-layer Perceptron– Going Forwards– Going Backwards: Back Propagation Error– Multilayer Perceptron in Practice– Examples of using the MLP– Overview– Deriving Back Propagation– Radial Basis Functions and Splines– Concepts– RBF Network– Curse of Dimensionality– Interpolations and Basis Functions– Support Vector Machines.	7

3	Tree and Probabilistic Models: Learning with Trees– Decision Trees– Constructing Decision Trees– Classification and Regression Trees– Ensemble Learning– Boosting– Bagging– Different ways to Combine Classifiers– Probability and Learning– Data into Probabilities– Basic Statistics– Gaussian Mixture Models– Nearest Neighbor Methods– Unsupervised Learning– K means Algorithms– Vector Quantization– Self Organizing Feature Map.	7

4	Dimensionality Reduction and Evolutionary Models: Dimensionality Reduction– Linear Discriminant Analysis– Principal Component Analysis– Factor Analysis– Independent Component Analysis– Locally Linear Embedding– Isomap– Least Squares Optimization. Evolutionary Learning– Genetic algorithms– Genetic Offspring- Genetic Operators– Using Genetic Algorithms– Reinforcement Learning– Overview– Getting Lost Example– Markov Decision Process.	7
5	Graphical Models: Markov Chain Monte Carlo Methods– Sampling– Proposal Distribution– Markov Chain Monte Carlo– Graphical Models– Bayesian Networks– Markov Random Fields– Hidden Markov Models– Tracking Methods.	7

Learning Resources:

1. Jeeva Jose, Introduction of Machine Learning, Khanna Publishing House, 2019.
2. S. Marsland, Machine Learning– An Algorithmic Perspective, 2nd Edition, Chapman andHall/CRC Machine Learning and Pattern Recognition Series, 2014.
3. T.M. Mitchell, Machine Learning, First Edition, McGraw Hill Education, 2013.
4. P. Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data,First Edition, Cambridge University Press, 2012.
5. J. Bell, Machine learning– Hands on for Developers and Technical Professionals, FirstEdition, Wiley, 2014.
6. E. Alpaydin, Introduction to Machine Learning (Adaptive Computation and MachineLearning Series), 3rd Edition, MIT Press, 2014.

CO-PO Mapping

Machine Learning

(Course Code – OE ME 701H**)**

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

OE ME 701I- Water Resource Engineering

Course Outcome (CO)

Student will be able to:

CO1	Understand characteristic features of closed conduit flow and open channel flow.
CO2	Know different features of surface water hydrology and rainfall.
CO3	Study about groundwater hydrology and its characteristic relationships.

Subject Code: I	**Category:** Open Elective Courses
Subject Name: Water Resource Engineering	**Semester:** Seventh
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Fluid Mechanics	

Module No.	Description of Topic	Contact Hrs.
1	**Fluid Mechanics:** Review of fluid statics, Review of fluid dynamics; dimensional analysis.	4
2	**Closed Conduit Flow:** Closed conduit flow, Design of water distribution systems, pipe network analysis: Hardy Cross Method,Design of Network Reservoir pipeline.	9
3	**Open Channel Flow:** Continuity, momentum equations, Chezy, Mannings and energy equations, Water surface profiles.	9
4	**Surface Water Hydrology:** Rainfall depth, duration, distribution, determination of average rainfall depth by Arithmatic, Mean Method, Thiessen Polygon Method and Isohyetal Method, Rainfall/ runoff equations, Rainfall/ runoff models, unit hydrograph, hydrologic routing models.	10

5	**Groundwater Hydrology:** Porosity and water content, Equations of ground water flow (unconfined aquifers/ confined, aquifers/ unsaturated flow), Estimation of aquifer parameters using graphical and analytical approach.	4

Learning Resources:

1. S.K. Garg, Hydrology and Water Resources Engineering, Khanna Pub., 1973.
2. R.A. Wurbs and W.P. James, Water Resources Engineering, Pearson, 2001.
3. K. Subramanya, Engineering Hydrology, 4th Edition, McGraw-Hill, New Delhi, 2013

CO-PO Mapping

Water Resource Engineering

(Course Code – OE ME 701I**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	3	3	2	2	2	1	3	1	3	2	1	3	3
CO2	2	2	-	2	-	1	1	-	-	1	1	2	2	2	-
CO3	3	-	-	-	2	2	3	-	--	-	3	3	3	-	2

HM HU 701- Economics for Engineers

Course Outcome (CO)

Student will be able to:

CO1	To understand Economic Decisions Making criteria
CO2	To know basic principles of engineering costs, estimation and depreciation analysis.
CO3	To understand basic accounting principles.

Subject Code: HM-HU701	**Category:** Humanities and Social Sciences including Management Courses
Subject Name: Economics for Engineers	**Semester**: Seventh
L-T-P: **2-0-0**	**Credit: 1**
Pre-Requisites: Nil	

Module No.	Description of Topic	Contact Hrs.
1	Economic Decisions Making- Overview, Problems, Role, Decision making process.	2
2	Engineering Costs & Estimation- Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring and Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs; Types of Estimate, Estimating Models - Per- Unit Model, Segmenting Model, Cost Indexes, Power- Sizing Model, Improvement & Learning Curve, Benefits.	4
3	Present Worth Analysis: End-of-Year Convention, Viewpoint of Economic Analysis Studies, Borrowed Money Viewpoint, Effect of Inflation & Deflation, Taxes, Economic Criteria, Applying Present Worth Techniques, Multiple Alternatives.	4
4	Cash Flow & Rate of Return Analysis- Calculations, Treatment of Salvage Value, Annual Cash Flow Analysis, Analysis Periods; Internal Rate of Return, Calculating Rate of Return, Incremental Analysis; Best Alternative Choosing an Analysis Method, Future Worth Analysis, Benefit-Cost Ratio Analysis, Sensitivity and Break Even Analysis. Economic Analysis in the Public Sector- Quantifying and Valuing Benefits & drawbacks.	4

5	Depreciation- Basic Aspects, Deterioration & Obsolescence, Depreciation and Expenses, Types of Property, Depreciation Calculation Fundamentals, Depreciation and Capital Allowance Methods, Straight-Line Depreciation Declining Balance Depreciation, Common Elements of Tax Regulations For Depreciation and Capital Allowances.	4
6	Inflation and Price Change- Definition, Effects, Causes, Price Change With Indexes, Types of Index, Composite vs Commodity Indexes, Use	3
	of Price Indexes in Engineering Economic Analysis, Cash Flows that inflate at different Rates.	
7	Accounting- Function, Balance Sheet, Income Statement, Financial Ratios Capital Transactions, Cost Accounting, Direct and Indirect Costs, Indirect Cost Allocation.	3

Learning Resources:

1. Premvir Kapoor, Sociology & Economics for Engineers, Khanna Publishing House, Delhi.
2. J.L. Riggs, D.D. Bedworth and S.U. Randhawa, Engineering Economics, 4th Edition,McGraw Hill International Edition, 1996.
3. D. Newnan, T. Eschembach and J. Lavelle, Engineering Economics Analysis, OxfordUniversity Press, 2019.
4. J.A. White, K.E. Case and D.B. Pratt, Principle of Engineering Economic Analysis, JohnWiley, 2016.
5. W.G. Sullivan, E.M. Wicks and C.P. Koelling, Engineering Economy, 17th Edition, Pearson,2018.
6. R. Panneerselvan, Engineering Economics, Prentice Hall of India, 1999.
7. M.R. Lindeburg, Engineering Economics Analysis: An Introduction, ProfessionalPublication, 1993.

CO-PO Mapping Economics for Engineers **(Course Code –** HM HU 701**)**															
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	-	-	-	-	-	-	1	1	2	1	3	2	1	1	-
CO2	-	-	-	-	-	1	-	2	2	1	3	3	2	1	-
CO3	-	-	-	-	-	-	-	-	-	1	3	3	-	-	1

PC ME 791- Mechanical Engineering Laboratory-III (Manufacturing)

Course Outcome (CO)

Student will be able to:

CO1	Study cutting forces in machining processes
CO2	Test the quality of weld and moulding sands
CO3	Develop a practical understanding of advanced manufacturing processes.
CO4	Understand the working of a robot and its programming
CO5	Identify and rectify defects in parts and manufacturing processes related problems.

Subject Code: PC-ME791	**Category:** Professional Core Courses
Subject Name: Mechanical Engineering Laboratory III (Manufacturing)	**Semester**: Seventh
L-T-P: **0-0-3**	**Credit: 1.5**
Pre-Requisites: Manufacturing Processes, Manufacturing Technology	

Course Contents (12 Experiments/ Problems/ Studies are to do):

1. Measurement of Cutting Force in Turning
2. Study of the effect of parametric variation in arc welding
3. Testing of moulding sand
4. Testing for Weld Quality
5. Study of and Solving problems on geometry of robot manipulator, actuators and grippers
6. Programming on CNC Lathe using G and M Codes
7. Programming on CNC Lathe using APT
8. Programming on CNC Milling Machine using G and M Codes
9. Programming on CNC Milling Machine using APT
10. Programming on CNC machine Simulator and to observe virtual machining
11. Robot Programming
12. Experiments on AJM/ USM/ WEDM/ EDM/ ECM/ LBM
13. Design and manufacture of products using Additive Manufacturing

Learning Resources:

1. M.P. Groover, Principles of Modern Manufacturing, 5th edition, Wiley, 2014.
2. E.P. DeGarmo, J.T. Black and R.A. Kohser, DeGarmo's Materials and Processes inManufacturing, 11th Edition, John Wiley & Sons, 2011.
3. S. Kalpakjian and Schmid, Manufacturing processes for engineering materials, 5th edition,Pearson Education, 2010

CO-PO Mapping

Mechanical Engineering Laboratory- III (Manufacturing)

(Course Code – PC ME 791**)**

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

PC ME 781- Project- III

Course Outcome (CO)

Student will be able to:

CO1	To develop the ability to conduct investigations of complex engineering problems using research knowledge, methods and other modern engineering tools.
CO2	To analyze a situation or mechanical system and identify possible ideas for practical implementation.
CO3	To train the students in preparing project reports.
CO4	To train the students to face review and viva voice examination.

Subject Code: PW-ME781	**Category:** Project
Subject Name: Project-III	**Semester**: Seventh
L-T-P: **0-0-6**	**Credit: 3**
Pre-Requisites: All courses	

CO-PO Mapping

Project- III

(Course Code – PW ME 781**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	3	3	-	-	-	2	-	2	2	3	2	2
CO2	2	3	1	1	1	1	-	-	2	-	1	1	2	1	3
CO3	1	-	-	-	-	2	1	2	2	3	2	1	-	-	1
CO4	1	-	-	-	-	-	-	1	-	3	-	1	-	-	1

8th Semester

PE ME 801/802A- Analysis and Performance of Fluid Machines

Course Outcome (CO)

Student will be able to:

CO1	To know about the dimensional analysis for fluid machinery.
CO2	To learn about different heads, losses and efficiencies for pumps, fans and turbines.
CO3	To know about the Interaction of pumps and Turbines and systems.
CO4	To know about the Performance characteristics of pumps and turbines.
CO5	To learn about Cavitation: NPSH, Thoma's cavitation parameter and suction specific speed.
CO6	To know about the Analysis of flow through propellers and windmills and jet propulsion.

Subject Code : A	**Category:** Professional Elective Courses
Subject Name : Analysis and Performance of Fluid Machines	**Semester**: Eighth
L-T-P : 3-0-0	**Credit:** 3
Pre-Requisites: Fluid Mechanics and Fluid Machinery	

Module No.	Description of Topic	Contact Hrs.
1	Dimensional analysis for fluid machinery: Dimensionless quantities and their use in design, selection and testing.	3
2	Different heads, losses and efficiencies for pumps, fans and turbines.	3
3	Interaction of pumps and Turbines and systems: Series and Paralleloperation of Pumps, Performance and selection of Pumps for different systems characteristics, Surging in Pipelines.	12

4	Performance characteristics: Pumps and Fans-Radial, Mixed flow andAxial flow. Turbines-Francis, Kaplan and Pelton wheel-operating characteristics and Muschel curves, Governing of Turbines.	8
5	Cavitation: NPSH, Thoma's cavitation parameter and suction specific speed.	4
6	Special Devices: Analysis of flow through propellers and windmills, Slipstream and actuator disc theory; Jet propulsion devices.	6

Learning Resources:

1. R.I. Lewis, Turbomachinery Performance Analysis, Arnold Butterworth-Heinemann, 1996.

J. Lal, Hydraulic Machines Including Fluidics, Metropolitan Book Co., 1994

CO-PO Mapping

Analysis and Performance of Fluid Machines

(Course Code - PE-ME801/802A**)**

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

PE ME 801/802B-Power Plant Engineering

Course Outcome (CO)

Student will be able to:

CO1	Understand functions of the various components of power plant.
CO2	Illustrate the working of nuclear, thermal and gas based power plants.
CO3	Evaluate the design layout and working of hydroelectric power plants.
CO4	Estimate the feasibility and its implications on power generating units

Subject Code: B	**Category:** Professional Elective Courses
Subject Name: Power Plant Engineering	**Semester**: Eighth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Thermodynamics, Heat Transfer	

Module No.	Description of Topic	Contact Hrs.
1	**Analysis of Steam Cycles:** Introduction to the course, Power plant layout and essential feature of Rankine cycle, Reheating and regeneration, Problems on Rankine Cycle, Combined cycle power generation, Binary vapour cycles.	3
2	**Boilers:** Definition, classification, fire tube and water tube boilers, mountings and accessories. Draft in boilers, performance of boiler - boilers efficiency, equivalent evaporation, Losses in boilers. Coal and combustion: Properties of coal, ultimate analysis and proximate analysis, combination calculation. Super heater, economizer and air- pre heater. Handling of coal and ash.	8
3	Fuel bed firing, PF firing and Fluidized bed boilers. Introduction toboiling and circulation in boilers. Power station boilers - Benson, Lamont. Supercritical boiler.	4
4	**Steam turbine:** i) parts and classification, ii) nozzles types, flow through nozzles and nozzle efficiency. Impulse turbine - velocity diagram, work done	6

	andblade efficiency.	
5	**Turbines:** Pressure compounding and velocity compounding of steam turbine. Impulse reaction turbine - Velocity diagram, degree of reaction and Parsons turbine. Governing in Steam turbine.	6
6	**Condensers:** Direct Contact Condenser Surface Condensers, Effect of various parameters on condenser performance, Design of condensers, cooling towers and cooling ponds.	6
7	**Power plant economics and other issues:**	3
	Load duration curves, Power plant economics, estimation of tariff. Diesel and gas plants, Pollution and control, Greenhouse effect and control, Peak load plants.	

Learning Resources:

1. P.K. Nag, Power Plant Engineering, McGraw Hill, 2017.
2. Domkundwar, Arora and Domkundwar, Power Plant Engineering, Dhanpat Rai & Sons,New Delhi, 2016.
3. M.M. Ei-Wakil, Power Plant Technology, McGraw Hill Com., 1985.
4. P.C. Sharma, Power Plant Engineering, S.K. Kataria & Sons, New Delhi, 2010.

CO-PO Mapping

Power Plant Engineering

(Course Code - PE-ME801802B**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	-	2	-	1	-	-	2	2	3	3	1	-
CO2	3	3	-	2	-	1	1	-	1	2	1	2	3	3	-
CO3	1	3	3	3	2	2	2	1	3	1	3	2	1	3	3
CO4	2	2	-	2	-	1	1	-	-	1	1	2	2	2	-

PE ME 801/802C-Cryogenics

Course Outcome (CO)

Student will be able to:

CO1	Understand principles of cryogenic systems.
CO2	Understand air and helium liquefaction processes.
CO3	Be able to classify cascade refrigeration systems.
CO4	Understand principles of ultra-low temperature systems and their applications.

Subject Code: C	**Category:** Professional Elective Courses
Subject Name: Cryogenics	**Semester**: Eighth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Thermodynamics, Heat Transfer	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Definition and engineering applications of cryogenics, Properties of solids for cryogenic systems.	5
2	**Low Temperature Properties:** Properties of engineering materials (Mechanical properties, Thermal properties, Electric and Magnetic properties), Properties of Cryogenicfluids.	3
3	**Refrigeration and Liquefaction:** Simple Linde cycle, Pre-cooled Joule-Thomson cycle, dual-pressure cycle, Simon helium liquefier, classical cascade cycle, mixed-refrigerant cascade cycle.	6
4	**Ultra-low-temperature refrigerators:** Definition and fundamentals regarding ultra-low temperature refrigerators, Equipment associated with low-temperature systems, Various advantages and disadvantages.	7
5	**Storage and Handling of Cryogenic Refrigerants:** Storage and transfer systems, Insulation, Various types of insulation typically employed, Poly Urethane Foams (PUFs) and Polystyrene Foams (PSFs), Vacuum Insulation, and so on.	7

6	**Cryogenic Instrumentation:** Pressure, flow-rate, liquid-level and temperature measurements. Types of heat exchangers used in cryogenic systems (only descriptionwith figure). Cryo pumping applications.	6
7	**Applications:** Broad applications of cryogenic refrigerants in various engineering systems.	2

Learning Resources:

1. M. Mukhopadhyay, Fundamentals of Cryogenic Engineering, Prentice Hall of India, 2010.
2. T. Flynn, Cryogenic Engineering, Revised and Expanded, CRC, 2004.
3. Arora and Domukundwar, Refrigeration and Air-conditioning, Dhanpat Rai & Co., 2018.
4. A.R. Jha, Cryogenic Technology and Applications, Butterworth-Heinemann, 2005.
5. K.D. Timmerhaus and R. Reed, Cryogenic Engineering, Fifty Years of Progress, Springer,2007.
6. R.F. Barron, Cryogenic Systems, McGraw Hill, 1986.
7. R.B. Scott, Cryogenic Engineering, Van Nostrand Co., 1959.

CO-PO Mapping

Cryogenics

(Course Code - PE-ME801/802C**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	2	2	-	1	3	3	3	1	-
CO2	2	3	3	3	-	1	2	3	2	1	3	2	3	-	1
CO3	3	-	2	3	3	-	1	-	2	-	-	-	1	1	3
CO4	3	3	-	-	-	-	2	3	-	3	2	2	2	3	-

PE ME 801/802D- Introduction to Wind Engineering

Course Outcome (CO)

Student will be able to:

CO1	know about the basic concepts of wind engineering.
CO2	learn about bluff body aerodynamics as applied to wind engineering.
CO3	know about the structural dynamics related to wind engineering.
CO4	know about the aero-elastic phenomena caused due to wind flows.
CO5	learn about wind tunnel simulation of aerodynamic and aero–elastic behaviour of bluff bodies

Subject Code : D	**Category:** Professional Elective Courses
Subject Name : Introduction to Wind Engineering	**Semester**: Eighth
L-T-P : 3-0-0	**Credit:**3
Pre-Requisites: Fluid Mechanics	

Module No.	Description of Topic	Contact Hrs.
1	Introduction; state of the art in wind engineering.	4
2	Bluff body aerodynamics: boundary layer separation; wake and vortex formations; pressure, lift, drag and moment effect.	7
3	Structural dynamics: single degree of freedom linear system; multi–degree of freedom linear system; example of along–windresponse.	7
4	Aero-elastic phenomena; vortex shedding and lock–inphenomena; models of vortex–induced response; across wind galloping; wake galloping; flutter; torsional divergence.	6
5	Wind tunnel simulation of aerodynamic and aero–elastic behaviour of bluff bodies.	6
6	Application to design of tall buildings, slender towers and stacks.	6

Learning Resources:

1. E. Simiu and R.H. Scanlan, Wind Effects on Structures– Fundamentals and Applications toDesign, John Wiley & Son, New York, 1996.
2. J.D. Holmes, Wind Loading of Structures, CRC Press, 2015. .
3. J.B. Barlow, W.H. Rae and A. Pope, Low Speed Wind Tunnel Testing, Wiley International,New York, 1999.

CO-PO Mapping

Introduction to Wind Engineering

(Course Code - PE-ME801/802D**)**

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

PE ME 801/802E- Tribology

Course Outcome (CO)

Student will be able to:

CO1	Be able to know the field of tribology.
CO2	Be able to know the surface, properties of surface and related instruments
CO3	Be able to understand the friction, friction theory and behavior of metals and non-metals
CO4	Be able to understand wear processes, wear theory, behavior of metals and non-metals and different instruments
CO5	Be able to understand the lubricants, lubrication and instruments for measuring lubricant's properties.

Subject Code: E	**Category:** Professional Elective Courses
Subject Name: Tribology	**Semester**: Eighth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Fluid Mechanics, Design of Machine Elements	

Module No.	Description of Topic	Contact Hrs.
1	Introduction to Tribology: Introduction to Tribology, Tribology in design, Tribology in industry, economic aspects of Tribology, lubrication, 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. Types of sliding contact bearings, comparison of sliding and rolling contact bearings.	6
2	Friction and Wear: Friction: Introduction, laws of friction, kinds of friction, causes of friction, friction measurement, theories of friction, effect of surface preparation. Wear: Types of wear, various factors affecting wear, measurement of wear, wear between solids and liquids, theories of wear.	6

3	Hydrodynamic lubrication: Theory of hydrodynamic lubrication, mechanism of pressure development in oil film, two-dimensional Reynold's equation, infinitely long journal bearing, infinitely short journal bearing, finite bearing. Hydrodynamic thrust bearing: Introduction, flat plate thrust bearing, pressure equation, load, centre of pressure, friction in tilting pad thrust bearing.	6
4	Hydrostatic Lubrication: Hydrostatic lubrication: Basic concept, advantages and limitations, viscous flow through rectangular slot, load carrying capacity and flow requirement of hydrostatic step bearing, energy losses, optimum design of step bearing. Compensators and their actions. Squeeze film lubrication: Introduction, circular and rectangular plates approaching a plane.	6
5	Elastohydrodynamic Lubrication and Gas Lubrication:	6
	Elastohydrodynamic Lubrication: Principle and application, pressure-viscosity term in Reynolds equation, Hertz theory. Ertel- Grubin Equation. Gas lubrication: Introduction, merits and demerits, applications. Lubrication in metal working: Rolling, forging, drawing and extrusion. Bearing materials, bearing constructions, oil seals, shields and gaskets.	
6	Surface Engineering: Introduction to surface engineering, concept and scope of surface engineering, manufacturing of surface layers, solid surface geometrical, mechanical and physic chemical concepts, superficial -layer, development of concept, structure of superficial layer, general characteristics of superficial layer, obtained by machining, strengthening and weakening of superficial layer.	6

Text Books:

1. A. Cameron, Basic Lubrication Theory, Wiley Eastern Ltd., 1976.
2. S. Wen and P. Huang, Principles of Tribology, 2nd Edition, Wiley, 2012.
3. B.C. Majumdar, Introduction to Tribology and Bearings, S. Chand and Company Ltd., NewDelhi, 2008.
4. D.D. Fuller, Theory and Practice of Lubrication for Engineers, John Wiley and Sons, 1984.
5. J. Halling, Principles of Tribology, McMillan Press Ltd., 1978.
6. B. Bhushan and B.K. Gupta, Handbook of Tribology: Materials, Coatings and SurfaceTreatments, McGraw-Hill, 1991.
7. J. Davis, Surface Engineering for Corrosion and Wear Resistance, Woodhead Publishing,2001.
8. T. Burakowski and T. Wierzchon, Surface Engineering of Metals: Principles, Equipment,Technologies, Taylor and Francis, 1999.

CO-PO Mapping Tribology (Course Code - PE-ME801/802E)															
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	2	3	1	1	-	1	1	2	3	2	1	2
CO2	2	3	1	1	2	2	1	1	1	-	1	3	3	3	3
CO3	1	1	-	-	2	-	-	-	-	-	-	1	2	2	1
CO4	3	3	-	-	-	-	2	3	-	3	2	2	2	3	-
CO5	3	3	-	-	-	-	2	3	-	3	2	2	2	3	-

Course Outcome (CO)

Student will be able to:

CO1	Develop CAD models for 3D printing, import and export CAD data to generate .stl file.
CO2	Select a specific material for the given application.
CO3	Select a 3D printing process for an application.
CO4	Produce a product using 3D Printing or Additive Manufacturing

PE ME 801/802F-3D Printing and Design

Course Outcome (CO)

Student will be able to:

CO1	Develop CAD models for 3D printing, import and export CAD data to generate .stl file.
CO2	Select a specific material for the given application.
CO3	Select a 3D printing process for an application.
CO4	Produce a product using 3D Printing or Additive Manufacturing

Subject Code: F	**Category:** Professional Elective Courses
Subject Name: 3D Printing and Design	**Semester:** Eighth
L-T-P: 3-0-0	**Credit:**3
Pre-Requisites: Computer Aided Design, Engineering Materials	

Module No.	Description of Topic	Contact Hrs.
1	**3D Printing (Additive Manufacturing):** Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications.	2
2	**CAD for Additive Manufacturing**: CAD Data formats, Data translation, Data loss, STL format.	3
3	**Additive Manufacturing Techniques:** 3.1 Stereo-Lithography, LOM, FDM, SLS, SLM, Binder Jet technology. 3.2 Process, Process parameter, Process Selection for various applications. 3.3 Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools	10
4	**Materials:** 4.1 Polymers, Metals, Non-Metals, Ceramics 4.2 Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties.	7

	4.3 Support Materials	
5	**Additive Manufacturing Equipment:** 5.1 Process Equipment- Design and process parameters 5.2 Governing Bonding Mechanism 5.3 Common faults and troubleshooting 5.4 Process Design	8
6	**Post Processing:** Requirement and Techniques	3
7	**Product Quality:** 7.1 Inspection and testing 7.2 Defects and their causes	3

Learning Resources:

1. L. Gibson, D.W. Rosen and B. Stucker, Additive Manufacturing Technologies: RapidPrototyping to Direct Digital Manufacturing, Springer, 2010.
2. A. Gebhardt, Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling,Rapid Manufacturing, Hanser Publisher, 2011.
3. C.K. Chua and K.F. Leong, 3D Printing and Rapid Prototyping- Principles and Applications,World Scientific, 2017.
4. J.D. Majumdar and I. Manna, Laser-Assisted Fabrication of Materials, Springer Series inMaterial Science, 2013.
5. L. Lu, J. Fuh and Y.S. Wong, Laser-Induced Materials and Processes for Rapid Prototyping,Kulwer Academic Press, 2001.
6. Z. Fan and F. Liou, Numerical Modelling of the Additive Manufacturing (AM)Processes ofTitanium Alloy, InTech, 2012.

CO-PO Mapping

3D Printing and Design

(Course Code - PE-ME802/801F**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	1	2	2	2	2	2	3	3	-
CO2	1	2	2	1	-	-	-	-	-	1	1	1	1	2	2
CO3	1	3	-	-	-	-	-	-	-	-	2	3	1	3	-
CO4	2	2	3	-	-	-	-	-	-	-	3	3	2	2	3

PE ME 801/802G- Micro and Nano Manufacturing

Course Outcome (CO)

Student will be able to:

CO1	Know different micro machining and micro-manufacturing technologies and their applications.
CO2	Gain some knowledge about nanotechnology by molecular or atomic manipulation and to make nano-features.
CO3	Get an idea about various application areas of some nano materials.

Subject Code: G	**Category:** Professional Elective Courses
Subject Name: Micro and Nano Manufacturing	**Semester:** Eighth
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Manufacturing Technology	

Module No.	Description of Topic	Contact Hrs.
1	Introduction to micromachining, milimachining and nanotechnology, their differences, history of their development, application of miniaturized components in electronics, mechanical, MEMS, medical applications such as laparoscopic surgery, laser angioplasty, etc.	3
2	Different fabrication processes: Silicon process, LIGA process, Precision Machining Processes- Laser-Assisted Etching, Photoforming, Stereolithography, Electrochemical Micromachining, etc.	6
3	Components of Micromachines: Microsensors, Microfittings, Microactuators- electromagnetic, electrostatic, piezoelectric, and thermally and photothermally actuated micromechanisms, Microfluidic devices.	4
4	Microdrip fabrication, Micromanufacturing using electron microscopes, Handling of micro components with laser tweezers, etc., Microfinishing Processes like honing, lapping, superfinishing, burnishing.	3

5	Mesoscopic domain of micromachines- Introduction, biological systems, cells as machines, role of proteins, physics of micromechanism, future prospects.	3
6	Fabrication of devices with high-precision nano-features on metals and semiconductors utilizing Electrochemical Microsystem Technology (EMST) and Electrochemical Nanotechnology (ENT), Self-Assembled Monolayers by molecular self-assembly, Manipulation with DNA in biological system based nanofabrication.	6
7	Nanomaterials, such as carbon nanotube (CNT) or graphene, etc. - Their uses in various manufacturing applications.	6

Learning Resources:

1. I. Fujimasa, Micromachines: A New Era in Mechanical Engineering, Oxford SciencePublications, 1996.
2. V.K. Jain, Introduction to Micromachining, Alpha Science International Ltd., 2014.
3. J.P. Davim and M.J. Jackson, Nano and Micromachining, Wiley, 2010.
4. J.A. McGeough, Micromachining of Engineering Materials, Taylor & Francis Inc, 2001.
5. B. Bhattacharyya, Electrochemical Micromachining for Nanofabrication, MEMS and Nanotechnology, Elsevier Publication, 2015.
6. S. Kalpakjian, Manufacturing Engineering and Technology, Pearson, 2002.
7. P.C. Pandey and H.S. Shan, Modern Machining Processes, Tata-McGraw Hill Publication,1980.
8. H.E. Hofy, Advanced Machining Processes- Nontraditional and Hybrid Machining Processes, McGraw Hill Publication, New York, 2005.
9. R.L. Murty, Precision Engineering in Manufacturing, New Age International Publishers,1996.
10. M. Ratner and D. Ratner, Nanotechnology, Prentice Hall/ Pearson Education, USA, 2003.

CO-PO Mapping

Micro and Nano Manufacturing

(Course Code - PE-ME802/801G**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	1	2	-	1	2	2	1	2	2	3	3	-
CO2	3	3	-	3	3	-	1	2	2	1	2	2	3	3	-
CO3	1	2	2	1	2	-	-	-	-	-	1	1	1	2	2

PE ME 801/802H-Process Planning and Cost Estimation

Course Outcome (CO)

Student will be able to:

CO1	Select the process, equipment and tools for various industrial products.
CO2	Prepare process planning activity chart.
CO3	Explain the concept of cost estimation.
CO4	Compute the job order cost for different type of shop floor.
CO5	Calculate the machining time for various machining operations.

Subject Code: H	**Category:** Professional Elective Courses
Subject Name: Process Planning and Cost Estimation	**Semester:** Eighth
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Manufacturing Processes	

Module No.	Description of Topic	Contact Hrs.
1	Introduction of Process Planning- methods of process planning, drawing interpretation, material evaluation, steps in process selection, production equipment and tooling selection.	6
2	Process planning activities- process parameter calculation for various production processes, selection of jigs and fixtures, selection of quality assurance methods, documents for process planning, economics of process planning, case studies.	8
3	Introduction to cost estimation- importance of costing and estimation, methods of costing, elements of cost estimation, types of estimates, estimating procedure, estimation of labour cost, material cost, allocation of overhead charges, calculation of depreciation cost.	7
4	Machining time estimation- importance of machine time calculation, machining time for different lathe operations, drilling and boring time calculations, Machining time calculation for Milling, Shaping, Planing and Grinding.	7
5	Production costs- different production processes for different jobs, estimation of forging cost, estimation of welding cost,	8

	estimationof foundry cost, estimation of machining cost.	

CO-PO Mapping

Process Planning and Cost Estimation

(Course Code - PE-ME802/801H**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO1 2	PSO1	PSO2	PSO3
CO1	1	-	-	-	1	3	2	3	1	1	3	2	3	2	2
CO2	1	1	-	1	-	2	2	1	-	3	3	3	1	1	1
CO3	1	-	2	1	2	1	3	2	2	-	3	2	2	-	1
CO4	1	1	1	-	-	2	2	1	1	2	3	1	1	1	3
CO5	1	-	1	2	-	1	2	1	1	2	3	1	3	3	3

PE ME 801/802I – Maintenance Engineering

Course Outcome (CO)

Student will be able to:

CO1	Know different types of repair and maintenance procedures practised in industry.
CO2	Understand different repair and maintenance strategies used in industry.
CO3	Understand the organizational structure of an industry for maintenance management and the economy involved in this.

Subject Code: I	**Category:** Professional Elective Courses
Subject Name: Maintenance Engineering	**Semester:** Eighth
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Manufacturing Processes	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Definitions of repair and maintenance; Importance of maintenance; Different maintenance systems- breakdown, preventive, planned; predictive maintenance through condition monitoring; Maintainability, failure pattern, availability of equipment/ systems, design for maintainability.	5
2	**Total Productive Maintenance (TPM):** definition, objective & methodology; Implementation of TPM; Lean maintenance; Overallequipment effectiveness (OEE).	3
3	**Organizational structures for maintenance:** Objective; Maintenance functions and activities; Organizational requirements; Types of maintenance organizations, Manpower planning; Engineering stores & inventory management.	4
4	**Economic Aspect of Maintenance:** Life cycle costing; Maintenance cost & its impact; Maintenance budget; Cost control;Maintenance audit- Procedure, tools, planning, reports.	4

5	**Function and use of Maintenance Equipment, Instruments & Tools:** Facilities like NDT, painting, coating and cladding, Gas cutting and welding, crack detection, vibration monitor, balancing equipment, compressor, basic machine tools, lubricators and lubricants, chain pulley block, Tools like different types of wrenches, torque wrench, pipe wrench, plier, screw driver, dimension measuring instruments, feeler gauge, scraper, fitting shop tools, spirit level, hand grinder & drill, screw jack, etc.	6
6	**Lubrication:** Purpose & importance; Type of lubricants, Properties of lubricants; Types of lubrication and their typical applications, lubrication devices, centralized lubrication system; Gasket, packing and seals.	4
7	**Repair & Maintenance Procedures:** Repair of cracks, threads,	10

Learning Resources:

1. R.C. Mishra and K. Pathak, Maintenance Engineering and Management, PHI, 2012.
2. S.K. Srivastava, Maintenance Engineering and Management, S. Chand & Company Ltd.,New Delhi, 1998.
3. K. Venkataraman, Maintenance Engineering and Management, PHI, 2007.
4. K. Mobley, Maintenance Engineering Handbook, McGraw Hill, Eighth Edition, 2014.

CO-PO Mapping

Process Planning and Cost Estimation

(Course Code - PE-ME802/801H**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO1 2	PSO1	PSO2	PSO3
CO1	1	-	-	-	1	3	2	3	1	1	3	2	3	2	2
CO2	1	1	-	1	-	2	2	1	-	3	3	3	1	1	1
CO3	1	-	2	1	2	1	3	2	2	-	3	2	2	-	1
CO4	1	1	1	-	-	2	2	1	1	2	3	1	1	1	3
CO5	1	-	1	2	-	1	2	1	1	2	3	1	3	3	3

OE ME 801/802A- Total Quality Management

Course Outcome (CO)

Student will be able to:

CO1	Understand the fundamental principles of Total Quality Management;
CO2	Choose appropriate statistical techniques for improving processes;
CO3	Develop research skills that will allow them to keep abreast of changes in the field of Total Quality Management

Subject Code: A	**Category:** Open Elective Courses
Subject Name: Total Quality Management	**Semester:** Eighth
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Basic Engineering Knowledge	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Need for quality, Definition of Quality, Evolution of quality, Product quality and Service quality, Dimensions of Quality, Definition of Total quality management, Quality Planning, Quality costs - Analysis, Techniques for Quality Costs, and Basic concepts of Total Quality Management. Quality Council, Quality Statements, Strategic quality planning, Barriers to TQM Implementation, Benefits of TQM, Contributions of Deming, Juran and Crosby.	6
2	**TQM Principles:** Customer satisfaction- Customer Perception of Quality, Customer Complaints, Service Quality. Customer Retention; 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 rating & selection.	6
3	**TQM Tools and Techniques:** Benchmarking- Reasons to Benchmark, Benchmarking Process; Quality Function Deployment (QFD); Taguchi Quality Loss Function; Seven traditional tools of quality; New management tools; Process capability; Six sigma-concepts, methodology; TPM- concepts, improvement needs, performance measures; FMEA- Stages of FMEA.	18

4	**Quality Systems:** Need for ISO 9000 and Other Quality Systems, ISO 9001:2015 Quality System- Elements, Documentation; Quality Auditing, QS 9000, ISO 14000- Concept, Requirements and Benefits; TQM implementation in manufacturing and service sectors	6

Learning Resources:

7. D.H. Besterfield, C. Besterfield, G.H. Besterfield, M. Besterfield, H. Urdhwareshe and R.Urdhwareshe, Total Quality Management, Pearson Education, 2018.
8. A. Mitra, Fundamentals of Quality Control and Improvement, Wiley Student Edition, 2008.
9. S. Ramasamy, Total Quality Management, McGraw Hill Publishing Co., New Delhi, 2011.
10. J.R. Evans and W.M. Lindsay, The Management and Control of Quality, Cengage Learning,1999.
11. D.C. Montgomery, Introduction to Statistical Quality Control, John Wiley, 2019.

CO-PO Mapping

Total Quality Management

(Course Code – OE ME 801/802A**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	2	2	-	1	3	3	3	1	-
CO2	2	3	3	3	-	-	2	3	2	1	3	2	3	-	1
CO3	3	2	2	3	3	-	1	-	2	-	-	-	1	2	3

OE ME 801/802B- Entrepreneurship Development

Course Outcome (CO)

Student will be able to:

CO1	Gain knowledge and skills needed to run a business successfully.
CO2	Interpret key regulations and legal aspects of entrepreneurship in India.
CO3	Understand the concept of business plan and ownerships.

Subject Code : B	**Category:** Open Elective Courses
Subject Name : Entrepreneurship Development	**Semester** : Eighth
L-T-P : **3-0-0**	**Credit: 3**
Pre-Requisites: Basic Engineering Knowledge	

Module No.	Description of Topic	Contact Hrs.
1	Entrepreneurship: Types of Entrepreneurs– Difference betweenEntrepreneur and Intrapreneur, Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.	7
2	Motivation: Major Motives Influencing an Entrepreneur– Achievement Motivation Training, Self Rating, Business Games, Thematic Apperception Test– Stress Management, Entrepreneurship Development Programs– Need, Objectives.	7
3	Business: Small Enterprises– Definition, Classification– Characteristics, Ownership Structures– Project Formulation– Steps involved in setting up a Business– identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment– Preparation of Preliminary Project Reports– Project Appraisal– Sources of Information– Classification of Needsand Agencies.	8
4	Financing And Accounting: Need– Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Taxation– Income Tax, Excise Duty– Sales Tax.	7

5	Support to Entrepreneurs: Sickness in small Business– Concept, Magnitude, Causes and Consequences, Corrective Measures– Business Incubators– Government Policy for Small Scale Enterprises– Growth Strategies in small industry– Expansion, Diversification, Joint Venture, Merger and Sub Contracting.	7

Learning Resources:

1. S.S. Khanka, Entrepreneurial Development, S. Chand & Co. Ltd., New Delhi, 2013.
2. D.F. Kuratko, Entrepreneurship– Theory, Process and Practice, 9th Edition, CengageLearning, 2014.
3. R.D. Hisrich and M.P. Peters, Entrepreneurship, 8th Edition, McGraw Hill, 2013.
4. M.J. Manimala, Enterprenuership Theory at Cross Roads: Paradigms and Praxis, 2nd Edition,Dream Tech, 2005.
5. R. Roy, Entrepreneurship, 2nd Edition, Oxford University Press, 2011.

CO-PO Mapping

Entrepreneurship Development

(Course Code – OE ME 801/802B**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	3	2	2	-	1	3	1	3	2	-
CO2	1	3	3	2	-	-	2	3	2	1	3	1	3	-	1
CO3	1	2	2	3	3	2	1	1	2	1	1	1	1	2	-

OE ME 801/802C- Safety and Occupational Health

Course Outcome (CO)

Student will be able to:

CO1	Primary knowledge of industrial and occupational safety and accident prevention
CO2	Understand occupational health and safety rules and regulations
CO3	Analyze the safety management issues along with accident compensation acts
CO4	Manage real life problems in the industries related to accident prevention and safety

Module No.	Description of Topic	Contact Hrs.
1	Development of industrial safety. Developments in Occupational Health, Occupational Safety and Health in India.	2
2	Accidents and their prevention, Theory of accident, Anatomy of an accident, Causalities of an accidents. Cost of accidents, Principles of accident prevention, Techniques of accident prevention, Safe work environment, Housekeeping, Job safety analysis, Investigation of accidents, Ergonomics, Personal protective equipment, Promotion of health and safety, Basic safety programming.	6
3	Fire hazard- Types of fire, Fire hazards, Fire explosion, fire prevention, Means of escape in case of fire inspection safety, Supervision safety, Responsibility safety inspection, Fire prevention authorities, Rules safety training safety, Appraisal safety communication, Safety audit.	6
4	Occupational health and safety- Occupational Health, Occupational health services in places of employment, Occupational physician, Occupational health in developing countries, Occupational safety, Occupational safety in developing countries, Promoting occupationalhealth and safety, Work related diseases, Occupational health hazards,Recognition of hazards, Industrial hygiene, Occupational diseases, Basics of OHSAS 18001.	6

5	Health and safety at workplaces- Health and Safety hazards, Occupational health requirements, Occupational safety requirements, Occupational welfare requirements, Abstracts and Notices, Obligations of a worker, Obligations of occupier, Personal protective equipment, Causes of accidents, Prevention of accidents, Safety Legislation, Safety Guidelines, emergency actions, related acts (related to chemical processes, mines, workshop practices, construction work, electrical installations).	6
6	Health and safety management- Basics of Safety management, Role of safety supervisor, Planning for safety, Safety Policies, Safety Promotion, Safety Committee, Safety education & training, Health and Safety Process, Measuring Safety, Risk Management, Loss Control.	4
7	Accident Compensation- Brief introduction to different acts- The Dangerous Machines (Regulations) Act, 1983, The Employers' Liability Act, 1938 The (Indian), Fatal Accidents Act, 1855, The Public Liability Insurance Act, 1991, The Workmen's Compensation Act, 1923, The Employees' State Insurance Act, 1948, Role of National Safety Council, International labour office.	6

Learning Resources:

1. A. Waring, Safety management Systems, Chapman & Hall, 1996.
2. N.P. Cheremisinoff and M.L. Graffia, Environmental Health & Safety Management– AGuide to Compliance, Noyes Publication, 2003.
3. J. Ridley and J. Channing, Safety at Work, 5th Edition, Butterworth & Heinemann, 2001.
4. J. Stranks, Occupational Health & Hygiene, Pitman Publication, 1995.
5. R. Pybuss, Safety Management: Strategy & Practice, Butterworth & Heinemann, 1997.
6. H.L. Kalia, A. Singh, S. Ravishankar & S.V. Kamat, Essentials of Safety Management,Himalaya Publishing House, 2002.
7. A.M. Sarma, Industrial Health & Safety Management, Himalaya Publishing House, 2002.
8. J.M. Stellman (Ed.), Encyclopaedia of Occupational Health & Safety (4th Ed.), Vol. I-IV,International Labour Office, Geneva, 2012.
9. A. Waring, Safety Management System, Chapman & Hill, London, 1996.
10. J. Jaynes, Practical Health & Safety Management for Small Business- 2000, ButterworthHeinemann, 2000.
11. H.L. Kalia, Industrial Safety and Human Behaviour, AITBS Publishes, India, 2019.

CO-PO Mapping Safety and Occupational Health **(Course Code –** OE ME 801/802C**)**															
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1	-	1	-	-	3	1	-	-	-	1	1	3	1	-
CO2	2	-	-	-	-	3	1	-	-	-	2	2	1	2	3
CO3	2	-	-	-	-	3	-	-	-	2	-	2	3	-	1
CO4	1	-	1	-	-	3	-	-	-	-	1	2	-	-	1

OE ME 801/802D- Industrial Pollution and Control

Course Outcome (CO)

Student will be able to:

CO1	Quantify and analyze the pollution load.
CO2	Analyze/design of suitable treatment for wastewater.
CO3	Model the atmospheric dispersion of air pollutants.
CO4	Selection and design of air pollution control devices.

Subject Code : D	**Category:** Open Elective Courses
Subject Name : Industrial Pollution and Control	**Semester :** Eighth
L-T-P : 3-0-0	**Credit:** 3
Pre-Requisites: Basic Chemistry, Thermodynamics, Fluid Mechanics	

Module No.	Description of Topic	Contact Hrs.
1	Introduction; classification of pollution; effects of pollution on human beings, plants and animals.	8
2	Air pollution: physical effects; atmospheric dispersion and diffusion; method of sampling and analysis; modeling technique; practical control of air pollution and abatement.	10
3	Water pollution: water quality parameters; dispersion and diffusion of pollutants in water; control and abatement of water pollution.	9
4	Noise pollution: physics of sound generation and transmission; physical characters of noise; physiological effects of noise; measuring instruments and technique; assessment of noise; noise control principle, practice and laws.	9

Learning Resources:

1. P.N. Chermisinoff, Air Pollution Control and Design for Industry, Taylor & Francis,1993.
2. N.J. Sell, Industrial Pollution Control: Issues and Techniques, Wiley–Blackwell, 1992.

CO-PO Mapping Industrial Pollution and Control **(Course Code –** OE ME 801/802D**)**															
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	2	-	2	-	3	2	-	1	1	3	3	1	-
CO2	2	3	-	-	-	-	3	3	2	1	3	-	3	2	1
CO3	2	2	2	3	3	-	1	1	2	-	-	-	1	2	3
CO4	1	-	-	-	2	-	2	3	-	3	1	2	3	-	-
CO5	2	3	-	2	-	2	2	1	2	1	-	3	3	-	1

OE ME 801/802E- Energy Conservation and Management

Course Outcome (CO)

Student will be able to:

CO1	Obtain knowledge about energy conservation policy, regulations and business practices
CO2	Design to improve the thermal efficiency by designing suitable systems for heat recovery and cogeneration
CO3	Analyze the energy audit methods learnt to identify the areas deserving tighter control to save energy expenditure
CO4	Evaluate the cost

Subject Code : E	**Category:** Open Elective Courses
Subject Name : Energy Conservation and Management	**Semester**: Eighth
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Thermodynamics, Basic Electrical Engineering	

Module No.	Description of Topic	Contact Hrs.
1	Introduction to energy & power scenario of world, National Energy consumption data, environmental aspects associated with energy utilization; Energy Auditing- need, types, methodology and barriers, role of energy managers, instruments of energy auditing.	9
2	Components of EB billing, HT and LT supply, transformers, cable sizing; Concept of capacitors, power factor improvement, harmonics; Electric motors- motor efficiency computation, energy efficient motors; Illumination- Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting.	9
3	Thermal systems, Boilers, Furnaces and Thermic Fluid heaters- efficiency computation and energy conservation measures; Steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories.	9
4	Energy conservation in major utilities; pumps, fans, blowers, compressed air systems, Refrigeration& Air Conditioning systems, Cooling Towers, DG sets. Energy Economics- discount period, payback period, internal rate of	9

	return, net present value; Life Cycle costing- ESCO concept.	

Learning Resources:

1. L.C. Witte, P.S. Schmidt and D.R. Brown, Industrial Energy Management and Utilization,Hemisphere Publication, Washington, 1988.
2. P.W. Callaghn, Design and Management for Energy Conservation, Pergamon Press, Oxford,1981.
3. B.K. De, Energy Management Audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
4. W.R. Murphy and G. McKay, Energy Management, Butterworths Publication, London,1987.
5. Energy Manager Training Manual, Bureau of Energy Efficiency (BEE) under Ministry ofPower, GOI, 2004 (available at www.energymanagertraining.com).

CO-PO Mapping

Energy Conservation and Management

(Course Code – OE ME 801/802E**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	2	1	-	2	3	-	2	-	-	3	1	1
CO2	3	1	2	-	-	1	2	1	1	1	-	-	3	2	-
CO3	2	2	-	2	1	-	2	2	-	1	-	-	1	2	3
CO4	3	-	2	-	-	2	-	3	-	2	-	-	3	2	2

OE ME 801/802F- Waste to Energy – An Overview

Course Outcome (CO)

Student will be able to:

CO1	Know about the various types of bio-wastes.
CO2	Learn about biomass pyrolysis, gasification and gasifiers.
CO3	Know about biomass combustion and combustors, biogas plants and production

Subject Code : F	**Category:** Open Elective Courses
Subject Name : Waste to Energy- An Overview	**Semester :** Eighth
L-T-P : 3-0-0	**Credit:**3
Pre-Requisites: Basic Chemistry, Thermodynamics, Fluid Mechanics	

Module No.	Description of Topic	Contact Hrs.
1	Introduction to Energy from Waste: Classification of waste as fuel–Agro based, Forest residue, Industrial waste- MSW– conversion devices– Incinerators, gasifiers, digesters	6
2	Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture ofcharcoal – Methods – Yields and application – Manufacture of pyrolytic oils and gases, yields and applications	5
3	Biomass Gasification: Gasifiers– Fixed bed system– Downdraft and updraft gasifiers– Fluidized bed gasifiers– Design, construction andoperation	5
4	Biomass Combustion: Biomass stoves– Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined gratecombustors, Fluidized bed combustors.	4

5	Biogas: Properties of biogas (Calorific value and composition)- Biogas plant technology and status– Bio energy system- Design and constructional features- Biomass resources and their classification– Biomass conversion processes- Thermo chemical conversion- Direct combustion- biomass gasification- pyrolysis and liquefaction- biochemical conversion- anaerobic digestion– Types of biogas Plants.	10

Learning Resources:

1. A.V. Desai, Non Conventional Energy, Wiley Eastern Ltd., 1990.
2. K.C. Khandelwal and S.S. Mahdi, Biogas Technology - A Practical Hand Book, Vol. I & II,McGraw Hill Publishing Co. Ltd., 1983.
3. D.S. Challal, Food, Feed and Fuel from Biomass, IBH Publishing Co. Pvt. Ltd., 1991.

CO-PO Mapping

Waste to Energy-An Overview

(Course Code – OE ME 801/802F**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	1	-	1	3	1	2	3	-	1	1	3	1	-
CO2	2	-	-	-	2	3	1	3	1	-	2	2	1	2	3
CO3	2	-	-	-	-	3	2	1	2	1	-	-	3	-	1

OE ME 801/802G- Automation and Control

Course Outcome (CO)

Student will be able to:

CO1	Describe working of various blocks of basic industrial automation system.
CO2	Connect the peripherals with the PLC.
CO3	Use various PLC functions and develop small PLC programs.
CO4	Summarize Distributed control system and SCADA system.
CO5	Use various industrial motor drives for the Industrial Automation

Subject Code : G	**Category:** Open Elective Courses
Subject Name : Automation and Control	**Semester :** Eighth
L-T-P : 3-0-0	**Credit:** 3
Pre-Requisites: Basic Electronics Engineering, Mathematics	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to control system:** Concept of feedback and Automatic control, Effects of feedback, Objectives of control system, Definition of linear and nonlinear systems, Elementary concepts of sensitivity and robustness. Types of control systems, Servo mechanisms and regulators, examples of feedback control systems. Transfer function concept. Pole and Zeroes of a transfer function. Properties of Transfer function. **Mathematical modeling of dynamic systems:** Translational systems, Rotational systems, Mechanical coupling, Liquid level systems, Electrical analogy of Spring–Mass-Dashpot system. Block diagram representation of control systems. Block diagram algebra. Signal flow graph. Mason's gain formula. **Control system components:** Potentiometer, Synchros, Resolvers, Position encoders.	8

2	**Time domain analysis:** Time domain analysis of a standard second order closed loop system. Concept of undamped natural frequency, damping, overshoot, rise time and settling time. Dependence of time domain performance parameters on natural frequency and damping ratio. Step and Impulse response of first and second order systems. Effects of Pole and Zeros on transient response. Stability by pole location. Routh-Hurwitz criteria and applications. **Error Analysis:** Steady state errors in control systems due to step, ramp and parabolic inputs. Concepts of system types and error constants.	8
3	**State variable Analysis:** State variable model of Linear Time-invariant system, properties of the State transition matrix, State transition equation, Definition of transfer function & Characteristic equation, definition of controllability and observability.	8
4	**Stability Analysis using root locus:** Importance of Root locus	12
	techniques, construction of Root Loci for simple systems. Effects of gain on the movement of Pole and Zeros. **Frequency domain analysis of linear system:** Bode plots, Polar plots, Nichols chart, Concept of resonance frequency of peak magnification. Nyquist criteria, measure of relative stability, phase and gain margin. Determination of margins in Bode plot. Nichols chart. M circle and M-Contours in Nichols chart.	
5	**Control System performance measure:** Improvement of system performance through compensation. Lead, Lag and Lead- lag compensation, PI, PD and PID control.	4

Learning Resources:

1. K. Ogata, Modern Control Engineering, 4th Edition, Pearson Education, 2010.
2. I.J. Nagrath and M. Gopal, Control System Engineering, New Age International, 2009.
3. D. Roy Choudhury, Control System Engineering, PHI, 2005.
4. B.C. Kuo and F. Golnaraghi, Automatic Control Systems, 8th Edition, PHI, 2014.
5. M.N. Bandyopadhyay, Control Engineering Theory & Practice, PHI, 2002.
6. K.R. Varmah, Control Systems, Mc Graw Hill, 2010.
7. Norman Nise, Control System Engineering, 5th Edition, John Wiley & Sons, 2010.
8. R.C. Dorf and R.H. Bishop, Modern Control System, 11th Edition, Pearson Education, 2011.
9. C.G. Graham, F. Graebe, F. Stefan, S.E. Mario, Control System Design, PHI, 2009.
10. N.F. Macia and G.J. Thaler, Modeling & Control of Dynamic System, Thompson, 2004.
11. C.T. Kilian, Modern Control Technology Components & Systems, 3rd Edition, CengageLearning, 2005.
12. Y. Singh and S. Janardhanan, Modern Control Engineering, Cengage Learning, 2010.
13. R. Anandanatarajan and R. Ramesh Babu, Control System Engineering, Scitech, 2015.

14. W.A. Wolovich, Automatic Control system, Oxford University Press, 1995.

CO-PO Mapping

Automation and Control

(Course Code – OE ME 801/802G**)**

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

OE ME 801/802H- Internet of Things

Course Outcome (CO)

Student will be able to:

CO1	Understand internet of Things and its hardware and software components
CO2	Interface I/O devices, sensors & communication modules
CO3	Remotely monitor data and control devices, and develop real life IoT based projects

Subject Code: H	**Category:** Open Elective Courses
Subject Name: Internet of Things	**Semester:** Eighth
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Sensors, System Integration, Cloud and Network Security	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to IoT:** Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics ofNetworking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service (XaaS), Role of Cloud in IoT, Security aspects in IoT.	7
2	**Elements of IoT**: Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API's (using Python/ Node.js/ Arduino) for Communication Protocols- MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.	8
3	**IoT Application Development:** Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.	15
4	**IoT Case Studies:** IoT case study and mini project based on Industrial automation/ Transportation/ Agriculture/ Healthcare/ HomeAutomation	6

Learning Resources:

1. V. Madisetti and A. Bahga, Ïnternet of Things, A Hands on Approach,

University Press,2015.

2. S.R.N. Reddy, R. Thukral and M. Mishra, Introduction to Internet of Things: A PracticalApproach, ETI Labs, 2017.
3. P. Raj and A.C. Raman, The Internet of Things: Enabling Technologies, Platforms and UseCases, CRC Press, 2017.
4. J. Jose, Internet of Things, Khanna Publishing House, New Delhi, 2018.
5. A. McEwen, Designing the Internet of Things, Wiley, 2013.
6. R. Kamal, Internet of Things: Architecture and Design, McGraw Hill, 2017.
7. C. Pfister, Getting Started with the Internet of Things, O Reilly Media, 2011.

CO-PO Mapping

Internet of Things

(Course Code – OE ME 801/802H**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	3	2	1	1	3	1	-	2	3	1	2	3
CO2	2	3	-	2	-	2	2	1	2	1	-	3	3	-	1
CO3	3	2	3	-	1	1	1	2	3	-	1	3	3	1	-

Department of Mechanical Engineering

OE ME 801/802I- Block Chain

Course Outcome (CO)

Student will be able to:

CO1	Understand block chain technology.
CO2	Develop block chain based solutions and writes mart contractusing Hyper ledger Fabric and Ethereum frameworks.
CO3	Build and deploy block chain application for on premise and cloud based architecture.
CO4	Integrate ideas from various domains and implement the musing block chain technology indifferent perspectives.

Subject Code:I	**Category:** Open Elective Courses
Subject Name: Block Chain	**Semester:** Eighth
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Cryptography Techniques, Data Structures and Algorithms, Introduction to Programming	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Introduction: Overview of Block chain, Public Ledgers, Bitcoin, Smart Contracts, Block in a Block chain, Transactions, Distributed Consensus, Public vs Private Block chain, Understanding Crypto currency to Block chain, Permissioned Model of Block chain, Overview of Security aspects of Block chain. Basic Crypto Primitives: Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography, A basic crypto currency.	5
2	**Understanding Block Chain with Crypto Currency**: Bitcoin and Block chain: Creation of coins, Payments and double spending, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay. Working with Consensus in Bitcoin: Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW) – basic introduction, Hashcash PoW, Bitcoin PoW, Attackson PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool.	7

3	**Understanding Block Chain for Enterprises:** Permissioned Block chain: Permissioned model and use cases, Design issues for Permissioned block chains, Execute contracts, State machine replication, Overview of Consensus models for permissioned block chain- Distributed consensus in closed environment, Paxos, RAFT Consensus, Byzantine general problem, Byzantine fault tolerant system, Lamport- Shostak- Pease BFT Algorithm, BFT over Asynchronous systems.	10
	Enterprise application of Block chain: Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Block chain, Block chain enabled Trade, We Trade– Trade Finance Network, Supply Chain Financing, Identity on Block chain	
4	**Block chain application development:** Hyperledger Fabric- Architecture, Identities and Policies, Membership and Access Control, Channels, Transaction Validation, Writing smart contract using Hyperledger Fabric, Writing smart contract using Ethereum, Overview of Ripple and Corda.	14

Learning Resources:

1. M. Swan, Block Chain: Blueprint for a New Economy, O'Reilly, 2015.
2. J. Thompsons, Block Chain: The Block Chain for Beginners- Guide to Block Chain Technology and Leveraging Block Chain Programming, CreateSpace Independent Publishing Platform, 2017.
3. D. Drescher, Block Chain Basics, 1st Edition, Apress, 2017.
4. A. Kaushik, Block Chain and Crypto Currencies, Khanna Publishing House, New Delhi, 2019.
5. I. Bashir, Mastering Block Chain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained, Packt Publishing, 2018.
6. R. Modi, Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Block Chain, Packt Publishing, 2018.
7. S. Baset, L. Desrosiers, N. Gaur, P. Novotny, A. O'Dowd and V. Ramakrishna, Hands-On Block Chain with Hyperledger: Building Decentralized Applications with Hyperledger Fabric and Composer, Import, 2018.

CO-PO Mapping

Block Chain

(Course Code – OE ME 801/802I**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	2	1	-	2	3	-	2	2	2	3	1	1
CO2	3	1	2	-	-	1	-	1	1	2	3	2	1	2	1
CO3	2	2	1	2	1	-	2	2	-	1	1	3	1	-	3
CO3	2	1	3	-	-	-	1	-	-	-	2	2	1	2	3

OE ME 801/802J- Cyber Security

Course Outcome (CO)

Student will be able to:

CO1	Understand, appreciate, employ, design and implement appropriate security technologies and policies to protect computers and digital information.
CO2	Identify & Evaluate Information Security threats and vulnerabilities in Information Systems and apply security measures to real time scenarios.
CO3	Identify common trade-offs and compromises that are made in the design and development process of Information Systems.
CO4	Demonstrate the use of standards and cyber laws to enhance information security in the development process and infrastructure protection.

Subject Code: J	**Category:** Open Elective Courses
Subject Name: Cyber Security	**Semester:** Eighth
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Basic knowledge of Computers, Basic knowledge of networking and Internet, Hands on Windows operating system	

Module No.	Description of Topic	Contact Hrs.
1	**Cyber Security Concepts:** Essential Terminologies: CIA, Risks, Breaches, Threats, Attacks, Exploits. Information Gathering (Social Engineering, Foot Printing & Scanning). Open Source/ Free/ Trial Tools: nmap, zenmap, Port Scanners, Network scanners.	2

2	**Cryptography and Cryptanalysis**: Introduction to Cryptography, Symmetric key Cryptography, Asymmetric key Cryptography, Message Authentication, Digital Signatures, Applications of Cryptography. Overview of Firewalls-Types of Firewalls, User Management, VPN Security, Security Protocols: security at the Application Layer- PGP and S/MIME, Security at Transport Layer- SSL and TLS, Security at Network Layer- IPSec. Open Source/ Free/ Trial Tools: Implementation of Cryptographic techniques, Open SSL, Hash Values Calculations MD5, SHA1, SHA256, SHA 512,Steganography (Stools)	4
3	**Infrastructure and Network Security:** Introduction to System Security, Server Security, OS Security, Physical Security, Introduction to Networks, Network packet Sniffing, Network Design Simulation. DOS/ DDOS attacks. Asset	5

	Management and Audits, Vulnerabilities and Attacks. Intrusion detection and Prevention Techniques, Host based Intrusion prevention Systems, Security Information Management, Network Session Analysis, System Integrity Validation. Open Source/ Free/ Trial Tools: DOS Attacks, DDOS attacks, Wireshark, Cain & abel, iptables/ Windows Firewall, snort, suricata, fail2ban.	
4	**Cyber Security Vulnerabilities& Safe Guards:** Internet Security, Cloud Computing & Security, Social Network sites security, Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Authorization, Unprotected Broadband communications, Poor Cyber Security Awareness. Cyber Security Safeguards- Overview, Access control, IT Audit, Authentication. Open Web Application Security Project (OWASP), Web Site Audit and Vulnerabilities assessment. Open Source/ Free/ Trial Tools: Win Audit, Zap proxy (OWASP), burp suite, DVWA kit.	6
5	**Malware:** Explanation of Malware, Types of Malware: Virus, Worms, Trojans, Root kits, Robots, Adware's, Spywares, Ransom wares, Zombies etc., OS Hardening (Process Management, Memory Management, Task Management, Windows Registry/ services another configuration), Malware Analysis. Open Source/ Free/ Trial Tools: Antivirus Protection, Anti Spywares, System tuning tools, Anti Phishing.	6

6	**Security in Evolving Technology:** Biometrics, Mobile Computing and Hardening on android and ios, IOT Security, Web server configuration and Security. Introduction, Basic security for HTTP Applications and Services, Basic Security for Web Services like SOAP, REST etc., Identity Management and Web Services, Authorization Patterns, Security Considerations, Challenges. Open Source/ Free/ Trial Tools: adb for android, xcode for ios, Implementation of REST/ SOAP web services and Security implementations.	6
7	**Cyber Laws and Forensics:** Introduction, Cyber Security Regulations, Roles of International Law, the state and Private Sector in Cyberspace, Cyber Security Standards. The INDIAN Cyberspace, National Cyber Security Policy 2013. Introduction to Cyber Forensics, Need of Cyber Forensics, Cyber Evidence, Documentation and Management of	7
	Crime Sense, Image Capturing and its importance, Partial Volume Image, Web Attack Investigations, Denial of Service Investigations, Internet Crime Investigations, Internet Forensics, Steps for Investigating Internet Crime, Email Crime Investigations. Open Source/ Free/ Trial Tools: Case Studies related to Cyber Law, Common Forensic Tools likedd, md5sum, sha1sum, Ram dump analysis, USB device	

Learning Resources:

1. W. Stallings, Cryptography and Network Security, Pearson Education/PHI, 2006.
2. V.K. Jain, Cryptography and Network Security, Khanna Publishing House, New Delhi,2013.
3. G. Gupta and S. Gupta, Information Security and Cyber Laws, Khanna Publishing House,New Delhi, 2019.
4. A. Kahate, Cryptography and Network Security, McGraw Hill, 2003.
5. V.K. Pachghare, Cryptography and Information Security, PHI Learning, 2015.
6. N. Godbole, Information System Security, Wiley, 2008.
7. H. Bothra, Hacking, Khanna Publishing House, New Delhi, 2017.

CO-PO Mapping

Cyber Security

(Course Code – OE ME 801/802 J**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	-	1	1	1	2	3	-	1	3	3	1	-
CO2	2	3	3	3	2	1	1	3	1	-	2	3	1	2	3
CO3	2	3	-	2	-	2	2	1	2	1	-	3	3	-	1
CO4	2	-	1	3	-	-	1	-	-	-	1	3	3	1	-

OE ME 801/802K- Quantum Computing

Course Outcome (CO)

Student will be able to:

CO1	Explain the working of a Quantum Computing program, its architecture and program model
CO2	Develop quantum logic gate circuits
CO3	Develop quantum algorithm
CO4	Program quantum algorithm on major toolkits

Subject Code: K	**Category:** Open Elective Courses
Subject Name: Quantum Computing	**Semester:** Eighth
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Data Structure and Algorithm, Programming in Python/C#	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to Quantum Computing:** 1.1 Motivation for studying Quantum Computing 1.2 Major players in the industry (IBM, Microsoft, Rigetti, D-Waveetc.) 1.3 Origin of Quantum Computing 1.4 Overview of major concepts in Quantum Computing • Qubits and multi-qubits states, Bra-ket notation. • Bloch Sphere representation • Quantum Superposition • Quantum Entanglement	4
2	**Math Foundation for Quantum Computing**: Matrix Algebra- Basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.	6

3	**Building Blocks for Quantum Program:** 3.1 Architecture of a Quantum Computing platform 3.2 Details of q-bit system of information representation: • Block Sphere • Multi-qubits States • Quantum superposition of qubits (valid and invalidsuperposition) • Quantum Entanglement • Useful states from quantum algorithmic perceptive e.g. Bell State • Operation on qubits: Measuring and transforming using gates. • Quantum Logic gates and Circuit: Pauli, Hadamard, phase shift, controlled gates, Ising, Deutsch, swap etc. 3.3 Programming model for a Quantum Computing Program • Steps performed on classical computer	7
	• Steps performed on Quantum Computer • Moving data between bits and qubits.	
4	**Quantum Algorithms:** 4.1 Basic techniques exploited by quantum algorithms. • Amplitude amplification • Quantum Fourier Transform • Phase Kick-back • Quantum Phase estimation • Quantum Walks 4.2 Major Algorithms • Shor's Algorithm • Grover's Algorithm • Deutsch's Algorithm • Deutsch -Jozsa Algorithm 4.3 OSS Toolkits for implementing Quantum program • IBM quantum experience • Microsoft Q • Rigetti PyQuil (QPU/QVM)	19

Learning Resources:

1. M.A. Nielsen, Quantum Computation and Quantum Information, Cambridge UniversityPress, 2010.
2. D. McMahon, Quantum Computing Explained, Wiley, 2016.
3. IBM Experience: https://quantumexperience,ng,bluemix.net
4. Microsoft Quantum Development Kit, https://www.microsoft.com/en-us/quantum/development-kit
5. S.D.K. Forest, PyQuil: https://pyquil.readthedocs.io/en/stable/

CO-PO Mapping

Quantum Computing

(Course Code – OE ME 801/802K**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	2	3	1	1	-	1	1	2	3	2	1	2
CO2	2	3	1	1	2	2	1	1	1	-	1	3	3	3	3
CO3	3	1	-	2	2	-	-	-	-	-	-	2	2	2	1
CO4	2	2	1	2	2	3	-	1	2	1	2	2	2	1	3

Department of Mechanical Engineering

OE ME 801/802L- Data Sciences

Course Outcome (CO)

Student will be able to:

CO1	Demonstrate understanding of the mathematical foundations needed for data science.
CO2	Collect, explore, clean, munge and manipulate data.
CO3	Implement models such as k-nearest Neighbors, Naive Bayes, linear and logistic regression, decision trees, neural networks and clustering.
CO4	Build data science applications using Python based toolkits.

Subject Code: L	**Category:** Open Elective Courses
Subject Name: Data Sciences	**Semester:** Eighth
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Introduction to Programming, Probability	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to Data Science:** Concept of Data Science, Traits of Big data, Web Scraping, Analysis vs Reporting	3
2	**Introduction to Programming Tools for Data Science**: 2.1 Toolkits using Python: Matplotlib, NumPy, Scikit-learn, NLTK 2.2 Visualizing Data: Bar Charts, Line Charts, Scatter plots 2.3 Working with data: Reading Files, Scraping the Web, Using APIs (Example: Using the Twitter APIs), Cleaning and Munging, Manipulating Data, Rescaling, Dimensionality Reduction	5
3	**Mathematical Foundations:** 3.1 Linear Algebra: Vectors, Matrices, 3.2 Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation and Causation 3.3 Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, The Central Limit Theorem 3.4 Hypothesis and Inference: Statistical Hypothesis Testing, Confidence Intervals, P- hacking, Bayesian Inference	10

4	**Machine Learning:** Overview of Machine learning concepts– Over fitting and train/test splits, Types of Machine learning– Supervised, Unsupervised, Reinforced learning, Introduction to Bayes Theorem, Linear Regression- model assumptions, regularization (lasso, ridge, elastic net), Classification and Regression algorithms- Naïve Bayes, K-Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees, and random forest, Classification Errors, Analysis of Time Series- Linear Systems Analysis, Nonlinear Dynamics, Rule Induction, Neural Networks- Learning and Generalization, Overview of Deep Learning.	14
5	**Case Studies of Data Science Application:** Weather forecasting, Stock market prediction, Object recognition, Real Time Sentiment Analysis.	4

Learning Resources:

1. J. Grus, Data Science from Scratch: First Principles with Python, O'Reilly Media, 2019.
2. A. Géron, Hands-On Machine Learning with Scikit- Learn and Tensor Flow: Concepts,Tools, and Techniques to Build Intelligent Systems, 1st Edition, O'Reilly Media, 2017.
3. V.K. Jain, Data Sciences and Analytics, Khanna Publishing House, New Delhi, 2019.
4. V.K. Jain, Big Data and Hadoop, Khanna Publishing House, New Delhi, 2017.
5. J. Jose, Machine Learning, Khanna Publishing House, New Delhi, 2020.
6. R. Chopra, Machine Learning, Khanna Publishing House, New Delhi, 2020.
7. I. Goodfellow, Y. Bengio and A. Courville, Deep Learning, MIT Press, 2016.
8. http://www.deeplearningbook.org
9. J. Han and J. Pei, Data Mining Concepts and Techniques, 3rd Edition, Morgan KaufmannPublishers, 2012.

CO-PO Mapping

Data Sciences

(Course Code – OE ME 801/802L**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	3	1	-	-	-	1	-	3	1	3	1	1	1
CO2	1	2	2	1	2	1	-	-	2	-	2	2	2	-	1
CO3	1	2	1	-	-	1	2	2	1	2	3	1	1	1	3
CO4	3	2	1	2	-	1	2	2	1	2	3	1	3	3	3

OE ME 801/802M- Virtual Reality

Course Outcome (CO)

Student will be able to:

CO1	Understand geometric modelling and Virtual environment.
CO2	Study about Virtual Hardware and Software
CO3	Develop Virtual Reality applications.

Subject Code: M	**Category:** Open Elective Courses
Subject Name: Virtual Reality	**Semester:** Eighth
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Fundamentals of C++	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to Virtual Reality:** Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark 3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism- Stereographic image.	5
2	**Geometric Modelling**: Geometric Modelling: Introduction, From 2D to 3D, 3D space curves, 3D boundary representation. Geometrical Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.	10

3	**Virtual Environment:** Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object in betweening, free from deformation, particle system. Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.	8

4	**VR Hardware and Software:** Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupleddisplays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML	8
5	**VR Applications:** Introduction, Engineering, Entertainment, Science, Training. The Future: Virtual environment, modes of interaction	5

Learning Resources:

1. J. Vince, Virtual Reality Systems, Pearson Education Asia, 2007.
2. R. Anand, Augmented and Virtual Reality, Khanna Publishing House, New Delhi.
3. Adams, Visualizations of Virtual Reality, McGraw Hill, 2000.
4. G.C. Burdea and P. Coiffet, Virtual Reality Technology, Wiley Inter Science, 2nd Edition,2006.
5. W.R. Sherman and A.B. Craig, Understanding Virtual Reality: Interface, Application andDesign, Morgan Kaufmann, 2008.
6. Websites for Reference: www.vresources.org
7. Websites for Reference: www.vrac.iastate.edu
8. Websites for Reference: www.w3.org/MarkUp/VRM

CO-PO Mapping

Virtual Reality

(Course Code – OE ME 801/802M**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	1	2	3	-	3	3	2	1	3	3	3	2	1
CO2	2	2	2	3	3	-	1	1	2	-	-	2	1	2	3
CO3	1	-	2	1	2	-	2	3	-	3	1	2	3	-	-

PW ME 881 – Project-IV

Course Outcome (CO)

Student will be able to:

CO1	To develop the ability to conduct investigations of complex engineering problems using research knowledge, methods and other modern engineering tools.
CO2	To analyze a situation or mechanical system and identify possible ideas for practical implementation.
CO3	To train the students in preparing project reports.
CO4	To train the students to face review and viva voice examination

CO-PO Mapping

Project-IV **(Course Code –** PW ME 881**)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	3	3	-	-	-	2	-	2	2	3	2	2
CO2	2	3	1	1	1	1	-	-	2	-	1	1	2	1	3
CO3	1	-	-	-	-	2	1	2	2	3	2	1	-	-	1
CO4	1	-	-	-	-	-	-	1	-	3	-	1	-	-	1

PW ME 882 – Comprehensive Viva

Course Outcome (CO)

Student will be able to:

CO1	To develop the ability to conduct investigations of complex engineering problems using research knowledge, methods and other modern engineering tools.
CO2	To analyze a situation or mechanical system and identify possible ideas for practical implementation.
CO3	To train the students in preparing project reports.
CO4	To train the students to face review and viva voice examination.
CO5	To prepare for the interview in a better way by brushing up different course papers so that overall knowledge on Mechanical Engineering areas would be sharpened.

CO-PO Mapping

Comprehensive Viva**(Course Code –** PW ME 882**)**

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