2.6

Student Performance and Learning Outcome

2.6.1 Programme and course outcomes for all Programmes offered by the institution are stated and displayed on website

Supporting Document : Students' Handbook (Sample of ME & First Year Engineering)

Regent Education and Research Foundation
Group of Institutions

Students' Handbook (Mechanical Engineering)

2022 - 23

AFFILIATION AND ACCREDITATION

Principal
Regent Education & Research Foundation
Bara Kanthalia, P.O.:Sewli Telinipara
Barrackpore, Kolkata- 700121

Regent Education and Research Foundation
Bara kanthalia,Barrackpore, P.O.: Sewli Telini Para,Kolkata – 700121,
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Website: www.rerf.in

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Regent Education and Research Foundation
Group of Institutions

RERF Group of Institutions a non profit-making trusts which has been set up to promote the technological and professional education of highest standards and to encourage research and training activities so that the students, conferred with the degree can not only meet the professional challenges but also all the challenges life has to offer . In this era of economic liberalization, globalization and technological super advancements our motto is to put quality education in the light of Swamiji's vision of spreading education throughout the society.

Founded in

2009

Located in

Barrackpore

Program Offered by the Institution

B.Tech in Civil Engineering

B.Tech in Computer Science & Engineering

B.Tech in Electrical Engineering

B.Tech in Electronics & Communication Engineering

B.Tech in Electrical & Electronics Engineering

B.Tech in Mechanical Engineering

Master of Business Administration

Master of Computer Application

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Vision

Our vision is to train the students to become quality executive with high standards of professionalism as well as morality and ethics using our excellent resources, infrastructural and technological support in all the streams. We believe in all round development of the students' personality. In this era of economic liberalization, globalization and technological super-advancement our aim is to put quality education in the light of Swamiji's vision of spreading education throughout the society.

Mission

Our Mission is to harmonize the traditional Indian values with the new values brought through the progress of science and technology and bring forth an all round development of the students with focus on innovation and improvement. Propagation of advanced and modern education on the firm grounds of our own philosophy and culture. We strive to make the college a centre of excellence and satisfaction with the highest levels of academic standard.

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Sabyasachi Mukherjee

HOD (Mechanical Engineering)

Ph.D.(Pursuing), ME, B. Tech.

Experience: 7 Year 1 Months

HOD's Message

A warm welcome to all the students...!!

Dear Students,

Mechanical Engineering is may be the most diverse and multipurpose of the engineering disciplines.

In addition to physics and mathematics, it includes key elements of production, electrical, civil, chemical and even materials science and bio-engineering. Mechanical engineering touches almost every aspect of modern life, from mobile phones and biomedical devices, to aircrafts and power plants. Not only engineering, mechanical engineers cope with economic matters, from the cost of a single component, to the economic influence of a manufacturing plant. Besides, Mechanical engineers can also be found in sales, engineering management, and corporate management. Adaptability is another distinctive advantage in a world that is undergoing constant economic, political, industrial, and social change. Mechanical engineers are polished and positioned, not only to adapt, but to define and direct change. Department students are getting ranks at university level almost every year. As a part of co-curricular activities students of the department are visiting Automotive, Machine Tool and other allied mechanical engineering industries in India. At department of mechanical engineering students are educated not only by teaching- learning but also through the real time projects from industries. Students are involved in R & D projects ofthe department.

The student of mechanical engineering department will enjoy the best facilities and equipments and essential to learn the frontier technology like mechatronics , automation, CAD/CAM/CIM, Robotics and CNC machine in industrial engineering, teratology and computer graphics, solid modeling ,analysis of synthesis of linkage and laser machining process, NDT etc.in day to come. I congratulate the team of faculty members and the students for their brilliant and original efforts. I wish all the Students and Faculty a great academic career.

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Four Year Degree Course in Bachelor of Engineering Branch: MECHANICAL ENGINEERING
Semester Pattern (Choice Based Credit Grade System)

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 ThirdSemester			**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

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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 Code**	**Subject Name**	**Total No. of contact hours**			**Credits**
				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 Communicatio n	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

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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**

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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**

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-ME801	Elective V	3	0	0	3

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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

There are six Professional Electives in Semester VI, VII and VIII as follows: (Elective-I) PE-ME601, (Elective-II) PE-ME602, (Elective-III) PE-ME701, (Elective-IV) PE-ME702, (Elective-V) PE-ME801 and (Elective VI) PE-ME802.

There are three baskets of Professional Electives in each of Semester VI, VII and VIII. Students are to choose two papers from the basket of Professional Electives corresponding to a particular Semester.

List of Professional Electives in Semester VI for (Elective-I) PE-ME601 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

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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**.

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 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

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F	3D Printing and Design
Manufacturing Group	
G	Micro and Nano Manufacturing
H	Process Planning and Cost Estimation
I	Maintenance Engineering

List of Open Electives:

There are three Open Elective Course Papers in Semester VII and VIII as follows:
(Open Elective-I) OE-ME701, (Open Elective-II) OE-ME801 and (Open Elective-III) OE-ME802

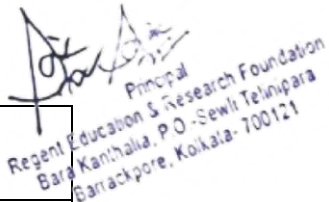
There are two baskets of Open Electives one each of Semester VII and VIII.
Students are to choose one paper from the basket of Open Electives corresponding to Semester VII, and two papers from the basket of Open Electives corresponding to Semester VIII.

List of Open Electives (OE-ME701)

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

List of Open Electives (OE-ME801 and OE-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)

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**

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2018-2019)

Semester-III

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	

Objectives:

1. To introduce the solution methodologies for second order Partial Differential Equations with applications in engineering
2. To provide an overview of probability and statistics to engineersCourse Content:

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 - evaluationof 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 goodnessof fit and independence of attributes.	12

Course Outcomes:

Upon completion of this course, students will be able to solve field problems in engineering involving PDEs. They can also formulate and solve problems involving random variables and apply statistical methods for analysing experimental data.

Textbooks/References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Chandrika Prasad & Reena Garg, Advanced Engineering Mathematics, Khanna Publishing House, 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

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	

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Course Content:

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 major kingdoms of life. A given organism can come under different category based on 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

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4	**Biomolecules** *Purpose*: To convey that all forms of life has the same buildingblocks and yet the manifestations are as diverse as one can imagine 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.	4
5	**Enzymes** *Purpose*: To convey that without catalysis life would not haveexisted on earth. Enzymology: How to monitor enzyme catalysed reactions. Howdoes 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. DNAas 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 inprotein structure. Primary secondary, tertiary and quaternarystructure. Proteins as enzymes, transporters, receptors and structural elements.	5
8	**Metabolism** *Purpose*: The fundamental principles of energy transactions are the same in physical and biological world. Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergoinc reactions. Concept ofKeq and its relation to standard free energy. Spontaneity. ATP as anenergy 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

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Course Outcomes:

After studying the course, the student will be able to:

1. Describe how biological observations of 18th Century that lead to major discoveries.
2. Convey that classification per se is not what biology is all about but highlight the underlying criteria, such as morphological, biochemical and ecological
3. Highlight the concepts of recessiveness and dominance during the passage of genetic material from parent to offspring
4. Convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine
5. Classify enzymes and distinguish between different mechanisms of enzyme action.
6. Identify DNA as a genetic material in the molecular basis of information transfer.
7. Analyse biological processes at the reductionistic level
8. Apply thermodynamic principles to biological systems.
9. Identify and classify microorganisms.

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 and Company
4. Molecular Genetics (Second edition), Stent, G. S.; and Calender, R. W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publish
5. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers
6. Biology for Engineers, Tata McGraw Hill (ISBN: 978-11-21439-931)

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	

Course Objective:

To provide an overview of electronic device components to Mechanical engineering students.

Course Content:

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-amp IC 741, inverting and non inverting amplifier applications: summing and difference amplifier, unity gain buffer, comparator, integrator anddifferentiator.	6
3	**Timing Circuits and Oscillators:** RC-timing circuits, IC 555 and its applications as tableand 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

Course Outcomes:

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

1. Understand the principles of semiconductor devices and their applications.
2. Design an application using Operational amplifier.
3. Understand the working of timing circuits and oscillators.
4. Understand logic gates, flip flop as a building block of digital systems.
5. Learn the basics of Electronic communication system Learning Resources:

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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, 3rd Edition, 2001
5. Shanti Ram Kal, Basic Electronics, PHI

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	

Objectives:

The objective of this Course is to provide an introductory treatment of *Engineering Mechanics* to all the students of engineering, with a view to prepare a good foundation for taking up advanced courses in the area in the subsequent semesters. A working knowledge of statics with emphasis on force equilibrium and free body diagrams provides an understanding of the kinds of stress and deformation and how to determine them in a wide range of simple, practical structural problems, and an understanding of the mechanical behavior of materials under various load conditions.

Course Content:

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
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, Moment of 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

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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; Plan curvilinear motion (rectangular, path, and polar coordinates). 3-Dcurvilinear motion; Relative and constrained motion; Newton's 2nd law(rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy.Impulse-momentum (linear, angular); Impact (Direct and oblique).	5
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 moment in the disc apparatus; Helical block; To draw a load efficiency curve for a screw jack.	12

Course Outcomes:

At the end of this course students will be able to

1. Use scalar and vector analytical techniques for analysing forces in statically determinate structures.
2. Apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems.
3. Apply basic knowledge of maths and physics to solve real-world problems.
4. 4.Understand measurement error, and propagation of error in processed data.
5. Understand basic kinematics concepts – displacement, velocity and acceleration and their angular counterparts).

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6. Understand basic dynamics concepts – force, momentum, work and energy.
7. Understand and be able to apply Newton's laws of motion.
8. Understand and be able to apply other basic dynamics concepts - the Work-Energy principle, Impulse-Momentum principle and the coefficient of restitution.
9. Extend all of concepts of linear kinetics to systems in general plane motion (applying Euler's Equation and considering energy of a system in general plane motion, and the work of couples and moments of forces).
10. Learn to solve dynamics problems. Appraise given information and determine which concepts apply, and choose an appropriate solution strategy, and
11. Attain an introduction to basic machine parts such as pulleys and mass-spring systems.

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, Pearson Press.
6. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford UniversityPress
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

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	

Course Objective:

1. To learn about work and heat interactions, and balance of energy between system and its surroundings
2. To learn about application of I law to various energy conversion devices
3. To evaluate the changes in properties of substances in various processes
4. To understand the difference between high grade and low grade energies and II law limitations on energy conversion.

Course Content:

Module No.	Description ofTopic	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

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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 S is 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 systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis.	8
7	Thermodynamic cycles - Basic Rankine cycle; Basic Brayton cycle; Basic vapor compression cycle and comparison with Carnot cycle.	4

Course Outcomes:

1. After completing this course, the students will be able to apply energy balance to systems and control volumes, in situations involving heat and work interactions
2. Students can evaluate changes in thermodynamic properties of substances
3. The students will be able to evaluate the performance of energy conversion devices
4. The students will be able to differentiate between high grade and low grade energies.

Learning Resources:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, *Fundamentals of*

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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

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	

Course Objective**:**

To motivate and challenge students to understand and develop an appreciation of the processes in correlation with material properties which change the shape, size and form of the raw materials into the desirable product by conventional or unconventional manufacturing methods.

Course Content:

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

Course Outcomes:

Upon completion of this course, students will be able to understand the different conventional and unconventional manufacturing methods employed for making different products

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, and Systems, Wiley Publication.
3. Degarmo, Black &Kohser, Materials and Processes in Manufacturing, Wiley Publication.
4. Mehta & Gaira, Manufacturing Process, Viva Books

Subject Code : PC-ME391	**Category:** Professional Core courses
Subject Name : Practice of Manufacturing Processes	**Semester** : Third
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

Semester – IV

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	

Course Objective:

1. Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.

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2. To provide a detailed interpretation of equilibrium phase diagrams
3. Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

Course Content:

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 resolved shear 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 with fatigue, 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 and microstructure development. Continuous cooling curves and interpretation 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

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Course Outcomes:

1. Student will be able to identify crystal structures for various materials and understand the defects in such

structures.

2. Understand how to tailor material properties of ferrous and non-ferrous alloys
3. 3.How to quantify mechanical integrity and failure in materials

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 India Private 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.

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	

Course Objective**:**

1. To learn about of I law for reacting systems and heating value of fuels
2. To learn about gas and vapor cycles and their first law and second law efficiencies
3. To understand about the properties of dry and wet air and the principles of psychrometry
4. To learn about gas dynamics of air flow and steam through nozzles
5. To learn the about reciprocating compressors with and without intercooling
6. To analyze the performance of steam turbine.

Course Content:

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

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3	Properties of dry and wet air, use of psychometric chart, processes involving heating/cooling and humidification/dehumidification, dew point.	4
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

Course Outcomes:

1. After completing this course, the students will get a good understanding of various practical power cycles and heat pump cycles.
2. They will be able to analyze energy conversion in various thermal devices such as combustors, air coolers, nozzles, diffusers, steam turbines and reciprocating compressors
3. They will be able to understand phenomena occurring in high speed compressible flows.

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

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	

Course Objective**:**

1. To learn about the application of mass and momentum conservation laws for fluid flows
2. To understand the importance of dimensional analysis
3. To obtain the velocity and pressure variations in various types of simple flows
4. To analyze the flow in water pumps and turbines.

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Course Content:

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- application of 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 of dimensionless 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

Course Outcomes:

1. Upon completion of this course, students will be able to mathematically analyze simple flow situations
2. They will be able to evaluate the performance of pumps and turbines.

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, Oxford University Press, 2010.
6. Hydraulics and Fluid Mechanics, P M Modi and S M Seth, Standard Book House.

Subject Code : PC-ME403	**Category:** Professional Core courses
Subject Name : Strength of Materials	**Semester** : Fourth

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L-T-P : 3-1-0	Credit:4
Pre-Requisites: No-prerequisite	

Course Objective**:**

1. To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads
2. To calculate the elastic deformation occurring in various simple geometries for different types of loading.

Course Content:

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, linear and shear strains- principal stresses and principal planes- Mohr's circle.	8
2	Beams and types transverse loading on beams- shear force andbend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point anddistributed loads.	8
3	Moment of inertia about an axis and polar moment of inertia,deflection of a 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 typesof constraints.	10
4	Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses anddeflection of helical springs.	8
5	Axial and hoop stresses in cylinders subjected to internal pressure, deforma of thick and thin cylinders, deformationin spherical shells subjected to intern pressure	8

Course Outcomes:

1. After completing this course, the students should be able to recognise various types loads applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components
2. The students will be able to evaluate the strains and deformation that will result due to the elastic stresses developed within the materials for simple types of loading

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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, Tata McGraw Hill Publishing Co. Ltd., New Delhi 2005.
6. Debabrata Nag and Abhijit Chanda, Fundamentals of Strength of Materials, Wiley India.

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	

Objectives:

1. To understand the working of linear and angular measuring instruments.
2. To familiarize with the working of optical measuring instruments and fundamentals of limits and limit gauges.
3. To give basic idea about various methods for measurement of screw thread and surface finish parameters.
4. To give an exposure to advanced measuring devices and machine tool metrology.
5. To provide students an overview of mechanical measurement systems and principle of instruments for motion and dimension measurement.
6. To provide basic idea about working principle and applications of devices for measurement of force and torque; strain and stress and temperature.

Course Content:

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

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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 – 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.	8
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- differentorder 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

Course Outcomes:

Upon successful completion of the course, student will have

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1. Understand the working of linear and angular measuring instruments.
2. 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.
3. Acquire an overview of mechanical measurement systems and principle of instruments for motion and dimension measurement.
4. Get basic idea about working principle and applications of devices for measurement of force and torque; strain and stress and temperature.

Text Books:

1. Anand K Bewoor, Vinay A Kulkarni, Metrology & Measurement, McGraw-Hill, 2009
2. Ernest O. Doebelin, Dhanesh N. Manik, Measurement Systems Application and Design, McGraw-Hill, 2004
3. Galyer J.F.W., Schotbolt C.R., Metrology for Engineers, ELBS,1990
4. Thomas G. Beckwith, John H. L., Roy D. M., Mechanical Measurements, 6/E, Pearson Prentice Hall, 2007
5. R.K. Rajput, Mechanical Measurements & Instrumentation, S.K.Kataria & Sons.

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

We as human being are not an entity separate from the environment around us rather we are a constituent seamlessly integrated and co-exist with the environment around us. We are not an entity so separate from the environment that we can think of mastering and controlling it rather we must understand that each and every action of ours reflects on the environment and vice versa. Ancient wisdom drawn from Vedas about environment and its sustenance reflects these ethoses. There is a direct application of this wisdom even in modern times. Idea of an activity based course on environment protection is to sensitize the students on the above issues through following two types of activities.

(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

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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.

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.

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.

Semester-V

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	

Course Objectives:

1. The aim of the course is to build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.
2. igorous treatment of governing equations and solution procedures for the three modes willbe provided, along with solution of practical problems using empirical correlations.
3. The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.

Course Contents:

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, heattransfer 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 heattransfer- Correlations for forcedand 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 radiativeproperties, 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

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5	Boiling and Condensation heat transfer, Pool boiling curve.	4
6	Introduction to mass transfer, Similarity between heat and mass transfer.	4

Course Outcomes:

1. After completing the course, the students will be able to formulate and analyze a heat transfer problem involving any of the three modes of heattransfer
2. The students will be able to obtain exact solutions for the temperature variation using analytical methods where possible or employ approximate methods or empirical correlations to evaluate the rate of heat transfer
3. The students will be able to design devices such as heat exchangers and also estimate the insulation needed to reduce heat losses where necessary.

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

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	

Course Objectives:
The objective is to present the mathematical and physical principles in understanding the linear continuum behaviour of solids.

Course Contents:

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

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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, stressconcentration problems, thermo- elasticity, 2-D contact problems.	9
5	Solutions using potentials. Energy methods. Introduction to plasticity.	7

Course Outcomes:

Upon completion of this course, students will be able understand the deformation behavior of solids under different types of loading and obtain mathematical solutions for simple geometries.

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.

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	

Course Objectives:

1. To understand the kinematics and rigid- body dynamics of kinematically driven machine components
2. To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link
3. To be able to design some linkage mechanisms and cam systems to generate specified output motion
4. To understand the kinematics of gear trains

Course Contents:

Modul e 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

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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 follower motions- 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- Static balancing, 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 andfour wheel vehicles taking turn.	2

Course Outcomes:

After completing this course, the students can design various types of linkage mechanisms for obtaining specific motion and analyze them for optimal functioning

Learning Resources:

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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.

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	

Course Objectives:

The course aims to teach students the principles of technical communication for their academic and professional needs, focusing on essential written and oral skills for presenting technical information effectively.

Course Contents:

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 goalsetting, 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

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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, Rapidreading, Taking notes, Complex problem solving, Creativity.	7

Course Outcomes:

After completing this course, the students will be able to

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

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, Edition, McGraw Hill Education, 2017.
7. Xebec, Presentation Book, McGraw Hill Education India, New Delhi, 2000.

Subject Code : MC ME501	**Category:** Mandatory Courses
Subject Name : Essence of Indian Knowledge Tradition	**Semester** : Fifth
L-T-P : 0-2-0	**Credit: 0**
Pre-Requisites: Nil	

Course Objectives:

To facilitate students with the concepts of Indian traditional knowledge and to make them understand the importance of the root of knowledge system.

Course Contents:

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

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2	Protection of traditional knowledge (TK): the need for protecting traditional knowledge Significance of TK Protection, value of TK in global 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

Course Outcomes:

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

1. Understand the concept of Traditional knowledge and its importance
2. Know the need and importance of protecting traditional knowledge.
3. Know the various enactments related to the protection of traditional knowledge.
4. Understand the concepts of Intellectual property to protect the traditional knowledge.

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 of Secondary Education, 2012.
4. E-Resources: http://nptel.ac.in/courses/121106003/

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 Machine	

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Course Objectives:

To understand the principles and performance characteristics of flow and thermal devices To know about the measurement of the fluid properties.

Course Contents (12 experiments/ studies/ problems are to perform from the list given below or relevant others):

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 centrifugal pump.
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 given objects.
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
12. Determination of the performance characteristics of a vapour compressionsystem

Course Outcomes:
The students who have undergone the course will be able to measure various properties of fluids and characterize the performance of fluid/thermal machinery.

Subject Code: PC-ME 592	**Category:** Professional Core Courses
Subject Name: Machine Drawing-II	**Semester**: Fifth
L-T-P: **0-0-3**	**Credit: 1.5**
Pre-Requisites: Engineering Drawing	

Course Objectives:

Student will get methodically and well thought out presentation that covers fundamental issues common to almost all areas of machine drawing.

1. Students have an ability to apply knowledge of Modeling, science & engineering.
2. Student can modeled this drawing even in CAD/CAM software by applying the basic knowledge of machine drawing.
3. Students will able to demonstrate an ability to design and conduct experiments, analyze and interpret data and assembly and disassembly drawings knowledge will be provided.

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

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proportions of river heads, Different views of different types of riveted Lap and 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

Course Outcomes:

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

To identify, formulates, analyzes and solve Engineering Problems in Optimum time.

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.

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	

Course Objectives:

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Course Outcomes:

Students will be able to gather some exposure on some projects, may be designing some innovative ideas, fabricating and/or demonstrating an innovative machine or product, etc.

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Semester-VI

Third Year Sixth Semester							
Sl. No.	Category	Subject Code	Subject Name	Total Number 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	Humanities II (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 (Design) II	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-ME601 and (Elective-II) PE-ME602

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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**.

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	

Course Objectives:

To impart knowledge to make students able to demonstrate the tooling needed for manufacturing, the dimensional accuracy and tolerances of products, assembly of different components. Also students will be able to understand the principles of working of NC, CNC machine tools and rapid prototyping.

Course Contents:

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

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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, 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.	8
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

Course Outcomes:

1. To describe machines and related tools for manufacturing various components.
2. To understand the relationship between process and system in manufacturing domain.
3. To experiment on CNC machine tools.
4. To demonstrate rapid prototyping methods.

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Learning Resources:

1. S. Kalpakjian and S.R. Schmid, Manufacturing Processes for Engineering Materials, 5th Edition, 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.
8. A. Ghosh, Rapid Prototyping, EW Press.

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	

Course Objectives:

This course seeks to provide an introduction to the design of machine elements commonly encountered in mechanical engineering practice, through

1. a strong background in mechanics of materials based failure criteria underpinning the safety-critical design of machine components
2. an understanding of the origins, nature and applicability of empirical design principles, based on safety considerations
3. an overview of codes, standards and design guidelines for different elements
4. an appreciation of parameter optimization and design iteration
5. an appreciation of the relationships between component level design and overall machine system design and performance.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Objective and scope of Mechanical Engineering Design; Design considerations; Review and selection of materials and manufacturing 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's factor, 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

Course Outcomes:

Upon completion of this course, students will get an overview of the design methodologies employed for the design of various machine components.

Learning Resources:

1. J.E. Shigley and C.R. Mischke, Mechanical Engineering Design, 5th Edition, McGraw Hill International, 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
7. P. Kannaiah, Machine Design, 2nd Edition, Scitech Publications.
8. Sadhu Singh, Machine Design, Khanna Book Publishing Co.

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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:	

Course Objectives:

1. To study the various Operations Research tools,
2. To study to apply an appropriate model to the given situation.
3. To formulate the problem.
4. To solve and analyze the problems on Operations Research.

Course Contents:

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

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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 with time, replacement by alternative equipment, Group and individual replacement policy.**	3

Course Outcome:

At the end of this course students will be able to

1. Apply forecasting methods for predicting demands.
2. Make decisions under certainty, uncertainty and conflicting situations.
3. Apply linear programming tools for optimal utilization of resources in various types of industries.
4. Solve transportation problems to minimize cost and understand the principles of assignment of jobs and recruitment polices.
5. Understand the basic elements of a Queuing model
6. Apply PERT/CPM for project scheduling and resource allocation in an optimal way.

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7. Manage inventory with cost effectiveness.

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 Systems Analysis, 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.

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

Course Objectives:

The objectives of this course help the students to

1. To provide basic information about Indian constitution.
2. To identify individual role and ethical responsibility towards society.
3. To understand human rights and its implications.

Course Contents:

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

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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

Course Outcomes:

On completion of the course student will

1. Have general knowledge and legal literacy and thereby to take up competitive examinations.
2. Understand state and central policies, fundamental duties.
3. Understand Electoral Process, special provisions.
4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies
5. Understand Engineering ethics and responsibilities of Engineers
6. Understand Engineering Integrity & Reliability

Learning Resources:

1. D.D. Basu, Introduction to the Constitution on India, 19th/ 20th Students Edition, Prentice Hall 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 of India Pvt. Ltd., New Delhi, 2004.
5. B.K. Sharma, Introduction to the Constitution of India, PHI Learning, New Delhi, 2011.
6. Latest Publications, Indian Institute of Human Rights, New Delhi.

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 Objectives:

To understand the measurement of mechanical properties of materials Tounderstand the deformation behaviour of materials To understand the kinematic and dynamic characteristics of mechanical devices

Course Contents (12 experiments/ problems/ studies are to perform):

1. Uniaxial tension test on mild steel rod
2. Torsion test on mild steel rod

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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, double rocker and oscillating cylinder mechanisms
10. Studying kinematics of typical mechanisms like pantograph, some straight line motion mechanisms, 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

Course Outcomes:

Students who have undergone the course will be able to understand the measurement of mechanical properties of materials and will be able to characterize the dynamic behavior of mechanical system.

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

Course Objectives:

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Course Outcomes:

Students will be able to understand the procedure to carry out practical projects related to any technical event/ competition to fabricate and demonstrate an innovative machine or product, etc.

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

Course Objectives:

To acquire knowledge about the IC engine cycles, classification, working Principles and to measure performance parameters along with heat balance sheet.
To explain different alternate fuels, gas turbines and about jet propulsion

Course Contents:

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. Biogas and Hydrogen in engines.	3
6	**Gas Turbine:** Introduction to Gas Turbines, Development, Classification and Application ofGas 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

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Course Outcomes:

1. Explained basic concepts of actual cycles with analysis and to describe the fundamental concepts of IC engines along with its working principles.
2. Described the combustion phenomenon in SI and CI engines.
3. Evaluated the performance of IC engines and the importance of alternate fuels.
4. Classified the essential components of gas turbine along with its performance improving methods.
5. Illustrated the working principle of different types of Jet propulsive engines and Rockets.

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 Turbine Theory, 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.

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	

Course Objective:

1. To know about the basics of refrigeration and air-conditioning system.
2. To learn about different types of Refrigeration, Air-Conditioning and ventilation systems.
3. To 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	

Course Objective:

1. To know about the basics of refrigeration and air-conditioning system.
2. To learn about different types of Refrigeration, Air-Conditioning and ventilation systems.
3. To know about designing a Refrigeration and Air-Conditioning system.

Course Content:

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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 Cooling and Dehumidification. Duct Sizing & Design. Air-conditioning equipment: Air handling units, Cooling Towers.	8

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Course Outcomes:

After completing this course, the students will

1. know about the systems of Refrigeration, Air-Conditioning and Ventilation.
2. learn about different components of these systems.
3. know about designing a Refrigeration and Air-Conditioning system.

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.
6. Sadhu Singh, Refrigeration and Air Conditioning, Khanna Publishing House, 2018.

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	

Course Objective:

To know about the basic characteristics of compressible and incompressible flow machines. To learn about deriving dimensionless numbers through dimensional analysis.
To know about system of testing and performance analysis of turbo machines.

Course Content:

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

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4	**Compressible-Flow Machines:** Static and stagnation states; Isentropic and adiabatic expansion and compression processes; Nozzle, diffuser and rows of stationary and moving blades; Efficiencies.	8
5	**Dimensional Analysis:** Similarity laws, volume-flow, mass-flowhead andpower 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 cavitation parameter, surge and choking.**	6

Course Outcomes:

After completing this course, the students will

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

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 & Fluid Machines, 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 Publishing House Ltd, 2010.
7. C.S.P. Ojha, R. Berndtsson and P.N. Chandramouli, Fluid Mechanics & Machinery, Oxford University Press, 2008.
8. S.C. Gupta, Fluid Mechanics and Hydraulic Machines, Pearson Publication, 2006.
9. A.T. Sayers, Hydraulic and Compressible Flow Turbomachines, McGraw-Hill, 1990.
10. R.K. Bansal, Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 2018.
11. S.S. Rattan, Fluid Mechanics and Hydraulic Machines, Khanna Book Publications, 2016.
12. I.J. Karassic, J.P. Messina, P. Cooper and C.C. Heald, Pump Handbook, McGraw-Hill,New York, 2001.
13. V.M. Cherkassky, Pumps, Fans and Compressors, MIR Publication, Moscow, 1985.

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	

Course Objective:

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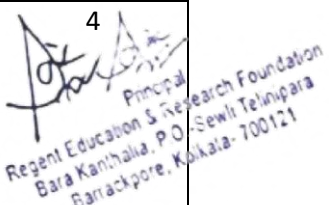
1. To know the basics of different types of fluid power control systems and their applications. understand working principles of different components of a pneumatic or hydraulic system.

Course Content:

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 gear pump, vane pump, axial piston pump and radial piston pump.	6
3	Hydraulic Actuators : Constructional features of single acting anddouble acting hydraulic cylinders; mounting of cylinders, cushioning ofcylinder; 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 valvepressure 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



Course Outcomes:

After completing this course, the students will

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

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

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	

Course Objective:

1. To know about compressible fluid flow.
2. To learn about ideal fluid flow.
3. To know about free surface flow.

To know about unsteady flow.

1. Course Content:

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, hydraulic jump.	8
4	Unsteady flow– water hammer.	4

Course Outcomes:

After completing this course, the students will

1. know about compressible fluid flow.
2. learn about ideal fluid flow.
3. know about free surface flow.
4. know about unsteady flow.

Learning Resources:

1. Sadhu Singh, Fluid Mechanics and Hydraulic Machines, Khanna Book Publishing, New Delhi, 2018.
2. R.K. Bansal, A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publication, New Delhi, 2010.
3. S.K. Som, G. Biswas and S. Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, McGraw-Hill, 2012.

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	

Course Objectives:

To understand the mechanical behaviour of composite materials.

To get an overview of the methods of manufacturing composite materials.

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Course Contents:

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 manufacturing processes	8
3	Basic assumptions of laminated anisotropic plates, symmetric laminates, angle ply laminates, cross ply laminates, laminate structural moduli, evaluation of lamina properties, determination of lamina 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

Course Outcomes:

Upon completion of this course, the students will have an overview of the mechanical behaviour and application of composite materials

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 International Publishing, 2019.
4. M. Mukhopadhyay, Mechanics of Composite Materials and Structures, University Press, 2013.

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	

Course Objectives:

To provide knowledge on electrical circuits, signal conditioning.
To make familiar about control system and power electronics in designing mechatronic system

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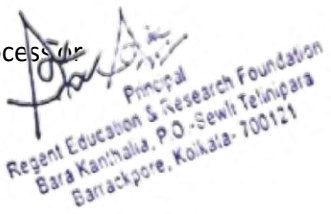
Course Contents:

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, Input and 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
4	Electrical Drives: Stepper motors, servo drives.	2
5	Mechanical Drives: Different mechanisms, Ball screws, Linear motion bearings, Transfer systems.	3
6	Pneumatic and Hydraulic Drives: Elements of pneumatic and hydraulic drives, comparison between them. Design of pneumatic and hydraulic circuits, symbolic representations of such circuits indicating different valves, actuators, etc.	4
7	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
8	Use of On-Off, PI and PID controllers to control different drives, Programming in PLC controller using Ladder diagram.	4
9	Mathematical modeling of physical systems, such as spring-mass vibration system, linear and rotory motion and its Laplace Transform.	2
10	Basics of time domain analysis, Introduction to discrete-time systems and Z-transform.	2
11	Introduction to Mechatronic systems, such as automatic brake, door closing and opening, robot, CNC machine, AGV, etc.	2

Course Outcomes:

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

1. Model and analyze mechatronic systems for an engineering application
2. Identify sensors, transducers and actuators to monitor and control the behavior of process or product.
3. Develop PLC programs for an engineering application.
4. Evaluate the performance of mechatronic systems.



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, 4th Edition, 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.
7. HMT Ltd., Mechatronics, McGraw Hill Publication, 2017.
8. F.H. Raven, Automatic Control Engineering, McGraw Hill India, 2013.
9. K. Ogata, Modern Control Engineering, Prentice Hall, 2010.
10. B.C. Kuo, Automatic Control Systems, Prentice Hall, 1975.
11. A. Ambikapthy, Control Systems, Khanna Publishing House, 2015.

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

Course Objective:
To impart knowledge about the engineering aspects of Robots and their application

Course Contents:

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

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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

Course Outcome:

1. To familiarize the Basics of robots Control system.
2. To familiarize the end effectors, Sensor technology and Industrial application of robot.

Learning Resources:

1. S.R. Deb, Robotics technology and flexible automation, McGraw Hill publishing company limited, New Delhi, 1994.
2. M.P. Groover. Industrial Robotics Technology Programming and Applications, McGraw Hill Book Co, Singapore, 1987.
3. S.K. Saha, Introduction to Robotics, McGraw-Hill Publication, 2014.
4. Y. Koren, Robotics for Engineers, McGraw Hill, New York, 1985.
5. P.G. Ranky and C.Y. Ho, Robots Modelling Control and Applications with Software, Springer Verlag, 1985.
6. J.J. Craig, Introduction to Robotics, Addison-Wesley, 2009.
7. R.J. Schilling, Fundamentals of Robotics Analysis and Control, Prentice Hall of India, 1996.
8. T. Yoshikawa, Foundations of Robotics Analysis and Control, Prentice Hall of India, 2010.
9. K.S. Fu, R.C. Gonzales and C.S.G. Lee, Robotics: Control, Sensing, Vision and Intelligence, McGraw Hill, 1997.
10. W. Stadler, Analytical Robotics and Mechatronics, McGraw Hill Book Co., 1995.

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	

Course Objective:

1. To know about the material handling systems used in industry.
2. To learn about basic designing principles of some material handling systems.
3. To know about modern handling system using a robot.

Course Content:

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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) Slide and trough gates, (ii) belt, screw and vibratory feeders, (iii) Chutes, (iv) positioners like elevating platform, ramps, universal vice; (v) ball table.	3

Course Outcomes:

After completing this course, the students will

1. know about constructional features, working principle and specific applications of each of the material handling system.
2. learn about unit load calculation and selecting specification of some material handling system.

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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.

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	

Course Objectives:

To provide knowledge on different aspects of management applied in an industry.
To make familiar about some management decision making systems and motivational aspects usually practiced in an industry.

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

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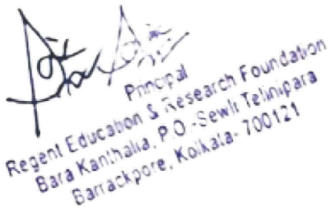
6	**Financial Management:** Financial functions of management, Financial Planning, Management of Working Capital, Sources of Finance.	5
7	**Marketing Management:** Functions of Marketing, Product Planning & Development, Marketing Organization, Sales Organization, Sales Promotion, Consumer Behaviour, Marketing Research and Information.	5

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

1. Understand the evolutionary development of management thought and general principles of management.
2. Understand the management functions in an organization

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.
5. J.A.F. Stoner, R. Freeman and D.R. Gilbert. Jr., Management, Prentice Hall of India, 1985.
6. H. Koontz and H. Weihrich, Essentials of Management, McGrew Hill, 2007.
7. D.C. Bose, Principles of Management and Administration, Prentice Hall of India, 2012.
8. K. Nerkar, V. Chopde and Kogent Learning Solutions Inc, Principles and Practices of Management, Dreamtech Press, 2011.
9. P. Diwan, Management Principles and Practices, Excel Books, New Delhi, 2002.
10. R.L. Daft, Principles of Management, Cengage Learning, 2012.
11. Premvir Kapoor, Principles of Management, Khanna Publishing House, 2019.



Semester-VII

Fourth Year Seventh Semester							
Sl. No.	Category	Subject Code	Subject Name	Total Number 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-ME701	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	

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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	SubjectName
A	Industrial Engineering
B	Project Management
C	Introduction to Product Design andDevelopment
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**.

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	

Course Objectives:

To introduce principles of material removal mechanism of advanced machining processes such as mechanical, electro-chemical and thermal.

To give basic understanding of the machining capabilities, limitations, and productivity of advanced manufacturing technologies.

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Course Contents:

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

Course Outcomes:

Student will be able

1. To understand non- traditional machining processes and the effect of process parameters
2. To differentiate the various non-traditional machining processes
3. To demonstrate micromachining technology

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 Book Series, Narosa Publishing House, New Delhi, 1997.
8. P.C. Pandy and H.S. Shan, Modern Machining Processes, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1980.
9. V. K. Jain, Introduction to Micromachining, Alpha Science International Limited, 2010.
10. J. A. McGeough, Micromachining of Engineering Materials, Taylor & Francis, 2001.

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	

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Course Objectives:

To make general awareness among budding engineers regarding basic principles of economics and that needed to use in an industry.

To give basic understanding of engineering costs, estimation, depreciation analysis and nasic accountingprinciples .

Course Contents :

Modul e 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 of Price Indexes in Engineering Economic Analysis, Cash Flows that inflate at different Rates.	3
7	Accounting- Function, Balance Sheet, Income Statement, Financial Ratios Capital Transactions, Cost Accounting, Direct and Indirect Costs, Indirect Cost Allocation.	3

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Course Outcomes:

Student will be able

1. To understand Economic Decisions Making criteria
2. To know basic principles of engineering costs, estimation and depreciation analysis.
3. To understand basic accounting principles.

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, Oxford University Press, 2019.
4. J.A. White, K.E. Case and D.B. Pratt, Principle of Engineering Economic Analysis, John Wiley, 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, Professional Publication, 1993.

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 Objectives:

Students will gain a practical knowledge of various manufacturing processes in a hands-on environment through experiments and simulations.

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

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11. Robot Programming
12. Experiments on AJM/ USM/ WEDM/ EDM/ ECM/ LBM
13. Design and manufacture of products using Additive Manufacturing

Course Outcomes:

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

1. Study cutting forces in machining processes
2. Test the quality of weld and moulding sands
3. Develop a practical understanding of advanced manufacturing processes.
4. Understand the working of a robot and its programming
5. Identify and rectify defects in parts and manufacturing processes related problems.

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 in Manufacturing, 11th Edition, John Wiley & Sons, 2011.
3. S. Kalpakjian and Schmid, Manufacturing processes for engineering materials, 5th edition, Pearson Education, 2010.

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

Course Objectives:

To develop the ability to identify, formulate and analyze engineering problems through literature survey, recent trends in industries and by applying the knowledge of science and engineering fundamentals.

To train students in preparing project reports, to face reviews and viva voce examination.Course Contents:

It is intended to start the project work early in the seventh semester and carry out both design and fabrication of a mechanical device whose working can be demonstrated. The design and formulation of theproblem is expected to be completed in the seventh semester and the fabrication and demonstration will be carried out in the eighth semester. The students in a group of 4 to 6 works on a topic are to be approvedby the head of the department under the guidance of a faculty member. The students prepare a comprehensive project report after completing the work to the satisfaction of the supervisor to be submitted at the end of the semester. The progress of the project is evaluated by a committee may be constituted by the Head of the Department. The project work is evaluated based on oral presentation and the project report may jointly by external and internal examiners constituted by the Head of the Department.

Course Outcomes:

Student will be able to carry out some project works based on some design or fabrication or experimental problems in a group building up team spirit and would get sufficient exposure for the way to proceed to solve a practical or design problem.

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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	

Course Objective:

To impart knowledge on various types of power-driven vehicles and to familiarize the students with the fundamentals of Automotive Engine System, Chassis and suspension system, braking and transmission system, and cooling system.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** History & Development of Automobile. Various sub systems of Automobile.	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

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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

Course Outcomes:

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

1. Understand the basic lay-out of an automobile.
2. Explain the operation of engine cooling, lubrication, ignition, electrical and air conditioning systems.
3. Illustrate the principles of transmission, suspension, steering and braking systems.
4. Demonstrate automotive electronics.
5. Study latest developments in automobiles.

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.

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	

Course Objectives:

To provide the student with the knowledge of basic principles of gas dynamics and its importance in jet propulsion applications.

Course Contents:

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Module No.	Description of Topic	Contact Hrs.
	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 heat transfer- 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- converging diverging nozzle flow with shock thickness- shock strength.	8
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

Course Outcomes:

Upon completion of this course, student will be able to:

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1. 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.
2. 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.
3. Explain the effect of heat transfer on flow parameters.
4. Illustrate the jet propulsion engines
5. Describe the basic concepts of rocket propulsion

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, New Age International (P) Ltd., 2007.
7. M.J. Zucrow, Aircraft & Missile Propulsion, Wiley, New York, 2013.

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	

Course Objectives:

The objective of the course is to impart knowledge on numerical modeling and its role for the solution of complex engineering problems in the field of heat transfer and fluid dynamics.

Course Contents:

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

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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 and Beta formulation methods, Approximate factorization, Fractional step methods, Consistency analysis, Linearization.	4
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, Solution of Generic Equation with tetrahedral Elements, 2-D Heat conduction with Triangular Elements.	3

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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

Course Outcomes:

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

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

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, Narosa Publishing 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.
5. K.A. Hoffman, and S.T.C. Hiang, Computational Fluid Dynamics, Vol. I, II and III, Engineering Education System, Kansas, USA, 2000.
6. T.J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2003.
7. D.A. Anderson, J.C. Tannehill, and R.H. Pletcher, Computational Fluid Mechanics and Heat Transfer, McGraw Hill Book Company, 2002.

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	

Course Objective:

1. To know about the general structure of the atmosphere and its behaviour.

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2. To learn about various types of atmospheric circulations.
3. To know about the effects of earth's rotation and friction on wind movements.
4. To know about the structure of atmospheric boundary layer and turbulence.
5. To learn about smoke dispersion patterns and chimney height determination.
6. To know about the similarity analysis and scaling and wind tunnel simulation & testing.

Course Content:

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; wind tunnel testing.	7

Course Outcomes:

After completing this course, the students will

1. know about the general structure of the atmosphere and its behaviour.
2. learn about various types of atmospheric circulations.
3. know about the effects of earth's rotation and friction on wind movements.
4. know about the structure of atmospheric boundary layer and turbulence.
5. learn about smoke dispersion patterns and chimney height determination.
6. know about the similarity analysis and scaling and wind tunnel simulation & testing.

Learning Resources:

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

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	

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Course Objectives:

The subject exposes students to the basics parameter for selection of materials and different classes of materials, and various destructive and non destructive testing methods of materials and its industrial applications.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Engineering Materials** Introduction – classification of engineering materials – selection of materials 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

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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

Course Outcomes:

1. To understand importance of engineering materials.
2. To choose materials for engineering applications.
3. To identify the material properties.
4. To identify suitable testing technique to inspect industrial component.
5. To use different techniques and know its applications and limitations.

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, Narosa Publishing House, 2009.
5. ASM Metals Handbook, Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio, USA.

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	

Course Objectives:

To understand the importance of vibrations in mechanical design of machine parts that operate in vibratory conditions through acquiring knowledge on vibratory models of dynamic systems with changing complexities, differential equation of motion of vibratory systems, free and forced (harmonic, periodic, non-periodic) vibration, single and multi degree of freedom linear systems.

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Course Contents:

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, model analysis, 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

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

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1. Understand the causes and effects of vibration in mechanical systems.
2. Demonstrate schematic models for physical systems and formulate governing equations of motion.
3. Explain the role of damping, stiffness and inertia in mechanical systems
4. Analyze rotating and reciprocating systems and compute critical speeds.
5. Evaluate and design machine supporting structures, vibration isolators and absorbers.

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.

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	

Course Objectives:

To apprise the students about the basics of the Finite Element analysis technique, a numerical tool for the solution of different classes of problems in solid mechanics, thermal engineering, and fluid mechanics.

Course Contents:

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

Course Outcomes:

Student will be able to

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

Text Books:

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

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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	

Course Objective:

To impart knowledge about different welding processes and their applicability. To make the students understand the mechanism behind weld joints.
To impart ideas of different testing techniques of the welded joint.

Course Contents:

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, Choice of 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 on the 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

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Course Outcome:

1. To familiarize different types of welding processes.
2. To familiarize the basic mechanism behind weld joint and influencing factors.
3. To impart the knowledge different tests to judge soundness of the weld joint.

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, Narosa Publishing House, 2006.

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	

Course Objectives:

To provide knowledge on different types of quantity production methods practised in industry. To make students familiar with planning and scheduling for having high productivity and quality enhancement in industry.

Course Content:

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

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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 and FMS) 3.2 Design and use of jigs and fixtures for batch production in machine shops	6
4	**Productivity and Quality Enhancement in Quantity production:** Group technology; concept and application in large scale production. 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

Course Outcomes:

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

1. Gather knowledge about different quantity production methods practised in industry.
2. Understand planning and scheduling methods usually used in industry to have high productivity and to enhance quality.

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.
8. P.K. Mishra, Non-Conventional Machining, Narosa Publication, 1997.
9. A. Ghosh, Rapid prototyping, East-West Press Publication, New Delhi, 2016.
10. M. Palay, Metal Cutting Tool Production, MIR Publication, Moscow, 1968.

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	

Course Objective:

To impart knowledge about computer aided design- geometric modeling, stress analysis.
To give an idea about computer aided manufacturing system, its components including application of robot.

Course Contents:

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 for two elements.	6
3	Introduction to computer aided manufacturing (CAM) systems, basic building blocks of computer integrated manufacturing (CIM).	4

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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, Manufacturing from 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

Course Outcome:

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

Learning Resources:

1. P.N. Rao, N.K. Tewari and T.K. Kundra, Computer Aided Manufacturing, McGraw-Hill Publication, 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 International Publishers, 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-Hill Publication, 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.

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	

Course Objectives:

To provide introductory knowledge on Industrial Engineering, concept of Productivity and work study.
To make familiar about facility layout and planning, systems of production planning and control and technics of inventory management.

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Course Content:

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, exponential smoothing; 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

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

1. Understand the concepts of Industrial Engineering.
2. Explain production systems and their characteristics.
3. Understand the role of productivity in streamlining a production system.
4. Describe different aspects of work system design and facilities design pertinent to manufacturing industries
5. Apply forecasting and scheduling techniques to production systems.
6. Apply the inventory management tools in managing inventory

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, McGraw Hill 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.
10. S. Ray, Introduction to Materials Handling, New Age International, 2016.
11. S.L. Narasimhan, D.W. McLeavy and P.J. Billington, Production Planning and Inventory Control, Prentice Hall, 2009.
12. E.A. Silver, D.F. Pyke and R. Peterson, Inventory Management and Production Planning and Scheduling, John Wiley, 1998.

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	

Course Objectives:

To have knowledge about resource allocation, market and demand analysis, technical analysis, economic and ecological analysis related to project management.
To understand optimisation techniques applied to project management.

Course Content:

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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

Course Outcomes:

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

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

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 and Controlling, Wiley Student Edition, 2013.
4. J.D. Wiest and F.K. Levy, A Management Guide to PERT/ CPM with PERT/ PDM/ DCPM and Other Networks, PHI Learning Private Limited, 1970.
5. A. Kanda, Project Management: A Life Cycle Approach, PHI, 2010.

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	

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Course Objective:
To have an overall idea about the whole process of product design and development. To be able to explain concept generation, concept selection and concept testing.
To be able to apply the basic concepts on design for environment. To become industry-ready to work in product design department.

Course Content:

Module No.	Description of Topic	Conta ct 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,setting final specifications.	9
3	Concept generation– activities of concept generation, clarifying problem, exploring the output; Concept selection– concept screening and concept scoring, methods of selection.	9
4	Concept testing– qualitative and quantitative methods including survey, measurement and customer's response; Design for environment– basic concepts.	8

Course Outcomes:

After completing this course, the students will be
1. Identify and analyse the product design and development processes industry.
2. Define the components and their functions of product design and development processes
3. Analyse, evaluate and apply the methodologies for product design, development andmanagement.
4. Undertake a methodical approach to the management of product development to satisfycustomer needs.
5. Carry out cost and benefit analysis through various cost models.

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.

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	

Course Objective:

To have an idea about different sources of renewable energy that would be sustainable. To have the concept of using solar energy for heating as well as Photovoltaic Generation.

Course Content:

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 renewable energy, 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) Water Desalination, 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

Course Outcomes:

After completing this course, the students will

1. know about the energy scenario at present and the need of using renewable energy for sustainability.
2. know specifically the use of solar energy for heating as well as photovoltaic generation.

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.

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	

Course Objective:

To know musculoskeletal anatomy, dynamics to human motion and biomaterial interfaces.
To understand fundamentals of biomaterials science, physico-chemical properties of biomaterials and their testing techniques.

Course Content:

Module No.	Description of Topic	Conta ct 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 sterilization of 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

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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

Course Outcomes:

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

1. Understand dynamics of human motion with the knowledge of musculoskeletal anatomy and biomaterial interfaces.
2. Understand fundamental characteristics and properties of biomaterials and their testing techniques.

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 in medicine, 3rd Edition, Academic Press, New York, 2012.

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	

Course Objective:

To learn about different numerical techniques.

To learn about the application of numerical techniques in different fields of mechanical engineering. To learn about different transformation techniques.

To understand concept of linear regression and statistical analysis.

Course Content:

Module No.	Description of Topic	Contact Hrs.
1	**Approximations:** Accuracy and precision, round off and truncation errors, error propagation.	3

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2	**Linear algebraic equations:** Formulation and solution of linear algebraic equations, Gauss elimination, LU decomposition, iteration methods– 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

Course Outcomes:

On completion of this course the students will be able to

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

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 MATLAB and C, Brooks/Cole Pub., 2000.
4. W.W. Hines and Montgomery, Probability and Statistics in Engineering and Management Studies, John Wiley, 1990.

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	

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Course Objectives:

This course will give an opportunity to gain expertise in one of the most fascinating and fastest growing areas of Computer Science through classroom program that covers fascinating and compelling topics related to human intelligence and its applications in industry, defence, healthcare, agriculture and many other areas. This course will give the students a rigorous, advanced and professional graduate-level foundation in Artificial Intelligence.

Course Content:

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 open list, 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 observable MDPs.	10
5	**Reinforcement Learning:** Passive reinforcement learning, direct utility estimation, adaptive dynamic programming, temporal difference learning, active reinforcement learning-Q learning.	7

Course Outcomes:

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

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

Learning Resources:

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 3rd Edition, Prentice Hall, 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

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8. Websites for reference: https://aima.cs.berkeley.edu.

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	

Course Objective:
To introduce students to the basic concepts and techniques of Machine Learning.
To have a thorough understanding of the Supervised and Unsupervised learning techniques. To study the various probability based learning techniques.
To understand graphical models of machine learning algorithms.

Course Content:

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

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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

Course Outcomes:

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

1. Distinguish between, supervised, unsupervised and semi-supervised learning
2. Apply the appropriate machine learning strategy for any given problem
3. Suggest supervised, unsupervised or semi-supervised learning algorithms for any given problem
4. Design systems that uses the appropriate graph models of machine learning
5. Modify existing machine learning algorithms to improve classification efficiency

Learning Resources:

1. Jeeva Jose, Introduction of Machine Learning, Khanna Publishing House, 2019.
2. S. Marsland, Machine Learning– An Algorithmic Perspective, 2nd Edition, Chapman and Hall/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, First Edition, Wiley, 2014.
6. E. Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning Series), 3rd Edition, MIT Press, 2014.

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	

Course Objectives:

The objective of this course is to provide an understanding of the concepts of closed conduit flow, open channel flow, surface water hydrology and rainfall, and also groundwater hydrology and its charactristics.
Course Content:

Module No.	Description of Topic	Contact Hrs.
1	**Fluid Mechanics:** Review of fluid statics, Review of fluid dynamics; dimensional analysis.	4

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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

Course Outcomes:

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

1. Understand characteristic features of closed conduit flow and open channel flow.
2. Know different features of surface water hydrology and rainfall.

Study about groundwater hydrology and its characteristic relationships

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.
4. C.S.P. Ojha, R. Berndtsson and P. Bhunya, Engineering Hydrology, Oxford University Press, 2008.
5. M.J. Deodhar, Elementary Engineering Hydrology, Pearson Education, 2008.
6. K. Subramanya, Flow in Open Channels, 5th Edition, McGraw-Hill, 2019.
7. R. Srivastava, Flow through Open Channels, Oxford University Press, 2008.
8. V.T. Chow, Open-Channel Hydraulics, The Blackburn Press, 2009.
9. Elements of Water Pollution Control Engineering, Khanna Publishing House, 2019.

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Semester-VIII

Fourth Year Eighth Semester							
Sl No.	Category	Subject Code	Subject Name	Total Number of contact hours			Credits
				L	T	P	
Theory							
1	Professional Elective courses	PE-ME801	Elective V	3	0	0	3
2	Professional Elective courses	PE-ME802	Elective VI	3	0	0	3
3	Open Elective courses	OE-ME801	Open Elective- II	3	0	0	3
4	Open Elective courses	OE-ME802	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-Voce	0	0	0	1.5
	Total Practical			**0**	**0**	**10**	**6.5**
	Total of Eighth Semester			**12**	**0**	**10**	**18.5**

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

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F	3D Printing and Design
Manufacturing Group	
G	Micro and Nano Manufacturing
H	Process Planning and Cost Estimation
I	Maintenance Engineering

List of Open Electives (OE-ME801 and OE-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)

Subject Code: PW-ME881	**Category:** Project
Subject Name: Project- IV	**Semester**: Seventh
L-T-P: **0-0-10**	**Credit: 5**
Pre-Requisites: All courses	

Course Objectives:

To develop the ability to conduct investigations of complex engineering problems using research knowledge, methods and other modern engineering tools.
To train the students in preparing project reports, to face review and viva voce examination.

Course Contents:

It is intended to start the project work early in the seventh semester and carry out both design and fabrication of a mechanical device whose working can be demonstrated. The design and formulation of the problem is expected to be completed in the seventh semester and the fabrication and demonstration will

be carried out in the eighth semester. The students in a group of 4 to 6 works on a topic are to be approved by the head of the department under the guidance of a faculty member. The students prepare a comprehensive project report after completing the work to the satisfaction of the supervisor to be submitted at the end of the semester. The progress of the project is evaluated by a committee may be constituted by the Head of the Department. The project work is evaluated based on oral presentation and the project report may jointly by external and internal examiners constituted by the Head of the Department.

Course Outcomes:
Student will be able to carry out some project works based on some design or fabrication or experimental problems in a group building up team spirit and would get sufficient exposure for the way to proceed to solve a practical or design problem.

Subject Code: PW-ME882	**Category:** Professional Core Courses
Subject Name: Comprehensive Viva-Voce	**Semester**: Eighth
L-T-P: **0-0-0**	**Credit: 1.5**
Pre-Requisites: All courses	

Course Objectives:
The objective of comprehensive viva-voce is to assess the overall knowledge, a student acquired in the relevant field of engineering over 4 years of study in the programme. In doing so, the main objective is to prepare the students to face interview both in the academic and the industrial sector.

Course Contents:
The Comprehensive Viva-Voce will be conducted by a Committee consisting of Head of the Department and all Faculty members of the department. The Comprehensive Viva-Voce is intended to assess the student's understanding of the courses he/ she studied during the 4 years B. Tech. programme.

Course Outcomes:
Student will be able 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.

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	

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Course Objective:

1. To know about the dimensional analysis for fluid machinery.
2. To learn about different heads, losses and efficiencies for pumps, fans and turbines.
3. To know about the Interaction of pumps and Turbines and systems.
4. To know about the Performance characteristics of pumps and turbines.
5. To learn about Cavitation: NPSH, Thoma's cavitation parameter and suction specific speed.
6. To know about the Analysis of flow through propellers and windmills and jet propulsion.

Course Content:

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 Parallel operation of Pumps, Performance and selection of Pumps fordifferent systems characteristics, Surging in Pipelines.	12
4	Performance characteristics: Pumps and Fans-Radial, Mixed flow and Axial 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

Course Outcomes:

After completing this course, the students will

1. know about the dimensional analysis for fluid machinery.
2. learn about different heads, losses and efficiencies for pumps, fans and turbines.
3. know about the Interaction of pumps and Turbines and systems.
4. know about the Performance characteristics of pumps and turbines.
5. learn about Cavitation: NPSH, Thoma's cavitation parameter and suction specific speed.
6. know about the Analysis of flow through propellers and windmills and jet propulsion.

Learning Resources:

1. R.I. Lewis, Turbomachinery Performance Analysis, Arnold Butterworth-Heinemann, 1996.
J. Lal, Hydraulic Machines Including Fluidics, Metropolitan Book Co., 1994.

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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	

Course Objectives:

To familiarize students with different aspects of power plant engineering, working of power plants based on different fuels and to expose the students to the principles of safety and environmental issues.

Course Contents:

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 to boiling 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 and blade efficiency.	6
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:** Load duration curves, Power plant economics, estimation of tariff. Diesel and gas plants, Pollution and control, Greenhouse effect and control, Peak load plants.	3

Course Outcomes:

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

1. Understand functions of the various components of power plant.
2. Illustrate the working of nuclear, thermal and gas based power plants.
3. Evaluate the design layout and working of hydroelectric power plants.
4. Estimate the feasibility and its implications on power generating units.

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.

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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

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	

Course Objectives:

To provide the knowledge of evolution of low temperature science, properties of materials at low temperature and to familiarize with various gas liquefaction and refrigeration systems.

Ourse content

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Definition and engineering applications of cryogenics, Properties of solidsfor 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

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5. Course Contents:

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 Cryogenic fluids.	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 description with figure). Cryo pumping applications.	6
7	**Applications:** Broad applications of cryogenic refrigerants in various engineering systems.	2

Course Outcomes:

Students will

1. Understand principles of cryogenic systems.
2. Understand air and helium liquefaction processes.
3. Be able to classify cascade refrigeration systems.
4. Understand principles of ultra-low temperature systems and their applications.
5. Be able to evaluate storage systems used in cryogenic applications.

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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.

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	

Course Objective:

1. To know about the basic concepts of wind engineering.
2. To learn about bluff body aerodynamics as applied to wind engineering.
3. To know about the structural dynamics related to wind engineering.
4. To know about the aero-elastic phenomena caused due to wind flows.
5. To learn about wind tunnel simulation of aerodynamic and aero–elastic behaviour of bluff bodies
6. To know about the application of wind engineering to design tall structures and stacks.

Course Content:

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–in phenomena; models of vortex–induced response; across wind galloping; wake galloping; flutter; torsional divergence.	6
5	Wind tunnel of aerodynac an aero–simulation d elastic behaviour of bluff bodies.	6
6	Application to design of tall buildings, slender towers and stacks.	6

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Course Outcomes:

After completing this course, the students will

1. know about the basic concepts of wind engineering.
2. learn about bluff body aerodynamics as applied to wind engineering.
3. know about the structural dynamics related to wind engineering.
4. know about the aero-elastic phenomena caused due to wind flows.
5. learn about wind tunnel simulation of aerodynamic and aero–elastic behaviour of bluff bodies.
6. know about the application of wind engineering to design tall structures and stacks.

Learning Resources:

1. E. Simiu and R.H. Scanlan, Wind Effects on Structures– Fundamentals and Applications to Design, 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.

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	

Course Objectives:

1. To provide students with the fundamental knowledge in the field of Industrial tribology.
2. To provide basic concepts in the design of automotive lubrication system.
3. To provide knowledge of friction and wear mechanism in automotive system.

Course Contents:

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 andchemical, 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

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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 journalbearing, 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: 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
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

Course Outcomes:

Lerner will be able to

1. Apply knowledge of tribology for industrial component design.
2. Apply design concepts practically for automotive lubrication systems.

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., New Delhi, 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 Surface Treatments, 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.

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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	

Objectives:

The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry 4.0environment.

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:** Stereo-Lithography, LOM, FDM, SLS, SLM, Binder Jet technology. Process, Process parameter, Process Selection for various applications. Additive Manufacturing Application Domains: Aerospace Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools	10
4	**Materials:** Polymers, Metals, Non-Metals, Ceramics Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties. Support Materials	7
5	**Additive Manufacturing Equipment:** Process Equipment- Design and process parameters Governing Bonding Mechanism Common faults and troubleshooting Process Design	8
6	**Post Processing:** Requirement and Techniques	3
7	**Product Quality:** Inspection and testing Defects and their causes	3

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Course Outcomes:

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

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

Learning Resources:

1. L. Gibson, D.W. Rosen and B. Stucker, Additive Manufacturing Technologies: Rapid Prototyping 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 in Material 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 of Titanium Alloy, InTech, 2012.

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	

Course Objective:

To give an outline of different micromachining and micro manufacturing technologies and their applications.

To give an idea about nanotechnology by molecular or atomic manipulation and to make nano- features. Also to give knowledge various application areas of some nano materials.

Course Contents:

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

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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

Course Outcome:

After completing this course, the students will

1. Know different micromachining and micro-manufacturing technologies and their applications.
2. Gain some knowledge about nanotechnology by molecular or atomic manipulation and to make nano-features.
3. Get an idea about various application areas of some nanomaterials.

Learning Resources:

1. I. Fujimasa, Micromachines: A New Era in Mechanical Engineering, Oxford Science Publications, 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.

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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	

Course Objectives:

To introduce process planning concepts to make cost estimation for various products.

Course Contents:

Module No.	Description of Topic	ContactHrs.
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, estimation of foundry cost, estimation of machining cost.	8

Course Outcomes:

Upon completion of this course, the students will be able to use the concepts of process planning and cost estimation for various products

Learning Resources:

1. P. Scalon, Process Planning, Design/ Manufacture Interface, Elsevier Sc. & Tech, 2002.
2. P.F. Ostwaal and J. Munez, Manufacturing Processes and Systems, 9th Edition, John Wiley, 1998.
3. A.V. Chitale and R.C. Gupta, Product Design and Manufacturing, 2nd Edition, Prentice Hall, 2002.

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	

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Course Objectives:

To provide knowledge on different aspects of repair and maintenance practised in industry. To make students familiar with different repair and maintenance strategies used in industry.

Course Content:

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; Overall equipment 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, worn shafts, keyways, bush bearing, damaged gear tooth. Assembly and dismantling of antifriction bearing; Maintenance of bearing, clutches, coupling, brakes, Alignment of shafts, belt and chain drives, gear drives, centrifugal pump, pipe and pipe fittings, electrical wiring, isolators and main switches, small induction motors; Steps for installation of a machine.	10

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Course Outcomes:

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

1. Know different types of repair and maintenance procedures practised in industry.
2. Understand different repair and maintenance strategies used in industry.
3. Understand the organizational structure of an industry for maintenance management and the economy involved in this.

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.

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	

Course Objectives:

To express knowledge about various aspects of quality and total quality management. To understand different tools of TQM and related standards.

Course Content:

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

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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

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

1. Understand quality management philosophies, techniques, and frameworks
2. Apply tools and techniques of TQM in manufacturing and service sectors.
3. Understand the implications of quality management standards and systems

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.

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	

Course Objective:

To develop and strengthen entrepreneurial quality and motivation in students and to impart basic entrepreneurial skills.
To understand how to run a business efficiently and effectively.

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Course Content:

Module No.	Description of Topic	Contact Hrs.
1	Entrepreneurship: Types of Entrepreneurs– Difference between Entrepreneur 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 Needs and 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

Course Outcomes:

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

1. Gain knowledge and skills needed to run a business successfully.
2. Interpret key regulations and legal aspects of entrepreneurship in India.
3. Understand the concept of business plan and ownerships.

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, Cengage Learning, 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, Dreamtech, 2005.

R. Roy, Entrepreneurship, 2nd Edition, Oxford University Press, 201

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Subject Code: C	**Category:** Open Elective Courses
Subject Name: Safety and Occupational Health	**Semester:** Eighth
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Basic Engineering Knowledge	

Course Objectives:

To express knowledge about various aspects of industrial safety and occupational health. To understand causalities of an accident and steps for their prevention.
To aware about health and safety management and related legislation.

Course Contents:

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 occupational health 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

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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

Course Outcome:

1. To have knowledge about various aspects of industrial safety and occupational health.
2. To have understanding about the reasoning behind an accident and steps for their prevention.
3. To have awareness about legislation related to health and safety management.

Learning Resources:

1. A. Waring, Safety management Systems, Chapman & Hall, 1996.
2. N.P. Cheremisinoff and M.L. Graffia, Environmental Health & Safety Management– A Guide 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, Butterworth Heinemann, 2000.
11. H.L. Kalia, Industrial Safety and Human Behaviour, AITBS Publishes, India, 2019.

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	

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Course Objective:
To know about the various types of pollution caused by the industries and their effects on the environment.
To learn specifically about the causes, processes and control techniques of air pollution.
To know specifically about the causes, processes and control techniques of water pollution. To know specifically about the causes, processes and control techniques of noise pollution.

Course Content:

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

Course Outcomes:

After completing this course, the students will
1. know about the various types of pollution caused by the industries and their effects on theenvironment.
2. know specifically about the causes, processes and control techniques of air pollution.
3. know specifically about the causes, processes and control techniques of water pollution.
4. know specifically about the causes, processes and control techniques of noise pollution.

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.

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	

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Objectives:

To understand the energy data from industries and carry out energy audit for energy savings.

Course Content:

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 return, net present value; Life Cycle costing- ESCO concept.	9

Course Outcomes:

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

1. Understand principles of energy management and its influence on environment.
2. Comprehend methods of energy production for improved utilization.
3. Improve the performance of thermal systems using of energy management principles
4. Analyse the methods of energy conservation for air conditioning, heat recovery and thermal energy storage systems.
5. Prepare energy audit report of energy consumption for industries.

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, 2013.
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 of Power, GOI, 2004 (available at www.energymanagertraining.com).

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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	

Course Objective:

To know about the various types of bio-wastes.

To learn about biomass pyrolysis, biomass gasification and gasifiers.

To know about biomass combustion and combustors, biogas plants and production.

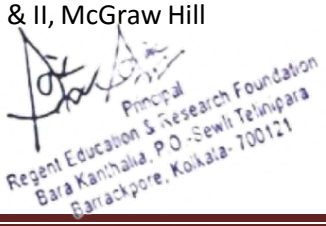
Module No.	Description of Topic	Contact Hrs.
1	Introduction to Energy from Waste: Classification of waste as fuel– Agro based, Forest residue, Industrial waste- MSW–conversion devices– Incinerators, gasifiers, digesters	6
2	Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods – 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 and operation	5
4	Biomass Combustion: Biomass stoves– Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, 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

After completing this course, the students will

1. know about the various types of bio-wastes.
2. learn about biomass pyrolysis, gasification and gasifiers.
3. know about biomass combustion and combustors, biogas plants and production.

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.



Course Outcomes:

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	

Course Objective:

To know about various types of control systems used in different industries. To learn about mathematical representation and analysis of control systems.

Course Content:

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

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4	**Stability Analysis using root locus:** Importance of Root locus 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.	12
5	**Control System performance measure:** Improvement of system performance through compensation. Lead, Lag and Lead- lag compensation, PI, PD and PID control.	4

Course Outcomes:

After completing this course, the students will
know about the various types of control systems.
learn about modeling control systems

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, Cengage Learning, 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.

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	

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Objectives:

The objective of this course is to impart necessary and practical knowledge of components of Internet of Things and develop skills required to build real-life IoT based projects.

Course Content:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to IoT:** Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, 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, RaspberryPi), 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/Home Automation	6

Course Outcomes:

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

5. Understand internet of Things and its hardware and software components
6. Interface I/O devices, sensors & communication modules
7. Remotely monitor data and control devices, and develop real life IoT based projects

Learning Resources:

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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 Practical Approach, ETI Labs, 2017.
3. P. Raj and A.C. Raman, The Internet of Things: Enabling Technologies, Platforms and Use Cases, 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.

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	

Course Objectives:

The objective of this course is to provide conceptual understanding of how block chain technology can be used to innovate and improve business processes. The course covers the technological underpinning of block Chain operations in both theoretical and practical implementation of solutions using block Chain technology.

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. 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	10
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

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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.

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	

Course Objectives:

The course has been designed to give students an extensive overview of cyber security issues, tools and techniques that are critical in solving problems in cyber security domains. The course aims at providing students with concepts of computer security, cryptography, digital money, secure protocols, detection and other security techniques. The course will help students to gauge understanding in essential techniques in protecting Information Systems, IT infrastructure, analysing and monitoring potential threats and attacks, devising security architecture and implementing security solutions. The students will also have a wider perspective to information security from national security perspective from both technology and legal perspective.

Course Content

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

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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
4	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. **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

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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 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	7

Course Outcomes:

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

1. Understand, appreciate, employ, design and implement appropriate security technologies and policies to protect computers and digital information.
2. Identify & Evaluate Information Security threats and vulnerabilities in Information Systems and apply security measures to real time scenarios.
3. Identify common trade-offs and compromises that are made in the design and development process of Information Systems.
4. Demonstrate the use of standards and cyber laws to enhance information security in the development process and infrastructure protection.

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.

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6. N. Godbole, Information System Security, Wiley, 2008.
7. H. Bothra, Hacking, Khanna Publishing House, New Delhi, 2017.

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#	

Course Objectives:
The objective of this course is to impart necessary knowledge to the learner so that he/she candevelop and implement algorithm and write programs using these algorithms.

Course Content:

Modu le No.	Description of Topic	Conta ct Hrs.
1	**Introduction to Quantum Computing:** Motivation for studying Quantum Computing Major players in the industry (IBM, Microsoft, Rigetti, D-Waveetc.) Origin of Quantum Computing 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 andHilbert spaces, matrices and tensors, unitary operators and projectors,Dirac notation, Eigen values and Eigen vectors.	6

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3	**Building Blocks for Quantum Program:** Architecture of a Quantum Computing platform Details of q-bit system of information representation: ● Block Sphere ● Multi-qubits States ● Quantum superposition of qubits (valid andinvalid superposition) ● Quantum Entanglement ● Useful states from quantum algorithmic perceptive e.g. BellState ● Operation on qubits: Measuring and transforming using gates. ● Quantum Logic gates and Circuit: Pauli, Hadamard, phase shift,controlled gates, Ising, Deutsch, swap etc. 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:** Basic techniques exploited by quantum algorithms. ● Amplitude amplification ● Quantum Fourier Transform ● Phase Kick-bac ● Quantum Phase estimation ● Quantum Walks Major Algorithms ● Shor's Algorithm ● Grover's Algorithm ● Deutsch's Algorithm ● Deutsch -Jozsa Algorithm OSS Toolkits for implementing Quantum program ● IBM quantum experience ● Microsoft Q ● Rigetti PyQuil (QPU/QVM)	19

Course Outcomes:

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

1. Explain the working of a Quantum Computing program, its architecture and programmodel
2. Develop quantum logic gate circuits
3. Develop quantum algorithm
4. Program quantum algorithm on major toolkits

Learning Resources:

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1. Microsoft Quantum Development Kit, https://www.microsoft.com/en-us/quantum/development-kit
2. S.D.K. Forest, PyQuil: https://pyquil.readthedocs.io/en/stable

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	

Course Objectives:
The objective of this course is to impart necessary knowledge of the mathematical foundations needed for data science and develop programming skills required to build data science applications.

Course Content:

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**: Toolkits using Python: Matplotlib, NumPy, Scikit-learn, NLTK Visualizing Data: Bar Charts, Line Charts, Scatter plots 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:** Linear Algebra: Vectors, Matrices, Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation and Causation Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, The Central Limit Theorem Hypothesis and Inference: Statistical Hypothesis Testing, Confidence Intervals, P- hacking, Bayesian Inference	10

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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

Course Outcomes:

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

1. Demonstrate understanding of the mathematical foundations needed for data science.
2. Collect, explore, clean, munge and manipulate data.
3. Implement models such as k-nearest Neighbors, Naive Bayes, linear and logistic regression, decision trees, neural networks and clustering.
4. Build data science applications using Python based toolkits.

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 Kaufmann Publishers, 2012.

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++	

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Course Objectives:

The objective of this course is to provide a detailed understanding of the concepts of Virtual Reality and its applications.

Course Content:

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-coupled displays, 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

Course Outcomes:

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

1. Understand geometric modelling and Virtual environment.
2. Study about Virtual Hardware and Software
   Develop Virtual Reality applications.

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3. 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 and Design, 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

Faculty List:

Sl. No.	Name of the Faculty	Designation	Qualification	EXPERIENCE
1	SABYASACHI MUKHERJEE	Assistant Professor	PH.D.(PURSUING), ME, B. TECH.	6 YEAR 1 MONTHS
2	ARPAN MANDAL	Assistant Professor	PH.D.(PURSUING), ME. , B.TECH.	8 YEAR 7 MONTHS
3	DEBTANU PATRA	Assistant Professor	PH.D.(PURSUING), M.TECH., B. TECH.	2 YEAR 4 MONTHS
4	PUSPENDU CHANDRA CHANDRA	Assistant Professor	PH.D.(PURSUING), M.TECH., B. TECH.	7 YEAR 3 MONTHS
5	Dr. ABHIJIT BISWAS	Assistant Professor	P.HD, M.E	13 YEAR 0 MONTHS
6	ANINDA DAS	Assistant Professor	M.TECH IN MECHNICAL	6 YEAR 6 MONTHS
7	Dr. PABITRA MAJI	Assistant Professor	PH.D., M.TECH. , B.TECH.	2 MONTHS
8	Dr. RAHUL KANTI NATH	Assistant Professor	PH.D., M.TECH. , B.TECH.	9 MONTHS
9	BANARSI PANDEY	Assistant Professor	PH.D.(PURSUING), M.TECH., B. TECH.	13 YEAR 6 MONTHS
10	SUJOY BOSE	Technical Assistant	DIPLOMA IN MECHANICAL ENGINEERING	8 YEAR 2 MONTHS
11	SUNIL KUMAR DEY	Technical Assistant	B. TECH.	8 YEAR 7 MONTHS
13	ARUP GHOSH	Technical Assistant	DIPLOMA IN MECHANICAL ENGINEERING	13 YEAR 2 MONTHS

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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 ScienceCourses	ES-CS201	Programming for Problem Solving	3	0	0	3
4	Humanities and SocialSciences 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**

First Year Engineering

The college has all the facilities as per AICTE norms for the successful conduction of First-Year engineering programmes. Various laboratories for first-year are:

1. Computer Centre
2. Engineering Physics Lab
3. Engineering Chemistry Lab
4. Electrical Engineering Lab
5. Engineering Mechanics Lab
6. Workshop
7. Drawing Hall

SYLLABUS PRESCRIBED FOR FOUR YEAR DEGREE COURSE IN B.E
(Common to all Branches)
SEMESTER-I / II "GROUP A"

Course Code : BS-PH101/ BS-PH201	**Category :** Basic Science Courses
Course Title : Physics-I	**Semester** : First/ Second
L-T-P : **3-1-0**	**Credit:4**
Pre-Requisites:	

Course objectives :

Basic concepts of mechanics, optics and its applications, electricity, magnetism and qualitative understanding of concepts of quantum physics and statistical mechanics.

1. **Mechanics** (7L)

Problems including constraints & friction. Basic ideas of vector partial differential equations, potential energy function F = -grad V, equipotentialsurfaces and meaning of gradient. Conservative and non-conservative forces.

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Conservation laws of energy & momentum. Non-inertial frames of reference. Harmonicoscillator; Damped harmonic motion forced oscillations and resonance. Motion of a rigid body in a plane and in 3D. Angular velocity vector. Moment of inertia.

2. **Optics** (5L)

- 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 formulac only), characteristics of diffration grating and its applications.
- Polarisation : Introduction, polarisation by reflection, polarisation by double reflection, scattering of light, circular and elliptical polarisation, optical activity.
- Lasers : Principles and working of laser : population inversion, pumping, various modes, threshold population inversion with examples .

3. Electromagnetism and Dielectric Magnetic Properties of Materials **(8L)**

- Maxwell's equations. Polarisation, permeability and dielectric constant, polar and non- polar dielecrrics, internal fields in a solid, Clausius- Mossotti equation(expression only), applications of dielectrics.
- Magnetisation , permeability and susceptibility, classificationof magnetic materials, ferromagnetism, magnetic domains and hysteresis, applications.Quantum Mechanics (16L)
- 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.

4. Statistical Mechanics **(8L)**

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

Course outcomes:

Students will be familiar with

- Basic concepts of mechanics
- Bragg's Law and introduction to the principles of lasers, types of lasers and applications.
- Various terms related to properties of materials such as, permeability, polarization,etc.
- Some of the basic laws related to quantum mechanics as well as magnetic and dielectric properties of materials.
- Simple quantum mechanics calculations.

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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

Course Code : BS-CH101/ BS-CH201	**Category :** Basic Science Courses
Course Title : Chemistry-I	**Semester** : First/ Second
L-T-P : **3-1-0**	**Credit:4**
Pre-Requisites:	

Detailed contents

i) Atomic and molecular structure (10 lectures)

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.

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ii) Spectroscopic techniques and applications (8 lectures)

Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterisation techniques. Diffraction and scattering. **iii)Intermolecular *forces and potential energy surfaces (4 lectures)***

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

iv) Use of free energy in chemical equilibria (8 lectures)

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.

v) Periodic properties (4 Lectures)

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

vi)* Stereochemistry *(4 lectures)

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

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

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

Course Outcomes

The concepts developed in this course will aid in quantification of several concepts in chemistry

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that have been introduced at the 10+2 levels in schools. Technology is being increasingly based on the electronic, atomic and molecular level modifications. Quantum theory is more than 100 years old and to understand phenomena at nanometer levels, one has to base the description of all chemical processes at molecular levels. The course will enable the student to:

- Analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces. Rationalise bulk properties and processes using thermodynamic considerations.
- Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
- Rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.
- List major chemical reactions that are used in the synthesis of molecules.

Learning Resources:

1. Engineering Chemistry, Satyaprakash, Khanna Book Publishing, Delhi
2. University chemistry, by B. H. Mahan
3. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
4. Fundamentals of Molecular Spectroscopy, by C. N. Banwell
5. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
6. Physical Chemistry, by P. W. Atkins
7. Spectroscopy of Organic Compounds, by P.S.Kalsi, New Age International Pvt Ltd Publishers
8. Physical Chemistry, P. C. Rakshit, Sarat Book House
9. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp

Course Code : BS-M101	**Category :** Basic Science Course
Course Title : Mathematics – I A	**Semester** : First (CSE & IT)
L-T-P : **3-1-0**	**Credit: 4**
Pre-Requisites: High School Mathematics	

Module No.	Description of Topic	Lectures Hours

1	***Calculus (Integration):*** 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.	8
2	***Calculus (Differentiation):*** Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin's theorems with remainders; Indeterminate forms and L'Hospital's rule; Maxima and minima.	6
3	***Matrices:*** 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.	7
4	***Vector Spaces:*** 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.	9
5	***Vector Spaces (Continued):*** Eigenvalues, Eigenvectors, Symmetric, Skew-symmetric, and Orthogonal Matrices, Eigenbases. Diagonalization; Inner product spaces, Gram-Schmidt orthogonalization.	10

Course Outcomes:

The students will be able to:

- Apply the concept and techniques of differential and integral calculus to determine curvature and evaluation of different types of improper integrals.
- Understand the domain of applications of mean value theorems to engineering problems.
- Learn different types of matrices, concept of rank, methods of matrix inversion and their applications. Understand linear spaces, its basis and dimension with corresponding applications in the field of computer science.
- Learn and apply the concept of eigen values, eigen vectors, diagonalisation of matrices and orthogonalization in inner product spaces for understanding physical and engineering problems

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, New Delhi.
7. S.K. Mapa, Higher Algebra: Abstract and Linear, Sarat Book House Pvt.Ltd.
8. Hoffman and Kunze: Linear algebra, PHI.

Course Code : BS-M102	**Category :** Basic Science Course
Course Title : Mathematics –I B	**Semester** : First (All stream except CSE & IT)
L-T-P : **3-1-0**	**Credit: 4**
Pre-Requisites: High School Mathematics	

Module No.	Description of Topic	Lectures Hours
1	***Calculus (Integration):*** 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.	8
2	***Calculus (Differentiation):*** Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin's theorems with remainders; Indeterminate forms and L'Hospital's rule; Maxima and minima.	6
3	***Sequence and Series:*** 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.	11
4	***Multivariate Calculus:*** 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.	9
5	***Matrices:*** 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.	8

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Course Outcomes:

After completing the course the student will be able to

- Apply the concept and techniques of differential and integral calculus to determine curvature and evaluation of different types of improper integrals.
- Understand the domain of applications of mean value theorems to engineering problems.
- 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. Apply the knowledge for addressing the real life problems which comprises of several variables or attributes and identify extremum points of different surfaces of higher dimensions.
- Understand different types of matrices, their eigen values, eigen vectors, rank and also their orthogonal transformations which are essential for understanding physical and engineeringproblems.

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, New Delhi.

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

Detailed contents:

Module 1: DC Circuits (8 hours)

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 (8 hours)

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real

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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 (6 hours)

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 (8 hours)**

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 (6 hours)

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

Module 6: Electrical Installations (6 hours)

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.

Course Outcomes

To understand and analyze basic electric and magnetic circuits
To study the working principles of electrical machines and power converters. To introduce the components of low voltage electrical installations

Learning Recourses:

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.

Course Code : BS-PH191/ BS-PH291	**Category :** Basic Science course
Course Title : Physics-I Laboratory	**Semester** : First/ Second
L-T-P : **0-0-3**	**Credit:1.5**
Pre-Requisites:	

Choose 10 experiments including at least one from Optics, Electricity and Magnetism and Quantum Mechanics and at least a total of six from these three groups.

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

Course Code : BS-CH191/ BS-CH291	**Category :** Basic Science Courses
Course Title : Chemistry-I Laboratory	**Semester** : First/ Second
L-T-P : 0-0-3	**Credit:1.5**
Pre-Requisites:	

Choose 10 experiments from the following:

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.

Course Code : ES-EE191	**Category :** Engineering Science Courses
Course Title : Basic Electrical Engineering Laboratory	**Semester** : First
L-T-P : 0-0-2	**Credit: 1**

Pre-Requisites:

Choose 10 experiments from the following:

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 color code , 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. Determination of Torque speed characteristics and observation of directionreversal by change of phase sequence of connection of Induction motor.
12. Determination of operating characteristics of Synchronous generator.
13. Demonstration of operation of (a) DC-DC converter (b) DC-AC converter (c) DC-AC converter for speed control of an Induction motor
14. Demonstration of components of LT switchgear.

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Course Code : ES-ME191/ ES-ME 291	**Category :** Engineering Science Courses
Course Title : Engineering Graphics & Design	**Semester** : First/ Second
L-T-P : **1-0-4**	**Credit: 3**
Pre-Requisites:	

Sl. No.	Content	Lecture (L)	Practical (P)
1	**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.	1	4
2	**LETTERING, DIMENSIONING, SCALES** Plain scale, Diagonal scale and Vernier Scales.	1	4
3	**GEOMETRICAL CONSTRUCTION AND CURVES** Construction of polygons, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid, Involute, Archemedian Spiral.	1	4
4	**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.	1	4
5	**PROJECTION OF REGULAR SOLIDS** Regular solids inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale (Cube, Pyramid, Prism, Cylinder, Cone).	1	4
6	**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.	1	4

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7	**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;	1	4
8	**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)	1	4
9	**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;	1	4
10	**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;	2	8

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11	**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).	2	8

Course Outcomes

The student will learn:

- Introduction to engineering design and its place in society
- Exposure to the visual aspects of engineering design
- Exposure to engineering graphics standards
- Exposure to solid modelling

General Instructions

1. In every topic some problems are to be done in the class and some are to be given to students as home assignment.
2. The problems for class work are to be prepared on drawing sheet of A1 size in the class/ using AutoCAD software.
3. The problems for home assignments are to be prepared on drawing copy/ using AutoCAD software.
4. Print out of every assignment is to be taken for CAD Drawings on Drawing sheets (A4 Sheets).
5. A title block must be prepared in each sheet/ assignment.

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Following is the list of drawing instruments that required for making engineering drawings on paper with perfection.

1. Drawing Board
2. Mini drafter/ Set-squares (45°–45° & 60°–90°), T-square 3. Protractor (180°, 360°)
4. Scales (Plain, Diagonal)
5. Compass (Small and Large)
6. Divider (Small and Large)
7. French Curves
8. Drawing paper (A1 Size)
9. Drawing pencil (H, HB, B)
10. Sharpener
11. Eraser
12. Drawing pins & clips
13. Duster or handkerchief etc.

Learning Resources:

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

Course Code : ES-ME192/ ES-ME 292	**Category :** Engineering Science Courses
Course Title : Workshop/ Manufacturing Practices	**Semester** : First/ Second
L-T-P : **1-0-4**	**Credit:3**
Pre-Requisites:	

(i) Lectures & videos:

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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 (8 hours)

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 (8 hours)

Typical jobs that may be made in this practice module:

To make a Gauge from MS plate.

Carpentry (8 hours)

Typical jobs that may be made in this practice module:

To make wooden joints and/or a pattern or like.

Welding shop (8 hours (Arc welding 4 hrs + gas welding 4 hrs))

Typical jobs that may be made in this practice module:

ARC WELDING (4 hours): To join two thick (approx 6mm) MS plates by manual metal arc welding.
GAS WELDING (4 hours): To join two thin mild steel plates or sheets by gas welding.

Casting (8 hours)

Typical jobs that may be made in this practice module:

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One/ two green sand moulds to prepare, and a casting be demonstrated.

Smithy (4 hours) ~ 4 hours

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 (4 hours)

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 (8 hours)

Familiarization with LT switchgear elements, making its sketches and noting down its specification. Kitkat fuse, Glass cartridge fuse, Plastic fuse holders (optional), Ironclad 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.

Laboratory Outcomes

Upon completion of this laboratory course, students will be able to fabricate components with their own hands.

They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.

By assembling different components, they will be able to produce small devices of their interest.

Learning Resources:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Kalpakjian S. and Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology – I" Pearson Education, 2008.
4. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
5. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGrawHill House, 2017.

Course Code : BS-M201	**Category :** Basic Science Course
Course Title : Mathematics – II A	**Semester** : Second (CSE &IT)
L-T-P : **3-1-0**	**Credit: 4**
Pre-Requisites: High School Mathematics and BS-M101	

Module No.	Description of Topic	Lectures Hours
1	**Basic Probability:** 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.	11
2	**Continuous Probability Distributions:** Continuous random variables and their properties, Distribution functions and densities, Normal, Exponential and Gamma densities.	4
3	**Bivariate Distributions:** Bivariate distributions and their properties, distribution of sums and quotients, Conditional densities, Bayes' rule.	5

4	**Basic Statistics:** 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.	8
5	**Applied Statistics:** 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.	8
6	**Small samples:** 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.	4

Course Outcomes:

The students will be able to:

Learn the ideas of probability and random variables, various discrete and continuousprobability distributions with their properties and their applications in physical and engineering environment.

Understand the basic ideas of statistics with different characterisation of aunivariate and bivariate data set.

Apply statistical tools for analysing data samples and drawing inference on a given dataset.

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.

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Course Code : BS-M202	**Category :** Basic Science Course
Course Title : Mathematics – II B	**Semester** : Second (All stream except CSE & IT)
L-T-P : **3-1-0**	**Credit: 4**
Pre-Requisites: High School Mathematics and BS-M102	

Module No.	Description of Topic	Lectures Hours
1	***Multivariate Calculus (Integration):*** Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, change of variables (Cartesian to Polar), Applications: Areas and volumes, 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.	11
2	***First order ordinary differential equations:*** 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.	5
3	***Ordinary differential equations of higher orders:*** 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.	9
4	***Complex Variable – Differentiation*** 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.	6

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5	***Complex Variable – Integration*** Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, Zeros of analytic functions, Singularities, Laurent's series; Residues, Cauchy residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.	9

Course Outcomes:

The students will be able to:

- Learn the methods for evaluating multiple integrals and their applications to different physical problems.
- 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.
- Learn different tools of differentiation and integration of functions of a complex variable that are used with various other techniques for solving engineering problems.
- Apply different types of transformations between two 2- dimensional planes for analysis of physical or engineering problems.

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, New Delhi.
7. E. L. Ince, Ordinary Differential Equations, Dover Publications.
8. J. W. Brown and R. V. Churchill, Complex Variables and Applications, Mc-Graw Hill.

Course Code : ES-CS201	**Category :** Engineering Science Courses
Course Title : Programming for Problem Solving	**Semester** : Second
L-T-P : **3-0-0**	**Credit:3**

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Detailed contents

Unit 1: Introduction to Programming **(4 lectures)**

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) - **(1 lecture).**

Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples. **(1 lecture)**

From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code- **(2 lectures)**

Unit 2: Arithmetic expressions and precedence **(2 lectures) Unit 3:** Conditional Branching and Loops **(6 lectures)**

Writing and evaluation of conditionals and consequent branching **(3 lectures)**

Iteration and loops **(3 lectures) Unit 4:** Arrays **(6 lectures)**

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

Unit 5: Basic Algorithms **(6 lectures)**

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 **(5 lectures)**

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

Unit 7: Recursion **(4 -5 lectures)**

Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

Unit 8: Structure **(4 lectures)**

Structures, Defining structures and Array of Structures

Unit 9: Pointers **(2 lectures)**

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Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)

Unit 10: File handling (only if time is available, otherwise should be done as part of the lab)

Course Outcomes

The student will learn

- To formulate simple algorithms for arithmetic and logical problems. To translate the algorithms to programs (in C language).
- To test and execute the programs and correct syntax and logical errors. To implement conditional branching, iteration and recursion.
- To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
- To use arrays, pointers and structures to formulate algorithms and programs.
- To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
- To apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration.

Learning Resources:

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

Course Code : ES-CS291	**Category :** Engineering Science Courses
Course Title : Programming for Problem Solving	**Semester** : Second
L-T-P : **0-0-4**	**Credit:2**
Pre-Requisites:	

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

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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

Laboratory Outcomes

- To formulate the algorithms for simple problems
- To translate given algorithms to a working and correct program To be able to correct syntax errors as reported by the compilers
- To be able to identify and correct logical errors encountered at run time To be able to write iterative as well as recursive programs
- To be able to represent data in arrays, strings and structures and manipulate them through a program To be able to declare pointers of different types and use them indefining self-referential structures. To be able to create, read and write to and fromsimple text files.

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Course Code : HM-HU201	**Category :** Humanities and Social Sciences including Management courses
Course Title : English	**Semester** : Second
L-T-P : **2-0-0**	**Credit:2**
Pre-Requisites:	

Detailed contents

1. Vocabulary Building

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

2. Basic Writing Skills

Sentence Structures & Types: Simple, Compound, Complex
Use of phrases and clauses in sentences: Transformation of sentences, active, passive, narration
Importance of proper punctuation
Creating coherence: Arranging paragraphs & Sentences in logical order
Creating Cohesion: Organizing principles of paragraphs in documents
Techniques for writing precisely

3. Identifying Common Errors in Writing

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

4. Nature and Style of sensible Writing

Describing
Defining
Classifying
Providing examples or evidence
Writing introduction and conclusion

5. Writing Practices

Comprehension
Précis Writing

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Essay Writing
Business Letter, Cover Letter & CV; E-mail

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"-Nira Konar, Prentice Hall of India 2nd edition, New Delhi, 2011
(x) Gajendra Singh Chauhan, Smita Kashiramka and L. Thimmesha. Functional English. Cengage , 2019.

Course Outcomes

The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

Course Code : HM-HU291	**Category :** Humanities and Social Sciences including Management courses
Course Title : Language Laboratory	**Semester** : Second
L-T-P : **0-0-2**	**Credit:1**
Pre-Requisites:	

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 them with key strategies for success2P

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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; 2P

8) Honing 'Writing Skill' and its sub skills by using Language Lab Audio –Visual input; PracticeSessions 2P

Course Outcomes

- The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

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Relevant Clauses:

1) The **Internal Assessment** marks for theory should be based on Class Test/ Continuous assesment as follows:

Continuous Assessment also Popularly Known as **CA Internal Exam** is an Integral Part of Academic Activity which Include Internal Class Presentation, Pen Paper Mode Exam, Group Discussion and Online MCQ Test in Portal.

Schedule and Activity List of Continuous Assessment:

Continuous Assessment	Activities
CA1	PPT presentation, Quiz, Group Discussion
CA2	Report writing, contents/Exercise and Assignment
CA3	Class test in Pen and paper Mode (DVS Portal)
CA4	Centralized MCQ online test in **Portal**

Continuous Assessment 1 (CA1)

CA1 would be based on presentation, Quiz, Group Discussion etc skill of a student. Faculties would advice students to make ppt presentation based on the some contents/assignments of the courses taught in the semester and also assess students on Quiz, Group Discussion etc. During setting the strategies of content/topics of presentation, components of outcome based education (OBE) and Bloom's Level (BL) of taxonomy should be considered. Appropriate assessment rubrics to be developed and followed during this evaluation. The pdf version of the presentation would be uploaded in the University portal during submission of marks of the CA1. This would help students to enhance their presentation, group activity etc skills.

Continuous Assessment 2 (CA2)

CA2 would be based on report writing skill of a student. Faculties would advice students to submit report based on the contents/exercise and assignments of the courses taught in the semester. During setting the strategies of content/topics of presentation, components of outcome based education (OBE) and Bloom's Level (BL) of taxonomy should be considered. Appropriate assessment rubrics to be developed and followed during this evaluation. The pdf version of the report would be uploaded in the University portal during submission of marks of the CA2. This would help students to enhance their report.

Continuous Assessment 3 (CA3)

CA3 would be based on class test in pen and paper mode. The process of CA4 of the last semester would be followed in this matter. After the internal examinations conducted at college level, the scripts are to be uploaded in the University portal and assessment to be done online in the University portal. Marks would be automatically transferred to the CA3 panel. During setting the question papers, appropriate strategies of OBE and BL to be followed. This would help students to enhance their offline.

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Continuous Assessment 4 (CA4)

CA4 would be based on centralized online test to be arranged by the University. The process of online examinations used in the end semester examinations in last academic year would be followed. Students would appear on online MCQ based questions in the proctored environment. The CA4 would be based on the entire syllabus of the curriculum and would be conducted at the completion of the semester. This would help students to enhance their online examination skill.

2) The computation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) of an examinee shall be as given below :-

You will have to first add grade points achieved in all subjects in a particular academic term and calculate their average to arrive at your SGPA.

You can also refer to the following methodology to figure out what your SGPA is:

1. Find out your credit point for each of your subjects.
2. Multiply the credit points of each subject with the grade you have attained in the respective subject.
3. Add all the products you get from the previous step.
4. Next, you need to divide the sum you get after adding the products of each subject by the sum of all the credits to derive your SGPA.

Consider the following example to understand this method-

Say the credits for each of your subjects are:

- **Subject 1-** 2
- **Subject 2-** 3
- **Subject 3-** 3

Now let us assume you have scored the following grades in each of these subjects:

- **Subject 1-** 8
- **Subject 2-** 7.8
- **Subject 3-** 9

Next, you have to multiply each of the grades with their respective subject credits:

- **Subject 1-** 2 x 8 = 16
- **Subject 2-** 3 x 7.8 = 23.4
- **Subject 3-** 3 x 9 = 27

Following this, you need to get the summation of all the products:

16 + 23.4 + 27 = 64.4. This is your total score.

Then add all the credits of individual subjects:

(Subject 1 + Subject 2 + Subject 3) which is 2 + 3 + 3 = 8

Finally, divide the total score you get by the total credits of the subjects:

64.4 / 8 = 8.3

Therefore, your **SGPA is 8.3.**

CGPA = (SGPA of all the semesters in a particular year / total number of semesters)

For example, if you score 7 and 8 SGPAs in two semesters, you will have to divide the total by 2:

(7 + 9)/2=16/2

So, your CGPA is 8.

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The below table will help you understand how the grade points are calculated:
The marks will be given in all examinations which will include college assessment marks and the total marks for each Theory / Practical shall be converted into Grades as per Table given.

G*= Letter Grade Indicator

G*	Classification	Score on 100 Percentage Points	Points
O	Outstanding	100 to 90	10
E	Excellent	89 to 80	9
A	Very Good	79 to 70	8
B	Good	69 to 60	7
C	Fair	59 to 50	6
D	Below Average	49 to 40	5
F	Failed	Below 40	2
I	Incomplete	---	2

3) (i) The scope of the subjects shall be as indicated in the syllabi.
(ii)The medium of instruction and examination shall be English
iii) An examinee who does not pass; or who fails to present himself/herself for the examination shall be eligible for readmission to the same examination/semester, on payment of fresh fees and such other fees as may be prescribed.
iv) A candidate who could not complete a semester satisfactorily or who has failed will be eligible for readmission to the same semester. However readmission to semester should be allowed only when a regular session is running for the particular semester.

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Regent Education and Research Foundation
Student's Conduct and Disciplinary Code

"A disciplined mind leads to happiness, and an undisciplined mind leads to suffering."
– **Dalai Lama XIV**

Section 1: Title and Commencement

This code may be called **Regent Education and Research Foundation Student's Conduct and Disciplinary Code**. The code shall be deemed to have come into effect from the date on which the Chairman/ (***) resolved to implement this Conduct and Disciplinary Code.

Section 2: Preamble

Regent Education and Research Foundation is a learning centre where both the teachers and the students uphold the cause of maintaining order and discipline in the campus for the accomplishment of the vision of the institute and maintaining a harmonious atmosphere. Rules and regulations are therefore meant to achieve the contours of these much needed order and discipline. The student community should see that the rules envisaged in this code are strictly followed so that their conduct is in conformity to the institute's vision.

Section 3: Applicability of the Code

The code shall be applicable to all the students admitted to this Institution including any academic programme, activity or event conducted by the Institute. It is the responsibility and duty of each and every student to become acquainted with all the provisions of the Code. It is presumed that every student from the date of his/her admission to the institute to any academic programme/activity/event has knowledge of this Code. All students coming within the above categories are required to strictly adhere to this Code as a condition of their admission to the institute and this Code would be binding on and enforceable against them or any among them.

Section 4: Responsibilities of the Students.

The responsibilities of the students shall be to:

1. Familiarize and adhere to this Code and any amendment brought to this Code.
2. Behave and conduct themselves in the institute campus and premises in a dignified and courteous manner and show due respect to the authorities and employees.
3. Follow decent dressing manners, without any obscenity.
4. Foster and maintain vibrant academic, intellectual, cultural and social atmosphere which is consistent with the vision of the institute.
5. Access all educational opportunities and benefits available at the institute and make use good of them to prosper academically and develop scientific temper.
6. Follow Institutional rules and directions from college authorities for ensuring the safety, health and well-being of students in the college.

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7. Refrain from all activities deemed under the purview of 'ragging' which is a criminal offence.
8. Abstain from the use/possession of alcohol, tobacco, narcotic substances or any other intoxicants in the campus.
9. Report any violation of this Code to the functionaries.

Section 5: Behaviour of the students.

1. Student activities should supplement the harmonious function of the institute and all activities of students should be oriented in this direction. Activities that may adversely affect the harmonious function of the institute would not be permitted.
2. Students are encouraged to spend their free time in the Reading Room. Clustering in the verandahs or crowding in front of the offices or the Campus roads are to be avoided.
3. Regent Education and Research Foundation Campus is a "**Smoking Free Campus**".
4. Silence shall be maintained in the designated premises of the institute.
5. Students should avoid usage of mobile phones in the class room, Library, Computer Centre, Examination Halls, etc.
6. Students shall not indulge in any undesirable activity and shall maintain highest standard of discipline.
7. Possession or consumption of narcotic drugs, tobacco, alcohol and other intoxicating substances are strictly prohibited in the Campus.
8. Students are expected to exhibit highest order of self esteem and self respect and are prohibited from indulging in anti-institutional, anti-national, anti-social, communal, immoral or political expressions and activities within the Campus.
9. Politically based organizations or outfits are not allowed in the Campus. Students are strictly prohibited from organizing, attending or participating in any activity or agitation sponsored by politically based organizations.
10. Students shall exhibit highest order of decency not to deface, disfigure, damage or destroy or cause any loss in any manner to or regarding public, private or Institute properties.
11. Unauthorized entry of outsiders into the campus is strictly prohibited. Without specific permission of the authorities, students shall not bring outsiders (except parents or family members) to the institute.
12. Students shall not bring, distribute or circulate unauthorized notices, pamphlets, leaflets etc within the Campus.
13. The possession, distribution or exhibitions of obscene items are prohibited within the Campus or on any property owned/managed by the institute.
14. Students need to obtain written permission from college authorities to collect money from other students or faculty or any staff within the campus .

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15. The institute being a holy place of learning and an exclusive academic zone, nobody shall respond to any call for any form of strike, procession or agitation including slogan shouting, *dharna, gherao,* burning in effigy or indulge in anything which may harm the peaceful atmosphere of the institution and shall abstain from violence in the Campus and even outside.
    Engaging in *gherao*, keeping under captivity or illegally confining any official of the institute is prohibited
    Students can park their vehicle in the dedicated space exclusively reserved for them.
    Rash driving inside the campus is strictly prohibited.

16. Students shall leave the classroom only when the session is over with the permission of the teacher.

17. Students charged with criminal offence or under suspension can enter the institute Campus only with the permission of the competent authority.
18. Any case of criminal activity or violation of law and order in the institute Campus will be reported to the police.
19. Students may use the waste bins for dispensing waste materials within the Campus including classrooms and offices.
20. Students are to follow all the rules and regulations as directed by the University while appearing for any examination.
21. Students are expected not to involve in any conduct which leads to lowering of the esteem of the institution.

Section: 6: Respect for Women

Verbal or non verbal conduct such as unfair comments, remarks or jokes, letters, phone calls, SMS or emails, gestures, exhibition of pornography, indecent stares, physical contact, stalking sounds or displays of a derogatory nature which have the purpose and/or effect of interfering with a woman's academic performance or living environment will be considered as misbehavior to girls/ladies and is strictly prohibited in the campus.

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Section: 7: Disciplinary Sanctions

Any student exhibiting prohibited behavior mentioned in this Code shall, depending upon the gravity of the misconduct or depending on its recurrence, be subjected to any of the following disciplinary sanctions:

(a). Minor Sanctions

i) **Warning or Reprimand**

The student engaged in any prohibited behaviour will be issued a warning letter.

ii) **Tendering Apology**

The student engaged in any prohibited behaviour may be asked to tender an apology for his/her act. An undertaking that he/she shall not indulge in such or any of the prohibited behaviour in future will be sought.

(b) Major Sanctions

i) **Debarring from Examinations**
A student/group of students may be debarred from writing all/any/some of the examinations, which forms part of the academic programme for which he/she/they has/have joined.

ii) **Suspension**
A student may be suspended from the institute for violation of any of the provisions of this Code. The period of suspension and conditions, if any, shall be clearly indicated in the communication addressed to the student by the college authority. The student shall lose his/her attendance for the suspended period unless decided/informed otherwise by the college authority.

iii) **Restitution**
Restitution implies reimbursement in terms of money and/or services to compensate for personal injury or loss, damage/disfiguration to property of the institute or any property kept in the premises of the institute in any manner. The students/group of students may be asked to compensate for the loss that has been caused to any person or property of the institute or any property kept in the premises of the institute due to the act of vandalism perpetrated by the students. The students/group of students shall also be liable to put in their service to restore any loss or damage caused to any property and thereby bringing it to its original form if it is possible.

iv) **Forfeiture**
Caution deposit of any student engaged in any prohibited behaviour shall be forfeited.

v) **Expulsion**
Expulsion is the permanent dismissal of a student from the Institute. Such a student will not be eligible for readmission to any of the courses of this institute thereafter.

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Section 8: Functionaries under the Code.

i) Disciplinary Committee:

At the commencement of each academic year, it shall be the responsibility of the Principal to constitute a Disciplinary Committee consisting of not more than 20(twenty) Members. The Principal shall also appoint a senior faculty member to be designated as the Chairperson of the Disciplinary Committee. The Chairperson shall be assisted by a Deputy Chairperson, Senior Advisor and a Convener. The Disciplinary Committee must meet at least twice a month to conduct its business. The Disciplinary Committee will ensure compliance of Regent Education

and Research Foundation Student's Conduct and Disciplinary Code and will recommend suitable action in case of its violation to the Principal/ Dean, Academics.

ii) Head of the Departments/ Teacher In Charge.

As the persons in charge of the Departments, the respective functionaries of all Teaching Departments shall have the power and duty to take immediate action to curb any prohibitory behaviour as envisaged in this code. As these functionaries cannot single handedly manage the entire issues, they can assign part of the work to the teachers and the teachers of all the departments have the responsibility to inform any incident of prohibited behaviour to the Head of the Departments so that any serious issue can be settled before the same goes out of control. The Head of the Departments shall have the power to impose minor sanctions as envisaged in this of this Code. They may also bring any incident to the note of the **Disciplinary Committee** which may recommend imposition of major/minor sanctions as envisaged in this Code. The Head of the Departments while taking any action as envisaged in the code shall do so in an impartial manner and see to it that the sanction imposed/proposed is commensurate with the gravity of the prohibited behaviour. Any lapse on the part of a teacher to report any instance of violence/misconduct/ragging on the part of the students shall be reported to the Principal by the respective Head of the Departments.

ii) Dean, Academics.

Dean, Academics shall have the power to visit/inspect any premises, buildings, or any property of the institute when there is a genuine doubt that any act of prohibited behaviour is taking place. The authority may take any lawful actions to curb such behaviour. The HoDs shall report to the **Dean, Academics** any instances of prohibited behaviour, who in turn shall bring it to the notice of the **Disciplinary Committee for their recommendations**. The **Dean, Academics** shall forward the recommendations of the **Disciplinary Committee** to the Principal after noting his observations.

The Principal/Dean may also *suo moto* recommend action against any student(s) indulging in prohibited behaviour which is brought to his/her notice by the authorities of the institutes.

iii) Principal

The Principal shall be the ultimate authority in imposing major sanctions as envisaged against the students for acts of prohibited behaviour. The Principal can also entertain any appeal from any student (s) aggrieved by the action of any authority of the institute under or subordinate to the Principal and decide the case on merit.

Section 9: Right to Appeal

The student (s) aggrieved by the action of any authority of the institute under or subordinate to the Principal can appeal to the Principal. The decision of the principal shall be final and binding on the students.

Section 10: Assistance from Law Enforcement Agencies

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The Principal and the Dean, **Academics** (with the concurrence of the Principal) shall have the power and duty to call the Police immediately when there is a threat of law and order situation in the Campus and also when there is a genuine apprehension that any incident of rioting, vandalism or any other act prohibited by law is likely to take place. The HoDs/ Chief Administrative Officer shall in such a case give a detailed report to the Principal/Dean.

Section 11: Grievance Redressal Cell (GRC):
The Institute has a "**Grievance Redressal Cell**" where the students can air their grievances. On receipt of any complaint, the GRC shall forward the complaint to the concerned authority for the proper action and Redressal of the complaint.

Section 12: Undertaking by the Students ***
The students joining any academic programme of the institute will have to give an undertaking to the effect that he/she will comply with the provisions envisaged in this Code in letter and spirit and in case it is violated, it will be bound by the provisions of this Code.

Section 13: Opportunity for Hearing
No order other than the order suspending or warning a student shall be passed without giving an opportunity of hearing to the student (s).

Section 14: Ultimate Authority
For all disciplinary matters related to students, the Principal shall be the ultimate authority as provided herein.

Section 15: Amendments to the Code
The Chairman/ (***), **Regent Education and Research Foundation** shall have the power to amend any of the provisions in this Code. The amendments shall be brought to the notice of the students and teachers of the institute immediately.

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Unique features : Mechanical Engineering Department

1. A perfect blend of highly qualified and industry experienced faculties .
2. Prompt and smooth shift to online classes at the onset of the pandemic.
3. Qualified, experienced and affectionate technical assistants who make sure that every student is properly accustomed to the machines, experiments and engineering graphics.
4. Well-equipped Mechanical Workshop and laboratory set up is one of the basic strengths of the department which is catering to regular classes and varieties of student projects.
5. Consistently increasing number (with perfect mix) of students' placement in reputed core sector as well as in IT sector.
6. Glittering alumnus in the leading academics, foreign universities, in multinational organizations, and in other core industries.
7. The department offers several Value-Addition trainings which are designed to bridge the gap between the academia and industry. These include CREO, AutoCAD, Solid Works, ANSYS, Advanced Excel, etc.
8. A sustained training in personality development, soft skill and general & mathematical aptitude to increase employability .
9. Our department possesses some of the best lab facilities such as CNC Lab, Applied Mechanics Lab, Mechanical Workshop, Casting and Foundry Lab, Applied Thermodynamics Lab, Heat Transfer Lab, Fluid Mechanics Lab, Dynamics of Machines Lab, Metrology & Measurement lab, AutoCAD lab, Graphics lab, etc.
10. Industrial visits for students from 5 th semester onwards to enlighten them with the modern developments of the industries.
11. Organizing regular webinars where industrial experts keep the students updated about the latest developments around the world.
12. Effective Mentoring System to establish a healthy relationship between the students and their mentors while catering to the holistic requirements of the students.
13. An active ASME student chapter running successfully.
14. Providing willing students internship and brief visits to local industries.
15. An one-to-one guidance by the Entrepreneurship Development Cell to motivate willing students to pursue successful business models and assisting in setting up of start-ups in collaboration with CII and other local bodies.

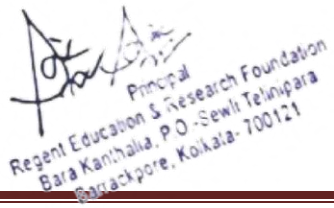
About Us

RERFGI is a renowned educational institution committed to academic excellence and holistic student development.

Civil Engineering (CE) is one of the traditional branches of Engineering and was amongst the founding courses when the institution was started. Civil Engineering Department is working right from the inception of RERF. Since then the department has made continuous progress and development. The department is having highly qualified, experienced and dedicated faculties. All faculties have contribution to technical journals and conferences in Civil Engineering across the globe. Different laboratories from the department are equipped with the modern instruments, machinery and experimental set ups. These laboratories undergo modernization and development so as to be consistent and compatible with professional field requirements.The department has been engaged in various activities involving industry - institute interaction, research and development, updating curriculum, improving teaching / learning process, development of students and services to society etc.

The Department of Computer Science & Engineering is at the forefront of turning out software engineers with a high degree of technical expertise. It fosters the innovation and breadth of vision necessary to excel in the blooming software industry. The experienced faculty exposes budding computer engineers to a rigorous and exhaustive curriculum designed to bring out the best in them and to keep them in touch with the latest state of the art technology. Besides imparting theoretical knowledge, the emphasis is on hands-on training and overall development of the individual personality. Equal importance is given to the classroom learning which is meant primarily for conceptual inputs. The teaching program has been devised keeping in view the need of a close interaction with the industry. The department has excellent computing facilities which include latest technology based computer systems, scanners, servers, multimedia kits, Indy Graphic workstations, etc. The Computer Laboratory maintains adequate number of computers and peripherals of latest configurations for teaching and research work.

Electronics And Communications Engineering (ECE)Department of RERF was started from the year of 2009, It is one of the best teaching and research centres with widespread reputation within the country. Our department is one of the best and prestigious stream in our college ,we obtain higher rank students from JEE. We have experienced faculty members in all subjects and maintaining proper teacher students ratio. We have well-equipped laboratories. Several students who have passed out successfully of this department are holding important positions at such prestigious organization such as Infosys, CTS etc. This department emphasizes technical skills that can be used to help design, develop, install, test and maintain communications systems. Students may begin to pursue career opportunities in a variety of entry-level positions, such as electronics engineering technologist, electronics engineering assistant, engineering sales/service representative, computer systems technologist, technical consultant, telecommunications technician, communication systems installer, field service representative, engineering technician or research technician.



The Electrical Engineering Department is one of the best department of RERF. All the labs of this department are fully equipped with advance level instruments. I want to congratulate all the existing students who are studying in this department as well as I welcome to all the students who will take the admission in this department.

Considering the need of Electrical Engineering, management of RERF started electrical engineering branch since academic year 2009 with the intake capacity of 60. Nowadays, power crises are being faced by all sectors. Government is emphasizing to cope up with the demand of electricity. Industries in various fields are also coming up with the huge demand of electrical engineering aspirants. This all scenario has given the momentum for the opportunities for the electrical engineers. The department has highly qualified and well experienced teaching staff. So far as to make the students practically perfect, the department has well established laboratories with modern equipment so as to provide the full-fledged training to the students. The department has also additional modern equipment apart from regular requirement considering the modern era of industries.

Electrical and electronics engineering is a very important branch of engineering, which has immense scope in practical and applied fields. One of the most advantages for studying in this branch is that the students will be eligible for getting the job in both the fields like Electrical as well as Electronics engineering and we are very happy to provide this stream for giving the combined effects of Electrical and Electronics Engineering among the students since 2009. The students get ample scopes to learn the theoretical part of the subject from the enthusiastic, Knowledgeable and competent faculty members of the department. Besides, they get enough scope for their hands-on training and practice in the practical classes in the well-equipped labs of the department. I take this opportunity to welcome all aspiring undergraduate Electrical and Electronics Engineering students to Electrical & Electronics Engineering Department of Regent Education & Research Foundation.

The Department of Electrical and Electronics Engineering (EEE), is one of the oldest departments at RERF. The department has well qualified; passionate and dedicated staff most of who are engaged in path breaking research and development. The Course at the department, is a healthy amalgam of power engineering, Electronics and Computers; compressive and in keeping modern trends of EEE education. Course pattern at the Department is revised periodically to keep the students up to date with recent trends and keeping them abreast of the shifting technological paradigms making them future and industry ready. The students are required to undergo quizzes in addition to assignments. They are evaluated on regular basis there by making the course learning and just not grade oriented.

Mechanical Engineering is may be the most diverse and multipurpose of the engineering disciplines. In addition to physics and mathematics, it includes key elements of production, electrical, civil, chemical and even materials science and bio-engineering. Mechanical engineering touches almost every aspect of modern life, from mobile phones and biomedical devices, to aircrafts and power plants. Not only engineering, mechanical engineers cope with economic matters, from the cost of a single component, to the economic influence of a manufacturing plant. Besides, Mechanical engineers can also be found in sales, engineering management, and corporate management. Adaptability is another distinctive advantage in a world that is undergoing constant economic, political, industrial, and social change. Mechanical engineers are polished and positioned, not only to adapt, but to define and direct change. Department students are getting ranks at university level almost every year. As a

part of co-curricular activities students of the department are visiting Automotive, Machine Tool and other allied mechanical engineering industries in India. At department of mechanical engineering students are educated not only by teaching- learning but also through the real time projects from industries. Students are involved in R & D projects of the department.

The student of mechanical engineering department will enjoy the best facilities and equipments and essential to learn the frontier technology like mechatronics , automation, CAD/CAM/CIM, Robotics and CNC machine in industrial engineering, teratology and computer graphics, solid modeling ,analysis of synthesis of linkage and laser machining process , NDT etc.in day to come. I congratulate the team of faculty members and the students for their brilliant and original efforts. I wish all the Students and Faculty a great academic career.

Basic Science and Humanities Department

HOD Message

It gives me great pleasure to inform the readers about the department and its extended family. The highly qualified, experienced and dedicated staff members of the Department of Basic Science and Humanities have always stood shoulder with the management and carried out their duties with a level of commitment. The department has a balanced combination of young and experienced faculties. We endow the students with wisdom and knowledge, so that they can contribute our society with their best human qualities and professional expertise. Apart from being a best quality human being, we motivate and educate our students with skills and knowledge so that they can justify with their academic and professional carrier.

About

The Basic Science and Humanities department was established in the year of 2009. It plays a distinctive role in an institute where the culture of Science and Technology prevails. The intend of the department is to provide high quality education in the field of Applied Sciences and Humanities for the undergraduate students in various engineering courses. They are taught about the three fundamental science subjects as well as English. In their curriculum they are encouraged to take up mini projects to supplement theoretical knowledge with practical experience. These projects enable them to understand the relevance of working in a group and also help them to realize the finer aspects and importance of teamwork. To achieve the goal the students are whole heartedly encouraged by not only the BSH faculties but also from other departmental staffs. As a result it is evidently reflected in their participation in various academic, co-curricular, extra-curricular, research & development as well as involvement in various activities of social relevance.

Our Facilities

- **Campus**

Integrated Hi-tech Campus

RERF's flagship project, its 1st Integrated Hi-tech Campus in India, located within Kolkata, West Bengal; the campus is spread over 12 acres of land. The basic infrastructure constitutes modern academic facilities, sports and recreational facilities, total computerization of the different campuses and departments of the Institution with networking facility.

- **Laboratories**

State of the art Laboratories

State of the art Hi-Tech Computer and other laboratories is designed to help students develop effective skills and capabilities in academic and professional settings. These labs focus on work environments and real life situations.

- **Library**

Fully Equipped Library

The library has a vast and comprehensive collection in:

- Science and Engineering Textbooks
- Journals and Magazines
- Books on religion, ethics and political science to enable the students to broaden their perspective.
- No. of Books (Volumes) : 45000

- **Canteen**

Hub of student activity

The cafeteria in the college are the hub of every student activity. Students throng the cafeterias and help themselves to a variety of tasty foods which of course comes at a very nominal rates. College Canteen provides delicious and hygienic food and very affordable prizes. South Indian, North Indian and Chinese Vegetarian foods are available.

Anti Ragging Committee

Objectives of the Committee:
The committee is tasked with the responsibility of furthering the ideals of the UGC Regulation and anyother laws put in place with regards to the menace of ragging by the Governments of India .

Functions of the Committee:

- To Prevent, Prohibit, and Redress any and all forms and instances of Ragging in the College.
- To educate the students on the meaning of ragging and what constitutes it.
- To educate the students on the ill-effects of ragging and the consequences, including legal consequences of indulging in ragging.
- To conduct awareness programmes on the menace of ragging, its impact, consequences and redressal mechanism available.
- To enquire into any instances of ragging that have been reported, and if necessary, take all appropriate action against the students found to have indulged in ragging.
- Assist the Principal and other authorities of RERF if necessary, in notifying the appropriate authorities in cases of ragging.