PERIYAR MANIAMMAI INSTITUTE OF SCIENCE & TECHNOLOGY

PERIYAR MANIAMMAI
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University)
Established Under Sec. 3 of UGC Act, 1956 • NAAC Accredited
think • innovate • transform

Criterion 1 – Curricular Aspects

Key Indicator	1.1	Curriculum Design and Development
Metric	1.1.3	Average percentage of courses having focus on employability/ entrepreneurship/ skill Development offered by the Mechanical engineering

DEPARTMENT OF MECHANICAL ENGINEERING

SYLLABUS COPY OF THE COURSES HIGHLIGHTING THE FOCUS ON EMPLOYABILITY/ ENTREPRENEURSHIP/ SKILL DEVELOPMENT

1. List of courses for the programmes in order of

S. No.	Programme Name
1.	Bachelor of Technology(Mechanical Engineering)(Full Time)
I2.	Master of Technology(Renewable Energy)(Full Time)

2. Syllabus of the courses as per the list.

Legend :

Words highlighted with **Blue Color** - Entrepreneurship

Words highlighted with **Red Color** - Employability

Words highlighted with **Green Color** - Skill Development

1. LIST OF COURSES

Name of the Course	Course Code	Year of Introduction	Activities/Content with direct bearing on Employability/ Entrepreneurship/ Skill development
B.Tech. Mechanical Engineering (Full Time)			
Calculus and Linear Algebra	XMA101	2018-19	Skill Development
Programming for Problem Solving	XCP102	2018-19	Employability
Applied Chemistry for Engineers	XAC103	2018-19	Skill Development
Engineering Graphics and Design	XEG104	2018-19	Skill Development
Speech Communication	XGS105	2021-22	Skill Development
Constitution of India	XUM106	2018-19	Skill Development
Programming for Problem Solving Laboratory	XCP107	2021-22	Employability
Applied Chemistry Laboratory for Engineers	XAC108	2021-22	Skill Development
Calculus, Ordinary Differential Equations and Complex Variables	XMA201	2018-19	Skill Development
Electrical and Electronic Engineering Systems	XBE202	2018-19	Skill Development
Applied Physics for Engineers	XAP203	2018-19	Skill Development
Technical Communication	XGS204	2021-22	Skill Development
Workshop Practices	XWP205	2008-09	Skill Development
Engineering Mechanics	XEM206	2018-19	Skill Development
Electrical and Electronic Engineering Systems Laboratory	XBE207	2018-19	Skill Development
Applied Physics for Engineers Laboratory	XAP208	2018-19	Skill Development
Transforms and Partial Differential Equations	XMA301	2022-23	Skill Development
Thermodynamics	XME302	2018-19	Skill Development
Strength of Materials	XME303	2018-19	Skill Development
Materials Engineering	XME304	2018-19	Skill Development
Machine Drawing	XME305	2021-22	Skill Development
Entrepreneurship Development	XUM306	2022-23	Entrepreneurship
Universal Human Values 2 : Understanding Harmony and gender	XUM307	2022-23	*****
Strength of Materials Laboratory	XME308	2021-22	Skill Development
Computer Aided Drafting Laboratory	XME309	2022-23	*****
In-plant Training - I	XME310	2018-19	Skill Development
Service Robotics with Drives and Sensors	XECHR1	2022-23	Skill Development
Probability Distribution and Statistical Methods	XMA401	2021-22	Skill Development
Applied Thermodynamics	XME402	2018-19	Skill Development

Fluid Mechanics and Fluid Machines	XME403	2018-19	Skill Development
Instrumentation and Control	XME404	2018-19	Skill Development
Economics for Engineers	XUM405	2018-19	Skill Development
Disaster Management	XUM406	2021-22	Skill Development
Thermal Engineering Laboratory	XME407	2021-22	Skill Development
Fluid Mechanics and Fluid Machines Laboratory	XME408	2021-22	Skill Development
Industrial Robotics and Automation	XECHR2	2022-23	Skill Development
Heat Transfer	XME501	2018-19	Skill Development
Solid Mechanics	XME502	2018-19	Skill Development
Manufacturing Processes	XME503	2018-19	Skill Development
Kinematics and Theory of Machines	XME504	2018-19	Skill Development
Professional Elective Course – I		2018-19	*****
Open Elective Course – I		2018-19	*****
Heat Transfer and Refrigeration Laboratory	XME507	2023-24	Skill Development
Kinematics and Theory of Machines Laboratory	XME508	2022-23	Skill Development
In-plant Training – II	XME509	2018-19	Skill Development
Fundamentals of ROS and Embedded in Robotics	XECHR3	2023-24	Skill Development
Artificial Intelligence and Computer Vision for Robotics	XECHR4	2023-24	Skill Development
Manufacturing Technology	XME601	2018-19	Employability
Design of Machine Elements	XME602	2018-19	Employability
Professional Elective Courses - II		2018-19	*****
Open Elective Courses – II		2018-19	*****
Professional Skills	XGS605	2023-24	Skill Development
Cyber Security	XUM606	2018-19	Employability
Machine Tools and Metrology Laboratory	XME607	2023-24	Employability
Tool Design and Drawing Laboratory	XME608	2023-24	Employability
Deep Learning for Robotics	XECHR5	2023-24	Skill Development
Open Elective-I		2018-19	*****
Automation in Manufacturing	XME702	2018-19	Employability
Elective III		2018-19	*****
Elective-IV		2018-19	*****
Elective V		2018-19	*****
Cyber Security	XUM706	2018-19	Employability
Mechanical Engineering Laboratory VI (Special Machines)	XME707	2023-24	Employability
Project phase – I	XME708	2018-19	Employability
Inplant Training – III (30 days)	XME709	2018-19	Skill Development
Non Destructive Testing	XMEM03	2018-19	Employability
Open Elective-II		2018-19	*****

Open Elective-III		2018-19	*****
Elective VI		2018-19	*****
Project phase – II	XME804	2018-19	Employability
M.TECH RENEWABLE ENERGY (FULL TIME)			
Solar Energy Systems	YRE101	2018-19	Employability
Wind, Ocean, Hydro and Geothermal Energy Systems	YRE102	2023-24	Employability
Process Modelling in Energy Systems	YRE103	2023-24	Employability
Professional Elective – I		2018-19	*****
Professional Elective – II		2018-19	*****
Solar Energy Laboratory	YRE106	2022-23	Skill Development
Research Methodology and IPR	YRM107	2018-19	Entrepreneurship/ Skill Development
English for Research Paper Writing	YEGOE1	2018-19	Entrepreneurship/ Skill Development
Process Modelling and Simulation Laboratory	YRE109	2022-23	Skill Development
Bio Energy Systems	YRE201	2018-19	Employability
Computational Fluid Dynamics	YRE202	2018-19	Employability
Electrical Energy Technology	YRE203	2018-19	Employability
Professional Elective – III		2018-19	*****
Professional Elective – IV		2018-19	*****
Computational Fluid Dynamics Laboratory	YRE206	2022-23	Skill Development
Bio Energy Laboratory	YRE207	2022-23	Skill Development
Constitution of India	YPSOE1	2018-19	Employability
Dissertation Phase – I	YRE301	2018-19	Employability/ Entrepreneurship/ Skill Development
Professional Elective - V		2018-19	*****
Open Elective Course		2018-19	*****
Dissertation Phase – II	YRE401	2018-19	Employability/ Entrepreneurship/ Skill Development

2. SYLLABUS
FOR B.TECH MECHANICAL (FT)
ACADEMIC YEAR 2023-24

Semester	**I**
Subject Name	**CALCULUS AND LINEAR ALGEBRA**
Subject Code	**XMA101**

L –T –P –C	C:P:A	L –T –P –H
3- 1 – 0– 4	**3:0.5:0.5**	**3- 1– 0 – 4**

PREREQUISITE: Differentiation and Integration

Course Outcome		Domain/Level C or P or A
CO1	**Apply** orthogonal transformation to reduce quadratic form to canonical forms.	**K1, K3**
CO2	**Apply** power series to tests the convergence of the sequences and series. Half range Fourier sine and cosine series.	**K1, K3**
CO3	**Find** the derivative of composite functions and implicit functions. Euler's theorem and Jacobian	**K1, P3**
CO4	**Explain** the functions of two variables by Taylors expansion, by finding maxima and minima with and without constraints using Lagrangian Method. Directional derivatives, Gradient, Curl and Divergence.	**K1, K2, A1**
CO5	**Apply** Differential and Integral calculus to notions of Curvature and to improper integrals.	**K3**
CO6	Analyze the given sequence is convergent or divergent by using the appropriate tests	**K4**

UNIT I	**Matrices**	**12 HRS**

Linear Transformation - Eigen values and Eigen vectors -Properties of Eigen values and Eigen vectors - Cayley-Hamilton Theorem – Diagonalisation of Matrices – Real Matrices: Symmetric - Skew-Symmetric and Orthogonal Quadratic form – canonical form - Nature of Quadratic form and Transformation of Quadratic form to Canonical form (Orthogonal only).

UNIT II	**Sequences and series**	**12 HRS**

Sequences: Definition and examples-Series: Types and convergence-Series of positive terms – Tests of convergence: comparison test, Integral test and D'Alembert's ratio test-. Fourier series: Half range sine and cosine series- Parseval's Theorem.

UNIT III	**Multivariable Calculus: Partial Differentiation**	**12 HRS**

Limits and continuity –Partial differentiation – Total Derivative – Partial differentiation of Composite Functions: Change of Variables – Differentiation

of an Implicit Function - Euler's Theorem- Jacobian.

UNIT IV	**Multivariable Calculus: Maxima and Minima and Vector Calculus**	**12 HRS**

Taylor's theorem for function of Two variables- Maxima, Minima of functions of two variables: with and without constraints - Lagrange's Method of Undetermined Multipliers – Directional Derivatives - Gradient, Divergence and Curl.

UNIT V	**Differential and Integral Calculus**	**12 HRS**

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.

L = 45 hrs T = 15 hrs P=0 hrs Total = 60 hrs

TEXT BOOKS

1. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill New Delhi, 11th Reprint, 2015**. (Unit-1, Unit-3 and Unit-4).**
2. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, Reprint, 2014. **(Unit-2).**
3. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 40th Edition, 2010. **(Unit-5).**

REFERENCES BOOKS

1. G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", 9th Edition, Pearson, Reprint, 2002.
2. Veerarajan T., "Engineering Mathematics for first year", Tata McGraw-Hill, New Delhi, 2008.
3. D. Poole, "Linear Algebra: A Modern Introduction", 2nd Edition, Brooks/Cole, 2005.
4. Erwin kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.

E REFERENCES

1. https://www.indiabix.com/c-programming/questions-and-answers/
2. https://www.javatpoint.com/c-programming-language-tutorial
3. https://www.w3schools.in/c-tutorial/

Mapping of COs with GA

	GA 1	**GA 2**	**GA 3**	**GA 4**	**GA 5**	**GA 6**	**GA 7**	**GA 8**	**GA 9**	**GA 10**	**GA 11**	**GA 12**
CO 1	3	2			2					1		2
CO 2	3	1								1		1
CO 3	3	1								1		1
CO 4	3	2								1		1
CO 5	3	2			1					1		2
	15	8	0	0	3	0	0	0	0	5	0	7
Scaled Value	3	2			1					1		

1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3

1 - Low, 2 – Medium, 3- High

Semester	**I**
Subject Name	**PROGRAMMING FOR PROBLEM SOLVING**
Subject Code	**XCP102**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	***Define*** programming fundamentals and ***Solve*** simple programs using I/O statements	**K1, K2, K3**
CO2	***Define*** syntax and ***write simple programs*** using control structures and arrays	**K1, K2, K3**
CO3	***Explain*** and ***write simple programs*** using functions and pointers	**K1, K2, K3**
CO4	***Explain*** and ***write simple programs*** using structures and unions	**K1, K2, K3**
CO5	***Explain*** and ***write simple programs*** using files and ***Build*** simple projects	**K1, K2, K3**

The objective of this course

- To learn programming language basics and syntax
- To ignite logical thinking
- To understand structured programming approach
- To deal with user defined data types
- To know about data storage in secondary memory

COURSE CONTENT

UNIT I	**PROGRAMMING FUNDAMENTALS AND I/O STATEMENTS**	**9HRS**

Introduction to components of a computer system, Program – Flowchart – Pseudo code – Software – Introduction to C language – Character set – Tokens: Identifiers, Keywords, Constants, and Operators – sample program structure -Header files – Data Types- Variables - Output statements – Input statements.

UNIT II	**CONTROL STRUCTURE AND ARRAYS**	**9HRS**

Control Structures – Conditional Control statements: Branching, Looping - Unconditional control structures: switch, break, continue, goto statements – Arrays: One Dimensional Array – Declaration – Initialization – Accessing

Array Elements – Searching – Sorting – Two Dimensional arrays - Declaration – Initialization – Matrix Operations – Multi Dimensional Arrays - Declaration – Initialization. Storage classes: auto – extern – static. Strings: Basic operations on strings.

UNIT III **FUNCTIONS AND POINTERS** **9HRS**

Functions: Built in functions – User Defined Functions - Parameter passing methods - Passing arrays to functions – Recursion - Programs using arrays and functions. Pointers - Pointer declaration - Address operator - Pointer expressions & pointer arithmetic - Pointers and function - Call by value - Call by Reference - Pointer to arrays - Use of Pointers in self-referential structures- Notion of linked list

UNIT IV **STRUCTURES AND UNIONS** **9HRS**

Structures and Unions - Giving values to members - Initializing structure - Functions and structures - Passing structure to elements to functions - Passing entire function to functions - Arrays of structure - Structure within a structure and Union.

UNIT V **FILES** **9HRS**

File management in C - File operation functions in C - Defining and opening a file - Closing a file - The getw and putw functions - The fprintf & fscanf functions - fseek function – Files and Structures.

L = 45 hrs T = 0 hrs P=0 hrs Total = 45 hrs

TEXT BOOKS

1. Byron Gottfried, "Programming with C", III Edition, (Indian Adapted Edition), TMH publications, 2010
2. Yeshwant Kanethker, “Let us C”, BPB Publications, 2008

REFERENCES BOOKS

1. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill, 7th edition 2017.
2. Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", Pearson Education Inc. 2005
3. Johnson baugh R. and Kalin M., “Applications Programming in ANSI C”, III Edition, Pearson Education India, 2003

E REFERENCES

1. https://www.indiabix.com/c-programming/questions-and-answers/
2. https://www.javatpoint.com/c-programming-language-tutorial
3. https://www.w3schools.in/c-tutorial/

Mapping of COs with PO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO 12	PSO 1	PSO 2
CO 1	3	2	0	0	3	0	0	0	0	0	2	3	2	0
CO 2	3	2	0	0	2	0	0	0	0	0	2	3	2	0
CO 3	2	2	1	2	2	0	0	0	0	0	2	2	2	0

CO 4	2	2	1	2	2	0	0	0	0	0	2	2	2	0
CO 5	2	2	1	0	2	0	0	1	0	2	2	2	2	0
Total	12	10	3	4	11	0	0	1	0	2	10	12	10	0

1 - Low, 2 – Medium, 3- High

Semester	**I**
Subject Name	**APPLIED CHEMISTRY FOR ENGINEERS**
Subject Code	**XAC103**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 1 – 0– 4	**2.5:1:0.5**	**3- 1– 0 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	***Identify***the periodic properties such as ionization energy, electron affinity, oxidation states and electro negativity. ***Describe*** the various water quality parameters like hardness and alkalinity.	**K1, P1**
CO2	***Explain*** *and* ***Measure*** microscopic chemistry in terms of atomic, molecular orbitals and intermolecular forces.	**K2, P2**
CO3	***Interpret*** bulk properties and processes using thermodynamic and kinetic considerations.	**K3, P4, A1**
CO4	***Describe, Illustrate*** *and* ***Discuss*** the chemical reactions that are used in the synthesis of molecules.	**K1, K4, P1, A2**
CO5	***Apply, Measure*** and ***Distinguish*** the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques	**K1, K3, P4**

The objective of this course

- Understand the application of chemistry in engineering.

COURSE CONTENT

UNIT I PERIODIC PROPERTIES AND WATER CHEMISTRY 11 HRS

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. **Water Chemistry**-Water quality parameters-Definition and explanation of hardness, determination of hardness by EDTA method-Introduction to

alkalinity.

UNIT II	USE OF FREE ENERGY IN CHEMICAL EQUILIBRIA	15 HRS

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. Corrosion-Types, factors affecting corrosion rate and Control methods. Use of free energy considerations in metallurgy through Ellingham diagrams. Advantages of electroless plating, electroless plating of nickel and copper on Printed Circuit Board (PCB).

UNIT III	ATOMIC AND MOLECULAR STRUCTURE	13 HRS

Schrodinger equation. Particle in a box solution and their applications for conjugated molecules and nanoparticles.. Molecular orbitals of diatomic molecules and plots of the multicenter orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic molecules. 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.

Intermolecular forces and potential energy surfaces

Ionic, dipolar and Vander waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H_3, H_2F and HCN and trajectories on these surfaces.

UNIT IV	SPECTROSCOPIC TECHNIQUES AND APPLICATIONS	10 HRS

Principles of spectroscopy and selection rules. Electronic spectroscopy-chromophore, auxochromes, types of electronic transition and application. Fluorescence and its applications in medicine. Vibrational spectroscopy-types of vibrations, Instrumentation and applications. Rotational spectroscopy of diatomic molecules. Nuclear magnetic resonance spectroscopy-concept of chemical shift and applications-magnetic resonance imaging. Diffraction and scattering.

UNIT V	STEREOCHEMISTRY AND ORGANIC REACTIONS	11 HRS

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

Organic reactions and synthesis of a drug molecule

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

L = 45 hrs T = 15 hrs P=0 hrs Total = 60 hrs

TEXT BOOKS

1. Puri B.R. Sharma, L.R., Kalia K.K. Principles of Inorganic Chemistry, (23rd edition), New Delhi, Shoban Lal Nagin Chand & Co., 1993.
2. Lee. J.D. Concise Inorganic Chemistry, UK, Black well science, 2006.
3. Trapp. C, Cady, M. Giunta. C, Atkins's Physical Chemistry, 10th Edition, Oxford publishers, 2014.
4. Glasstone S., Lewis D., Elements of Physical Chemistry, London, Mac Millan & Co.

Ltd, 1983.
5. Morrison R.T. and Boyd R.N. Organic Chemistry (6th edition), New York, Allyn& Bacon Ltd., 1976.
6. Banwell. C.N, Fundamentals of Molecular Spectroscopy, (3th Edition), McGraw-Hill Book Company, Europe 1983.
7. Bahl B.S. and Arun Bahl, Advanced Organic Chemistry, (4th edition), S./ Chand & Company Ltd. New Delhi, 1977.
8. P. S. Kalsi, Stereochemistry: Conformation and mechanism, (9th Edition), New Age International Publishers, 2017.

REFERENCES BOOKS

1. Puri B R Sharma L R and Madan S Pathania, "Principles of Physical Chemistry", Vishalpublishing Co., Edition 2004.
2. Kuriocose, J C and Rajaram, J, "Engineering Chemistry", Volume I/II, Tata McGraw-Hill Publishing Co. Ltd. New Delhi, 2000.

E REFERENCES

1. http://www.mooc-list.com/course/chemistry-minor-saylororg
2. https://www.canvas.net/courses/exploring-chemistry
3. http://freevideolectures.com/Course/2263/Engineering-Chemistry-I
4. http://freevideolectures.com/Course/3001/Chemistry-I
5. http://freevideolectures.com/Course/3167/Chemistry-II
6. http://ocw.mit.edu/courses/chemistry/

Mapping of COs with PO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO 12	PSO 1	PSO 2
CO 1	3	0	0	0	0	0	2	3	3	0	0	0	0	0
CO 2	2	0	0	0	0	0	1	2	2	0	0	0	0	0
CO 3	3	0	0	0	0	0	2	3	3	0	0	0	0	0
CO 4	3	0	0	0	0	0	3	3	3	0	0	0	0	0
CO 5	3	0	0	0	0	0	2	2	3	0	0	0	0	0
Total	13	0	0	0	0	0	10	13	14	0	0	0	0	0

1 - Low, 2 – Medium, 3- High

Semester	**I**
Subject Name	**Engineering Graphics and Design**
Subject Code	**XEG104**

L –T –P –C	**C:P:A**	**L –T –P –H**
1- 0 – 2– 3	**1.75:1:0.25**	**1- 0– 4 – 5**

Course Outcome		**Domain/Level C or P or A**
CO1	***Apply*** the national and international standards, ***construct*** and ***practice*** various curves	Cognitive (Apply) Psychomotor (Guided response) Affective (Responds to Phenomena)
CO2	***Interpret, construct*** **and** ***practice*** orthographic projections of points, straight lines and planes.	Cognitive (Understand) Psychomotor (Mechanism) Affective (Responds to Phenomena)
CO3	***Construct Sketch*** **and** ***Practice*** projection of solids in various positions and true shape of sectioned solids.	Cognitive (Apply) Psychomotor (Complex over response) Affective (Responds to phenomena)
CO4	***Interpret, Sketch*** **and** ***Practice*** the development of lateral surfaces of simple and truncated solids, intersection of solids.	Cognitive (Understand) Psychomotor (Complex over response) Affective (Responds to phenomena)

CO5	***Construct sketch* and *practice*** isometric and perspective views of simple and truncated solids.	Cognitive (Apply) Psychomotor (Complex over response) Affective (Responds to phenomena)

Objectives:

- to prepare the student to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- to prepare the student to communicate effectively
- to prepare the student to use the techniques, skills, and modern engineering tools necessary for engineering practice

COURSE CONTENT

UNIT I	**INTRODUCTION, FREE HAND SKETCHING OF ENGG OBJECTS AND CONSTRUCTION OF PLANE CURVE**	**12+6 hrs**
	Importance of graphics in engineering applications – use of drafting instruments – BIS specifications and conventions as per SP 46-2003. Pictorial representation of engineering objects – representation of three dimensional objects in two dimensional media – need for multiple views – developing visualization skills through free hand sketching of three dimensional objects. Polygons & curves used in engineering practice – methods of construction – construction of ellipse, parabola and hyperbola by eccentricity method – cycloidal and involute curves – construction – drawing of tangents to the above curves. Practice on basic tools of CAD	
UNIT II	**PROJECTION OF POINTS, LINES AND PLANE SURFACES**	**12+6 hrs**
	General principles of orthographic projection – first angle projection – layout of views – projections of points, straight lines located in the first quadrant – determination of true lengths of lines and their inclinations to the planes of projection – traces – projection of polygonal surfaces and circular lamina inclined to both the planes of projection-CAD practice on points and lines	
UNIT III	**PROJECTION OF SOLIDS AND SECTIONS OF SOLIDS**	**12+6 hrs**
	Projection of simple solids like prism, pyramid, cylinder and cone when the axis is inclined to one plane of projection – change of position & auxiliary projection methods – sectioning of above solids in simple vertical positions by cutting plane inclined to one reference plane and perpendicular to the other and above solids in inclined position with cutting planes parallel to one reference plane – true shapes of sections-CAD practice on solid models	
UNIT IV	**DEVELOPMENT OF SURFACES AND INTERSECTION OF SOLIDS**	**12+6 hrs**
	Need for development of surfaces – development of lateral surfaces of simple and truncated solids – prisms, pyramids, cylinders and cones – development of lateral surfaces of the above solids with square and circular cutouts	

perpendicular to their axes – intersection of solids and curves of intersection – prism with cylinder, cylinder & cylinder, cone & cylinder with normal intersection of axes and with no offset-CAD practice on intersection of solids.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 12+6 hrs

Principles of isometric projection – isometric scale – isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones – principles of perspective projections – projection of prisms, pyramids and cylinders by visual ray and vanishing point methods-CAD practice on isometric view

L = 30 hrs T = 0 hrs P=60 hrs Total = 90 hrs

TEXT BOOKS

1. Bhatt,N.D, "Engineering Drawing", Charotar Publishing House, 46th Edition-2003.
2. Natarajan,K.V, " A Textbook of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2006 .
3. Dr. P.K. Srividhya, P. Pandiyaraj, "Engineering Graphics", PMU Publications, Vallam, 2013

REFERENCES

1. Luzadder and Duff, "Fundamentals of Engineering Drawing" Prentice Hall of India PvtLtd, XI Edition - 2001.
2. Venugopal,K. and Prabhu Raja, V., "Engineering Graphics", New Age International(P) Ltd., 2008.
3. Gopalakrishnan.K.R,. "Engineering Drawing I & II", Subhas Publications, 1998.
4. Shah,M.B and Rana,B.C.,"Engineering Drawing", Pearson Education,2005.

E-REFERENCES

1. http://periyarnet/Econtent
2. http://nptel.ac.in/courses/112103019/

Mapping of COs with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	2	3	1	1	2	3	3	3	
CO2	3	3	3	1	3	1	3	1	1	1	2	3	3	
CO3	3	3	3	1	3	1	3	1	1	1	2	3	3	
CO4	3	3	3	1	3	1	3	1	1	1	2	3	3	
CO5	3	3	3	1	3	1	3	1	1	1	2	3	3	
Total	15	15	15	6	15	6	15	5	5	6	11	15	15	

1 - Low, 2 – Medium, 3- High

Semester	**I**
Subject Name	**XGS105**
Subject Code	**SPEECH COMMUNICATION**

L –T –P –C	**C:P:A**	**L –T –P –H**
0- 1 – 2– 3	**2.6:0.4:0**	**0- 1– 4 – 5**

Course Outcome		**Domain/Level C or P or A**
CO1	***Ability*** to recall the types of speeches	**K1**
CO2	***Apply*** the techniques in public speaking	**K3**
CO3	***Identify*** the common patterns in organizing a speech	**K1**
CO4	***Construct*** the nature and style of speaking	**K6**
CO5	***Practicing*** the speaking skills	**P3**
CO6	***Apply*** the techniques everyday life	**K3**

COURSE CONTENT

UNIT I	**Types of Speeches**	**9 HRS**

1.1 – Four types of speeches
1.2 – Analyzing the audience
1.3 - Developing ideas and supporting materials

UNIT II	**Public Speaking**	**9 HRS**

2.1 - Introduction to Public Speaking
2.2 - Competencies Needed for successful speech making
2.3 – Speaking about everyday life situations

UNIT III	**Organization of Speech**	**9 HRS**

3.1 – Developing a speech out line
3.2 - Organizing the speech
3.3 – Introduction - development – conclusion

UNIT IV	**Presentation**	**9 HRS**

4.1 - Tips for preparing the draft speech
4.2 – Presentation techniques using ICT tools
4.3 – Using examples from different sources

UNIT V	**Activities**	**9 HRS**

5.1 – Reading activities
5.2 – Creative presentations
5.3 – Media presentation techniques

L = 45 hrs T = 0 hrs P=0 hrs Total = 45 hrs

Suggested Readings:

(i) Michael Swan. *Practical English Usage.* OUP. 1995
(ii) Sanjay Kumar and Pushp Lata. *Communication Skills*. Oxford University Press. 2011

Semester	**I**
Subject Name	**CONSTITUTION OF INDIA**
Subject Code	**XUM106**

L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 0– 0	**0:0:0**	**3- 0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	**To Study** History of Constitution	**K2**
CO2	**To Explain** the Union Executive	**K1**
CO3	**To Identify** the concept of Union Legislature	**K3**
CO4	**To Analysis** the Union Judiciary	**K4**
CO5	**To Explain** the Centre State Relation	**K5**

COURSE CONTENT

UNIT I		**8 HRS**

Constitutional History- The Constitutional Rights- Preamble- Fundamental Rights- Fundamental Duties- Directive principles of State Policy.

UNIT II **9 HRS**

The Union Executive- The President of India (powers and functions)- Vice-President of India-The Council of Ministers-Prime Minister- Powers and Functions.

UNIT III **10 HRS**

Union Legislature- Structure and Functions of Lok Sabha- Structure and Functions of Rajya Sabha- Legislative Procedure in India- Important Committes of Lok Sabha- Speaker of the Lok Sabha

UNIT IV **9 HRS**

The Union Judiciary- Powers of the Supreme Court- Original Jurisdiction- Appelete jurisdictions- Advisory Jurisdiction- Judicial review.

UNIT V **9 HRS**

Centre State relations- Political Parties- Role of governor, powers and functions of Chief Minister-Legislative Assembly- State Judiciary- Powers and Functions of the High Courts.

L = 45 hrs T = 0 hrs P=0 hrs Total = 45 hrs

REFERENCES BOOKS

1. W.H.Morris Shores- Government and politics of India, NewDelhi,B.1.Publishers,1974.
2. M.V.Pylee- Constitutional Government in India, Bombay, Asia Publishing House, 1977.
3. R.Thanker- The Government and politics of India, London:Macmillon, 1995.
4. A.C.Kapur- Select Constitutions S,Chand & Co.,NewDelhi, 1995
5. V.D.Mahajan- Select Modern Governments,S,Chand &Co, NewDelhi,1995.
6. B.C.Rout- Democractic Constitution of India.
7. Gopal K.Puri- Constitution of India, India 2005.

Mapping of COs with PO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO 12	PSO 1	PSO 2
CO 1	2			1										
CO 2	2			1										
CO 3	2			1					1					
CO 4	2			1				1	1					

CO 5	2	2		1				1	1					
Total	10	2		5				2	3					

1 - Low, 2 – Medium, 3- High

Semester	**I**
Subject Name	**Programming for Problem Solving Laboratory**
Subject Code	**XCP107**

L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 1– 1	**0.75:0.25:0**	**0- 0– 2 – 2**

Course Outcome		**Domain/Level C or P or A**
CO1	***Solve*** simple programs using I/O statements	**K3, A2**
CO2	***Solve*** programs using control structures and arrays	**K3, A2**
CO3	***Solve*** programs using functions and pointers	**K3, A2**
CO4	***Solve*** programs using structures	**K3, A2**
CO5	***Solve*** programs using files	**K3, A2**
CO6	***Solve*** simple programs using I/O statements	**K3, A2**

COURSE OBJECTIVES

- To learn programming language basics and syntax

- To ignite logical thinking
- To understand structured programming approach
- To deal with user defined data types
- To know about data storage in secondary memory

COURSE CONTENT

EXP.NO	TITLE	CO RELATION
1	Program to display a Leave Letter as per proper format	**CO1**
2	i. Program for addition of two numbers ii. Program to solve any mathematical formula.	**CO1**
3	Program to find greatest of 3 numbers using Branching Statements	**CO2**
4	Program to display divisible numbers between n1 and n2 using looping Statement	**CO2**
5	Program to search an array element in an array.	**CO2**
6	Program to find largest / smallest element in an array.	**CO2**
7	Program to perform string operations.	**CO3**
8	Program to find area of a rectangle of a given number use four function types.	**CO3**
9	Programs to pass and receive array and pointers using four function types	**CO3**
10	Programs using Recursion for finding factorial of a number	**CO3**
11	Program to read and display student mark sheet of a student structures with variables	**CO4**
12	Program to read and display student marks of a class using structures with arrays	**CO4**
13	Program to create linked list using structures with pointers	**CO4**
14	Program for copying contents of one file to another file.	**CO5**
15	Program using files to store and display student mark list of a class using structures with array	**CO5**

TOTAL – 30 HRS

TEXT BOOKS

1. Byron Gottfried, "Programming with C", III Edition, (Indian Adapted Edition), TMH publications, 2010
2. Yeshwant Kanethker, “Let us C”, BPB Publications, 2008

REFERENCES

1. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill, 7th edition 2017.
2. Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", Pearson Education Inc. 2005
3. Johnson baugh R. and Kalin M., “Applications Programming in ANSI C”, III Edition, Pearson Education India, 2003

E RESOURCES

1. https://www.indiabix.com/c-programming/questions-and-answers/
2. https://www.javatpoint.com/c-programming-language-tutorial
3. https://www.w3schools.in/c-tutorial/

Mapping of COs with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	P O9	P O1 0	PO1 1	P O1 2	PS O1	PS O2
CO1	3	2	0	0	3	0	0	0	0	0	2	3	2	0
CO2	3	2	0	0	2	0	0	0	0	0	2	3	2	0
CO3	2	2	1	2	2	0	0	0	0	0	2	2	2	0
CO4	2	2	1	2	2	0	0	0	0	0	2	2	2	0
CO5	2	2	1	0	2	0	0	1	0	2	2	2	2	0
Total	12	10	3	4	11	0	0	1	0	2	10	12	10	0

1 - Low, 2 – Medium, 3- High

Semester	**I**	
Subject Name	**APPLIED CHEMISTRY LABORATORY FOR ENGINEERS**	
Subject Code	**XAC108**	
L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 1– 1	**0.25:0.5:0.25**	**0- 0– 2 – 2**

Course Outcome		**Domain/Level C or P or A**
CO1	Ability to Identify the principles of chemistry relevant to the study of science and engineering	**K1, P1**
CO2	Analyze and Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, extent of hardness, chloride content of water, etc.	**K4, P1, A1**
CO3	Analyze the synthetic procedure and rate constants of reactions from concentration of reactants/products as a function of time	**K3**

COURSE CONTENT

EXP.NO	TITLE	CO RELATION
1	Determination of chloride ion present in the water sample by Argentometric method.	**CO1**
2	Determination of total, temporary and permanent hardness of water sample by EDTA method.	**CO1**
3	Determination of cell constant and conductance of solutions.	**CO2**
4	Potentiometry - determination of redox potentials and emfs.	**CO2**
5	Determination of surface tension and viscosity.	**CO3**
6	Adsorption of acetic acid by charcoal.	**CO3**
7	Determination of the rate constant of a reaction.	**CO4**
8	Estimation of iron by colorimetric method.	**CO4**
9	Synthesis of a polymer/drug.	**CO5**
10	Saponification/acid value of oil.	**CO5**

TOTAL – 30 HRS

TEXT BOOKS

Laboratory Manual "ChemistryLab", Department of Chemistry, PMIST, Thanjavur.

REFERENCES

1. Mendham, Denney R.C,. Barnes J.D and Thomas N.J.K., "Vogel's Textbook of Quantitative Chemical Analysis", 6th Edition, Pearson Education, 2004.
2. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. "Experiments in Physical Chemistry", 8th Ed.; McGraw-Hill: New York, 2003.

E-RESOURCES- MOOC's

1. http://freevideolectures.com/Course/2380/Chemistry-Laboratory-Techniques
2. http://ocw.mit.edu/courses/chemistry/5-301-chemistry-laboratory-techniques
3. http://freevideolectures.com/Course/2941/Chemistry-1A-General-Chemistry-Fall-2011

Mapping of COs with PO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3	3	2	3	3	0	1	1	1	0	0	0
CO 2	2	2	2	2	1	2	2	1	1	1	1	1	1	1
CO 3	2	2	2	2	1	2	2	0	1	1	0	0	0	0
Total	7	7	7	7	4	7	7	1	3	3	2	1	1	1

1 - Low, 2 – Medium, 3- High

Semester	**II**
Subject Name	**CALCULUS, ORDINARY DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLE**
Subject Code	**XMA201**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 1 – 0– 4	**3:0.5:0.5**	**3- 1– 0 – 4**

PREREQUISITE: Calculus and Linear Algebra

Course Outcome		**Domain/Level C or P or A**
CO1	**Find** double and triple integrals and to find line, surface and volume of an integral by **Applying** Greens, Gauss divergence and Stokes theorem.	**K1, K3**
CO2	**Solve** first order differential equations of different types which are solvable for p, y, x and Clairaut's type.	**K3**
CO3	**Solve** Second order ordinary differential equations with variable coefficients using various methods.	**K3**
CO4	**Use** CR equations to verify analytic functions and to find Harmonic functions and harmonic conjugate. Conformal mapping of translation and rotation. Mobius transformation.	**K1, K3, P3**
CO5	**Apply** Cauchy residue theorem to evaluate contour integrals involving sine and cosine function and to state Cauchy integral formula, Liouvilles theorem. Taylor's series, zeros of analytic functions, singularities, Laurent's series.	**K3, A1**
CO6	**Analyze** the inter-relationship amongst the line integral, double and triple integral.	**K4**

UNIT I	**Multivariable Calculus (Integration)**	**12 HRS**
	Multiple Integration: Double integrals (Cartesian) - change of order of integration in double integrals - Change of variables (Cartesian to polar) - Triple integrals (Cartesian), Scalar line integrals - vector line integrals - scalar surface integrals - vector surface integrals - Theorems of Green, Gauss and Stokes.	
UNIT II	**First order ordinary differential equations**	**12 HRS**
	Exact - linear and Bernoulli's equations - Euler's equations - Equations not of first degree: equations solvable for p - equations solvable for y- equations solvable for x and Clairaut's type.	
UNIT III	**Ordinary differential equations of higher orders**	**12 HRS**

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.

UNIT IV **Complex Variable – Differentiation** **12 HRS**

Differentiation-Cauchy-Riemann equations- analytic functions-harmonic functions-finding harmonic conjugate- elementary analytic functions (exponential, trigonometric, logarithm) and their properties- Conformal mappings- Mobius transformations and their properties.

UNIT V **Complex Variable – Integration** **12 HRS**

Contour integrals - Cauchy-Goursat theorem (without proof) - Cauchy Integral formula (without proof)-Liouville's 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.

L = 45 hrs T = 15 hrs P=0 hrs Total = 60 hrs

TEXT BOOKS

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 40thth Edition, 2008.

REFERENCES BOOKS

1.G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", 9th Edition, Pearson, Reprint, 2002.
2. Erwin kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.
3.W. E. Boyce and R. C. DiPrima, "Elementary Differential Equations and Boundary Value Problems", 9thEdn. Wiley India, 2009.
4. S. L. Ross, "Differential Equations", 3rd Ed., Wiley India, 1984.
5.E. A. Coddington, "An Introduction to Ordinary Differential Equations", Prentice Hall India, 1995.
6. E. L. Ince, "Ordinary Differential Equations", Dover Publications, 1958.
7.J. W. Brown and R. V. Churchill, "Complex Variables and Applications", 7th Ed., McGraw Hill, 2004.
8. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, Reprint, 2008.

Mapping of COs with GA

	GA 1	GA 2	GA 3	GA 4	GA 5	GA 6	GA 7	GA 8	GA 9	GA1 0	GA1 1	GA1 2
CO 1	3	2			2					1		2
CO 2	3	1								1		1
CO 3	3	1								1		1

CO 4	3	2								1		1
CO 5	3	2			1					1		2
	15	8	0	0	3	0	0	0	0	5	0	7
Scaled Value	3	2			1					1		

1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3 ***1 - Low, 2 – Medium, 3- High***

Semester	**II**
Subject Name	**ELECTRICAL AND ELECTRONICS ENGINEERING SYSTEMS**
Subject Code	**XBE202**

L –T –P –C	C:P:A	L –T –P –H
3- 1– 0– 4	3:1:0	3- 1– 0 – 4

Course Outcome		Domain/Level C or P or A
CO1	**Define and Relate** the fundamentals of electrical parameters and **build** and **explain** AC, DC circuits by Using measuring devices	K2
CO2	**Define and Explain** the operation of DC and AC machines.	K2
CO3	**Recall and Illustrate** various semiconductor devices and their applications and displays the input output characteristics of basic semiconductor devices.	K2
CO4	**Relate and Explain the** number systems and logic gates. **Construc**t the different digital circuit.	K2
CO5	**Label and Outline the** different types of microprocessors and their applications.	K2

COURSE CONTENT

UNIT I	**FUNDAMENTALS OF DC AND AC CIRCUITS, MEASUREMENTS**	**12 HRS**
	Fundamentals of DC– Ohm's Law – Kirchhoff's Laws - Sources - Voltage and Current Relations –Star/Delta Transformation - Fundamentals of AC – Average Value, RMS Value, Form Factor - AC power and Power Factor, Phasor Representation of sinusoidal quantities, Simple Series, Parallel, Series Parallel Circuit - Operating Principles of Moving coil and Moving Iron Instruments (Ammeter, Voltmeter) and Dynamometer type meters (Watt meter and Energy meter).	
UNIT II	**ELECTRICAL MACHINES**	**12 HRS**
	Construction, Principle of Operation, Basic Equations, Types and Application of DC Generators, DC motors - Basics of Single-Phase Induction Motor and Three Phase Induction Motor- Construction, Principle of Operation of Single-Phase Transformer, Three phase transformers, Auto transformer.	
UNIT III	**SEMICONDUCTOR DEVICES**	**12 HRS**
	Classification of Semiconductors, Construction, Operation and Characteristics: PN Junction Diode – Zener Diode, PNP, NPN Transistors, Field Effect Transistors and Silicon Controlled Rectifier – Applications	
UNIT IV	**DIGITAL ELECTRONICS**	**12 HRS**
	Basic of Concepts of Number Systems, Logic Gates, Boolean Algebra, Adders, Subtractors, multiplexer, demultiplexer, encoder, decoder, Flipflops, Up/Down counters, Shift Registers.	
UNIT V	**MICROPROCESSORS**	**12 HRS**
	Architecture, 8085, pin diagram of 8085, ALU timing and control unit, registers, data and address bus, timing and control signals, Instruction types, classification of instructions, addressing modes, Interfacing Basics: Data transfer concepts – Simple Programming concepts.	

L = 45 hrs T = 15 hrs P=0 hrs Total = 60 hrs

TEXT BOOKS

1. Metha V.K, Rohit Mehta, 2020. Principles of Electronics,12th ed, S Chand Publishing.
2. Albert Malvino, David J.Bates., 2017. Electronics Principles. 7th ed, Tata McGraw-Hill. New
Delhi.
3. Rajakamal, 2014. Digital System-Principle & Design. 2nd ed. Pearson education.
4. Morris Mano, 2015. Digital Design. Prentice Hall of India.
5. Ramesh, S. Gaonkar, 2013, Microprocessor Architecture, Programming and its Applications with the 8085, 6th ed , India: Penram International Publications.

REFERENCES BOOKS

1. Cotton, H.,2005 Electrical Technology. CBS Publishers & Distributors Pvt Ltd.
2. Syed, A. Nasar, 1998, Electrical Circuits. Schaum Series.
3. Jacob Millman and Christos, C. Halkias, 1967, Electronics Devices, New Delhi: Tata McGraw- Hill.
4. Millman, J. and Halkias, C. C., 1972. Integrated Electronics: Analog and Digital Circuits and
Systems, Tokyo: McGraw-Hill, Kogakusha Ltd.
5. Mohammed Rafiquzzaman, 1999. Microprocessors - Theory and Applications: Intel and Motorola. Prentice Hall International.

E REFERENCES

1. NTPEL, Basic Electrical Technology (Web Course), Prof. N. K. De, Prof. T. K. Bhattacharya
and Prof. G.D. Roy, IIT Kharagpur.
2. Prof.L.Umanand, http://freevideolectures.com/Course/2335/Basic-Electrical-Technology#, IISc Bangalore.
3. http://nptel.ac.in/Onlinecourses/Nagendra/, Dr. Nagendra Krishnapura, IIT Madras.
4. Dr.L.Umanand, http://www.nptelvideos.in/2012/11/basic-electrical-technology.html, IISC Bangalore.

Mapping of COs with PO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO 12	PSO 1	PSO 2
CO 1	3	3	1	1	1	1			1	1	1			
CO 2	3	3	1	1	1	1			1	1	1			
CO 3	2	2	2	1	2	2	1	1	1	1	1			
CO 4	2	2	1	1	1	1	1	1	1	1	1			
CO 5	2	2	1	1	1	1	1	1	1	1	1			
Total	12	12	6	5	6	6	3	3	5	5	5			

1 - Low, 2 – Medium, 3- High

Semester	**II**
Subject Name	**APPLIED PHYSICS FOR ENGINEERS**
Subject Code	**XAP203**

L –T –P –C	C:P:A	L –T –P –H
3- 1 – 0– 4	**2.8:0.8:0.4**	**3- 1– 0 – 4**

PREREQUISITE: Basic Physics in HSC level

Course Outcome		**Domain/Level C or P or A**
CO1	***Identify*** the basics of mechanics, ***explain*** the principles of elasticity and ***determine*** its significance in engineering systems and technological advances.	**K1,K2 P4**
CO2	***Illustrate*** the laws of electrostatics, magneto-statics and electromagnetic induction; ***use*** and ***locate*** basic applications of electromagnetic induction to technology.	**K1 , K4 P4 A1**
CO3	***Understand*** the fundamental phenomena in optics by measurement and ***describe*** the working principle and application of various lasers and fibre optics.	**K2, K3 P4 A1**
CO4	***Analyse*** energy bands in solids, ***discuss*** and ***use*** physics principles of latest technology using semiconductor devices.	**K2,K4 P4 A1**
CO5	***Develop*** Knowledge on particle duality and ***solve*** Schrodinger equation for simple potential.	**K2, K3**

UNIT I MECHANICS OF SOLIDS — 12 HRS

Mechanics: Force - Newton's laws of motion - work and energy - impulse and momentum - torque - law of conservation of energy and momentum - Friction.
Elasticity: Stress - Strain - Hooke's law - Stress strain diagram - Classification of elastic modulus - Moment, couple and torque - Torsion pendulum - Applications of torsion pendulum - Bending of beams - Experimental determination of Young's modulus: Uniform bending and non-uniform bending.

UNIT II ELECTROMAGNETIC THEORY — 12 HRS

Laws of electrostatics - Electrostatic field and potential of a dipole; Dielectric Polarisation, Dielectric constant, internal field - Clausius Mossotti Equation - Laws of magnetism - Ampere's Faraday's law; Lenz's law - Maxwell's equation - Plane electromagnetic waves; their transverse nature - expression for plane, circularly and elliptically polarized light - quarter and half wave plates - production and detection of plane, circularly and elliptically polarized light.

UNIT III OPTICS, LASERS AND FIBRE OPTICS — 12 HRS

Optics: Dispersion- Optical instrument: Spectrometer - Determination of refractive index and dispersive power of a prism- Interference of light in thin films: air wedge - Diffraction: grating.
LASER: Introduction - Population inversion -Pumping - Laser action - Nd-YAG laser - CO_2 laser - Applications
Fibre Optics: Principle and propagation of light in optical fibre - Numerical

aperture and acceptance angle - Types of optical fibre - Fibre optic communication system (Block diagram).

UNIT IV **SEMICONDUCTOR PHYSICS** **12 HRS**

Semiconductors: Energy bands in solids - Energy band diagram of good conductors, insulators and semiconductors - Concept of Fermi level - Intrinsic semiconductors - Concept of holes - doping - Extrinsic semiconductors - P type and N type semiconductors - Hall effect.

Diodes and Transistors: P-N junction diode - Forward bias and reverse bias - Rectification action of diode - Working of full wave rectifier using P N junction diodes - PNP and NPN transistors - Three different configurations - Advantages of common emitter configuration - working of NPN transistor as an amplifier in common emitter configuration.

UNIT V **QUANTUM PHYSICS** **12 HRS**

Introduction to quantum physics, black body radiation, Compton effect, de Broglie hypothesis, wave – particle duality, uncertainty principle, Schrodinger wave equation (Time dependent and Time independent), particle in a box, Extension to three dimension - Degeneracy.

L = 45 hrs T = 15 hrs P=0 hrs Total = 60 hrs

TEXT BOOKS

1.Gaur R. K. and Gupta S. L., "Engineering Physics", Dhanpat Rai Publications, 2009.

2. Avadhanulu M. N. "Engineering Physics" (Volume I and II), S. Chand & Company Ltd., New Delhi, 2010.

REFERENCES BOOKS

1. Palanisamy P. K., "Engineering Physics", Scitech Publications (India) Pvt. Ltd, Chennai.

2. Arumugam M., "Engineering Physics" (Volume I and II), Anuradha Publishers, 2010.

3. Senthil Kumar G., "Engineering Physics", 2nd Enlarged Revised Edition, VRB Publishers, Chennai, 2011.

4. Mani P., "Engineering Physics", Dhanam Publications, Chennai, 2007.

E REFERENCES

NPTEL , Engineering Physics, Prof. M. K. Srivastava, Department of Physics, IIT, Roorkee.

Mapping of CO's with PO

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS1	PS2
CO1	3	2	2	2	1	-	-	-	1	-	-	1		
CO2	3		1		1	-	-	-		-	-	1		
CO3	3	2	2	2	1	-	-	-	1	-	-	1		
CO4	3	2	2	2	1	-	-	-	1	-	-	1		
CO5	3		2			-	-	-		-	-	1		
Total	**15**	**6**	**9**	**6**	**4**				**3**			**5**		
Scaled to 0,1,2,3 scale	**3**	**2**	**2**	**2**	**1**				**1**			**1**		

1 – 5 →1, 6 – 10→ 2, 11 – 15→ 3
0-No Relation, 1- Low Relation, 2-Medium Relation, 3-High Relation

Semester	**II**
Subject Name	**XGS204**
Subject Code	**TECHNICAL COMMUNICATION**

L –T –P –C	**C:P:A**	**L –T –P –H**
2- 0 – 0– 2	**3:0:0**	**2- 0– 0 – 2**

Course Outcome		**Domain/Level C or P or A**
CO1	***Ability*** to understand the basic principles	**K1**
CO2	***Apply*** the techniques in writing	**K3**
CO3	***Identify*** communicative styles	**K1**
CO4	***Construct*** the nature of writing	**K6**
CO5	***Ability*** to recall the Techniques	**K1**
CO6	***Apply*** the techniques in practice	**K3**

COURSE CONTENT

UNIT I	**Basic Principles**	**9 HRS**
	1.1 – Basic Principles of Technical Writing 1.2 – Styles used in Technical Writing 1.3 – Language and Tone	
UNIT II	**Techniques**	**9 HRS**
	2.1 – Special Techniques used in writing 2.2 – Definition & Description of mechanism 2.3 – Description- Classification-Interpretation	
UNIT III	**Communication**	**9 HRS**
	3.1 – Modern development in style of writing 3.2 - New letter writing formats	
UNIT IV	**Report Writing**	**9 HRS**
	4.1 – Types of Report writing 4.2 – Project writing formats	

Suggested Readings:

(i) John Sealy, Writing and Speaking Author; Oxford University Press, New Delhi, 2009

(ii) Williams K.S, Communicating Business. Engage Learning India Pvt Ltd, 2012

Semester	**II**
Subject Name	**Workshop Practices**
Subject Code	**XWP205**

L –T –P –C	**C:P:A**	**L –T –P –H**
1- 0 – 2– 3	**1:2:0**	**1- 0– 4 – 5**

Course Outcome		**Domain/Level C or P or A**
CO1	***Summarize*** the machining methods and ***Practice*** machining operation.	**K1, P3**
CO2	***Defining*** metal casting process, moulding methods and **relates**Casting and Smithy applications.	**K1, P3**
CO3	***Plan*** basic carpentry operations and ***Practice*** carpentry operations.	**K1, P3**
CO4	***Plan*** basic fitting operations and ***Practice***fitting operations.	**K1, P3**
CO5	***Summarize*** metal joining operation and ***Practice*** welding operation.	**K1, P3**
CO6	***Illustrate*** the electrical and electronics basics and ***Makes*** appropriate connections**.**	**K1, P3**

COURSE CONTENT

EXP.NO	**TITLE**	**CO RELATION**
1	Introduction to machining process	**CO1**
2	Plain turning using lathe operation	**CO1**
3	Introduction to CNC	**CO1**
4	Demonstration of plain turning using CNC	**CO1**
5	Study of metal casting operation	**CO2**
6	Demonstration of moulding process	**CO2**
7	Study of smithy operation	**CO2**
8	Study of carpentry tools	**CO3**
9	Half lap joint – Carpentry	**CO3**
10	Mortise and Tenon joint – Carpentry	**CO3**
11	Study of fitting tools	**CO4**
12	Square fitting	**CO4**
13	Triangular fitting	**CO4**
14	STUDY OF WELDING TOOLS	**CO5**
15	Square butt joint – welding	**CO5**
16	Tee joint – Welding	**CO5**

17	Introduction to house wiring	**CO6**
18	One lamp controlled by one switch	**CO6**
19	Two lamps controlled by single switch	**CO6**
20	Staircase wiring	**CO6**

TEXT BOOKS

1. Workshop Technology I,II,III, by S K Hajra, Choudhary and A K Chaoudhary. Media Promoters and Publishers Pvt. Ltd., Bombay
2. Workshop Technology by Manchanda Vol. I,II,III India Publishing House, Jalandhar.

REFERENCES

1. Manual on Workshop Practice by K Venkata Reddy, KL Narayana et al; MacMillan India Ltd.
2. Basic Workshop Practice Manual by T Jeyapoovan; Vikas Publishing House (P) Ltd.,New Delhi
3. Workshop Technology by B.S. Raghuwanshi, Dhanpat Rai and Co., New Delhi.
4. Workshop Technology by HS Bawa, Tata McGraw Hill Publishers, New Delhi.

E RESOURCES

1. http://nptel.ac.in/courses/112107145/

Mapping of COs with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	P O9	P O1 0	PO1 1	P O1 2	PS O1	PS O2
CO1	2	1	2	2	1			1	1		1	2	3	
CO2	2	1	2	2	1			1	1		1	2	3	
CO3	2	1	2	2	1			1	1		1	2	3	
CO4	2	1	2	2	1			1	1		1	2	3	
CO5	2	1	2	2	1			1	1		1	2	3	
CO6	2	1	2	2	1			1	1		1	2	3	
Total	**12**	**6**	**12**	**12**	**6**			**6**	**6**		**6**	**12**	**18**	

1 - Low, 2 – Medium, 3- High

COURSE CODE	XEM206	L	T	P	C
COURSE NAME	ENGINEERING MECHANICS	3	0	0	3
PREREQUISITES	NIL	L	T	P	H
C:P:A= 3:0:0		3	0	0	3

COURSE OBJECTIVES

Upon successful completion of the course, student will have:

- *Ability to apply knowledge of mathematics, science, andengineering.*
- Ability to design as well as to analyse and interpretdata.
- Ability to identify, formulate, and solve engineering problems.
- Ability to apply techniques and resources to solve complex mechanical engineering activities with an understanding of the limitations.

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Explain*** the principles forces, laws and theirapplications.	Cognitive	Understanding, Apply
CO2	***Classification***of friction, and ***apply*** the forces in Trusses and beams.	Cognitive	Understanding, Apply
CO3	***Explain*** and ***Apply*** moment of Inertia and Virtual work	Cognitive	Understanding, Apply
CO4	***Outline*** and ***Examine*** Dynamics	Cognitive	Understanding, Apply
CO5	***Explain*** free and forced vibration	Cognitive	Remember, Understanding

UNIT I	INTRODUCTION TO ENGINEERING MECHANICS	9

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 indeterminacy.

UNIT II	FRICTION AND BASIC STRUCTURAL ANALYSIS	9

Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack; 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.

UNIT III	CENTROID , CENTRE OF GRAVITY AND VIRTUAL WORK AND ENERGY METHOD	9

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. 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.		
UNIT IV	**REVIEW OF PARTICLE DYNAMICS AND INTRODUCTION TO KINETICS OF RIGID BODIES**	**9**
Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear 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). 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 bodyrotation.		
UNIT V	**MECHANICAL VIBRATIONS**	**9**
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.		
TEXT BOOKS		
1.	Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall	
2.	F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill	
REFERENCE BOOKS		
1.	R. C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.	
2.	Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press	
3.	Shanes and Rao (2006), Engineering Mechanics, Pearson Education	
4.	Hibler and Gupta (2010),Engineering Mechanics (Statics, Dynamics) by Pearson Education	
5.	Reddy Vijaykumar K. and K. Suresh Kumar(2010), Singer's Engineering Mechanics	
6.	Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications	
7.	Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.	
8.	Tayal A.K. (2010), Engineering Mechanics, Umesh Publications	
E-REFERENCES		
1.	https://archive.nptel.ac.in/courses/112/106/112106286/	
2.	https://onlinecourses.nptel.ac.in/noc23_me74/preview	
LECTURE: 45	**TUTORIAL: 0**	**PRACTICAL: 0**	**TOTAL:45**

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

	PROGRAM OUTCOMES											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	2	1	1	3	1	1	2	3	2	1	3
CO2	3	2	1	1	3	1	1	2	3	2	1	3
CO3	3	2	1	1	3	1	1	2	3	2	1	3
CO4	3	2	1	1	3	1	1	2	3	2	1	3

CO5	2	2	2	1	3	1	1	3	3	3	1	3

Correlation level - 1 – Low 2 – Medium 3 – High

Semester	**II**
Subject Name	**ELECTRICAL AND ELECTRONICS ENGINEERING SYSTEMS LABORATORY**
Subject Code	**XBE207**

L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 1– 1	**1.5:1:0.5**	**0- 0– 2 – 2**

PREREQUISITE: Physics

COURSE OBJECTIVES:

The course helps to

a. Learn the basic concepts of electrical and electronics components.
b. Understand the basic wiring methods and connection.
c. Study the characteristics of diodes, Zener diodes, NPN transistors.
d. Verify the working of simple logic gates, adders and subtractors.

Course Outcome		**Domain/Level C or P or A**
CO1	**Apply** the fundamental electrical concepts and **differentiate** the various electronic components.	**K2 P2 A3**
CO2	**Implement** and **execute** the different types of wiring connections.	**K2 P2 A3**
CO3	**Demonstrate** the Fluorescent lamp connection with choke.	**K2 P2 A3**
CO4	**Characterize** and **display** the basic knowledge on the working of PN junction and Zener diode.	**K2 P2 A3**
CO5	**Implement** and **execute** the various digital electronic circuits such as Adders and Subtractors.	**K2 P2 A3**

List of Experiments

1. Study of Electrical Symbols, Tools and Safety Precautions, Power Supplies.
2. Study of Active and Passive elements – Resistors, Inductors and Capacitors, Bread Board.
3. Testing of DC Voltage and Current in series and parallel resistors which are connected in breadboard by using Voltmeter, Ammeter and Multimeter.
4. Fluorescent lamp connection with choke.
5. Staircase Wiring
6. Forward and Reverse bias characteristics of PN junction diode.
7. Forward and Reverse bias characteristics of zener diode.

8. Input and Output Characteristics of NPN transistor.

9. Construction and verification of simple logic gates.

10. Construction and verification of adders and subtractors.

L = 0 hrs T = 0 hrs P=30 hrs Total = 30 hrs

Mapping of CO's with PO

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	3	3	1	1	1	1			1	1	1			
CO2	3	3	1	1	1	1			1	1	1			
CO3	2	2	2	1	2	2	1	1	1	1	1			
CO4	2	2	1	1	1	1	1	1	1	1	1			
CO5	2	2	1	1	1	1	1	1	1	1	1			
Total	12	12	6	5	6	6	3	3	5	5	5			
Scaled Value	3	3	2	1	2	2	1	1	1	1	1			

0-No Relation, 1- Low Relation, 2-Medium Relation, 3-High Relation

Semester	**II**
Subject Name	**APPLIED PHYSICS FOR ENGINEERS LAB**
Subject Code	**XAP208**

L –T –P –C	C:P:A	L –T –P –H
0- 0 – 1– 1	0:2:0	0- 0– 2 – 2

PREREQUISITE: Basic Physics in HSC level

Course Outcome		Domain/Level C or P or A
CO1	***Determine*** the significance of elasticity in engineering systems and technological advances.	**P4**
CO2	***use*** and ***locate*** basic applications of electromagnetic induction to technology.	**P4, A2**
CO3	***Describe*** the working principle and application of various lasers and fibre optics.	**P4**
CO4	***use*** physics principles of latest technology using semiconductor devices.	**P4**

LABORATORY

1. Torsional Pendulum - determination of moment of inertia and rigidity modulus of the given material of the wire.
2. Uniform Bending - Determination of the Young's Modulus of the material of the beam.
3. Non-Uniform Bending - Determination of the Young's Modulus of the material of the beam.
4. Meter Bridge - Determination of specific resistance of the material of the wire.
5. Spectrometer - Determination of dispersive power of the give prism.
6. Spectrometer - Determination of wavelength of various colours in Hg source using grating.
7. Air wedge - Determination of thickness of a given thin wire.
8. Laser - Determination of wavelength of given laser source and size of the given micro particle using Laser grating.
9. Post office Box - Determination of band gap of a given semiconductor.
10. PN Junction Diode - Determination of V-I characteristics of the given diode.

L = 0 hrs T = 0 hrs P=30 hrs Total = 30 hrs

REFERENCES BOOKS

1. Samir Kumar Ghosh, "A text book of Advanced Practical Physics", New Central

Agency (P) Ltd, 2008.
2. Arora C.L., "Practical Physics", S. Chand & Company Ltd., New Delhi, 2013.
3. Umayal Sundari AR., "Applied Physics Laboratory Manual", PMU Press, Thanjavur, 2012.

E REFERENCES

NPTEL, Engineering Physics, Prof. M. K. Srivastava, Department of Physics, IIT, Roorkee.

Mapping of CO's with PO

	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1	3	2	2	2	1	-	-	-	1	-	-	1		
CO2	3		1		1	-	-	-		-	-	1		
CO3	3	2	2	2	1	-	-	-	1	-	-	1		
CO4	3	2	2	2	1	-	-	-	1	-	-	1		
CO5	**12**	**6**	**7**	**6**	**4**				**3**			**5**		
Total	**3**	**2**	**2**	**2**	**1**				**1**			**1**		
Scaled to 0,1,2,3 scale	3	2	2	2	1	-	-	-	1	-	-	1		

1 – 5 →1, 6 – 10→ 2, 11 – 15→ 3

0-No Relation, 1- Low Relation, 2-Medium Relation, 3-High Relation

Semester	**III**
Subject Name	**TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS**
Subject Code	**XMA301**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 1 – 0– 4	**3:0.5:0.5**	**3- 1– 0 – 4**

PREREQUISITE: Algebra , Calculus and Laplace transforms

Course Outcome		**Domain/Level C or P or A**
CO1	**Solve** standard types of first order and second order partial differential equations with constant coefficients. Elimination of arbitrary constants and functions.	**K3, P1**
CO2	***State*** Dirichlet's condition. **Explain** general Fourier series of the curve y = f(x) in the interval (0,2π) (-π, π), (0, 2 ℓ), (-ℓ,ℓ) and (0, π). Perform harmonic analysis	**K1 , K2 P1**
CO3	***Solve*** the standard Partial Differential Equations, arising in engineering Problems, like one dimensional Wave equation and Heat flow equation by Fourier series method in Cartesian coordinates. Classify second order quasi pde.	**K3, A1**
CO4	**Find** the Fourier transform and Fourier sine and cosinetransforms of of simple functions using definition and its properties.	**K1, K3**
CO5	***Apply*** the properties of Z transform to ***Find*** theZ transform and inverse Z transform of sequence and functions, and to solve the difference equation using them.	**K1, K3**
CO6	***Analyze*** the periodic and aperiodic signals using transforms	**K4**

UNIT I	**Partial Differential Equations**	**12 HRS**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solution of standard types of first order partial differential equations – Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients.

UNIT II	**Fourier Series**	**12 HRS**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series –Parseval's identity – Harmonic Analysis.

UNIT III	Applications of Boundary Value Problems	12 HRS

Classification of second order quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state solution of two dimensional heat equation (Insulated edges excluded) – Fourier series solutions in Cartesian coordinates .

UNIT IV	Fourier Transform	12 HRS

Fourier integral theorem (without proof) – Fourier transform pairs – Fourier Sine and Cosine transforms – properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT V	Transform and Difference Equations	12 HRS

Z-transform – Elementary properties – Inverse Z – transform – Convolution theorem – Initial and Final value theorems - Formation of difference equations – Solution of difference equations using Z-transform.

L = 45 hrs T = 15 hrs P=0 hrs Total = 60 hrs

TEXT BOOKS

1. Grewal, B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, New Delhi (2012).
2. Narayanan, S., ManicavachagomPillay, T.K. and Ramaniah, G., "Advanced Mathematics for Engineering Students", Volumes II and III, S.Viswanathan (Printers and Publishers) Pvt. Ltd., Chennai (2002).
3. Veerarajan. T., "Transforms and Partial Differential Equations", Second reprint, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.

REFERENCES BOOKS

1. Churchill, R.V. and Brown, J.W., "Fourier Series and Boundary Value Problems", Fourth Edition, McGraw Hill Book Co., Singapore (1987).
2. Kandasamy, P., Thilagavathy, K., and Gunavathy, K., " Engineering Mathematics Volume III", S. Chand & Company Ltd., New Delhi (1996).
3. Bali N.P. and Manish Goyal, "A Text Book of Engineering Mathematics" 7th Edition Lakshmi Publications (P) Limited, New Delhi (2007).
4. Erwin Kreyszig, "Advanced Engineering Mathematics", 8 th Edition, Wiley India, 2007.
5. Ray Wylie. C and Barrett.L.C, "Advanced Engineering Mathematics" Tata McGraw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.

E REFERENCES

1. www.nptel.ac.in
2. Advanced Engineering Mathematics, Prof. Jitendra Kumar, Department of Mathematics, Indian Institute of Technology, Kharagpur, India.

Mapping of COs with GA

	GA 1	GA 2	GA 3	GA 4	GA 5	GA 6	GA 7	GA 8	GA 9	GA1 0	GA1 1	GA1 2
CO 1	3									1		1
CO 2	3									1		1
CO 3	3	2								1	1	2
CO 4	3	2			1					1	1	1
CO 5	3	2			1					1	1	1
	15	6	0	0	2	0	0	0	0	5	3	6
Scaled Value	3	2			1					1		

1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3

1 - Low, 2 – Medium, 3- High

Semester	**III**
Subject Name	**THERMODYNAMICS**
Subject Code	**XME302**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 1 – 0– 4	**3.5:0:0.5**	**3- 1– 0 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	The students ***apply*** energy balance to systems and control volumes, in situations involving heat and workinteractions	**K3**
CO2	The students can ***study*** the changes in thermodynamic properties ofsubstances	**K1**
CO3	The students will be able to ***study*** the performance of energy conversiondevices	**K1**
CO4	The students will be able to ***differentiate*** between high grade and low grade energies.	**K2**
CO5	The students can ***apply*** the energy balance to systems	**K3**
CO6	The students will be able to ***Classify*** various thermodynamic cycles	**K2**

The objective of this course

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

COURSE CONTENT

UNIT I	**BASIC CONCEPTS**	**7 hrs**

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.

UNIT II	**LAWS OF THERMODYNAMICS**	**8 hrs**

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

UNIT III	**PROPERTIES OF SUBSTANCES AND STEAM TABLES**	**8 hrs**

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.

UNIT IV	**FLOW PROCESS AND THERMO DYNAMIC RELATIONS**	**10 hrs**

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

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.

UNIT V	**ENTROPY AND CYCLES**	**12 hrs**

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 T-s 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

Thermodynamic cycles - Basic Rankine cycle; Basic Brayton cycle; Basic vapor compression cycle and comparison with Carnot cycle.

L = 40 hrs T = 12 hrs P=0 hrs Total = 52 hrs

TEXT BOOKS / REFERENCES

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

Mapping of COs with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2	-	1	-	3	-	2	2	2	-	-	2
CO2	3	-	-	2	3	-	1	-	1	-	-	3
CO3	1	-	1	3	1	-	1	2	-	2	-	1
CO4	2	-	-	1	1	-	2	1	2	2	-	1
CO5	-	-	-	1	1	-	-	-	1	1	-	2
CO6	-	-	-	1	1	-	-	-	1	1	-	2
Total	8	-	2	8	10	-	6	5	7	6	-	11

1 - Low, 2 – Medium, 3- High

Semester	**III**
Subject Name	**STRENGTH OF MATERIALS**
Subject Code	**XME303**

L–T–P–C	**C : P : A**	**L–T–P–H**
3–1–0–4	**4 : 0 : 0**	**3–1–0–4**

Course Outcome		**Domain/Level C or P or A**
CO1	Evaluate the deformation, strains and stresses due to axial loading and understand the concepts of principal planes and Mohr's circle	**Cognitive** (Remember, Understand, Apply)
CO2	Draw shear and moment diagrams of simple beams subjected to various loading conditions and evaluate the bending and shear stresses produced in beams	**Cognitive** (Remember, Understand, Apply)
CO3	Compute slopes and deflection of beams and determine moment of inertia of different sections	**Cognitive** (Remember, Understand, Apply)
CO4	Analyze torsional stresses, deformation and deflection of shafts and helical springs	**Cognitive (**Remember, Understand, Apply)
CO5	Evaluate the stresses and deformation in thin cylinders and spherical shells subjected to internal pressure	**Cognitive** (Remember, Understand, Apply)
CO6	Evaluate the stresses and deformation in thick cylinders and spherical shells subjected to internal pressure	**Cognitive** (Remember, Understand, Apply)

OBJECTIVES

- 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
- To calculate the elastic deformation occurring in various simple geometries for different typesof loading

COURSE CONTENT

UNIT I	**STRESS, STRAIN AND DEFORMATION OF SOLIDS**	**L8 + T2 = 10 hrs**

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

UNIT II	**BEAMS - LOADS AND STRESSES**	**L8 + T3 = 11 hrs**

Beams and types, transverse loading on beams - shear force and bend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads

UNIT III	**DEFLECTIONOF BEAMS**	**L8 + T3 = 11 hrs**

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

UNIT IV	**TORSION AND SHAFTS**	**L8 + T2 = 10 hrs**

Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs

UNIT V	**ANALYSIS OF STRESSES IN TWO DIMENSIONS**	**L8 + T2 = 10 hrs**

Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure

Lecture = 40 Hours Tutorial = 12 Hours Practical = 0 Hours Total = 52 Hours

TEXT BOOKS / REFERENCES

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
3. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw Hill Publishing Co. Ltd., New Delhi 2005.

Table 1: Mapping of COs with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO1	PSO2
CO1	3	3	2	3	3	1	2	1	2	1	2	3	2	
CO2	3	3	2	3	3	1	2	1	2	1	3	3	2	
CO3	3	3	2	3	3	1	2	1	2	1	2	3	2	
CO4	3	3	2	3	3	1	2	1	2	1	2	3	2	
CO5	2	2	1	2	2	1	1	1	1		2	2	1	
CO6	1	1	1	1	1		1		1	1	1	1	1	
Total	15	15	10	15	15	5	10	5	10	5	12	15	10	

1 - Low, 2 – Medium, 3- High

Semester	**III**
Course Name	**MATERIALS ENGINEERING**
Course Code	**XME304**

L –T –P –C	**C:P:A**	**L –T –P –H**
3 – 0 – 0– 3	**3:0:0**	**3–0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	***Study*** the basic crystal structures and different imperfections in solid	**K1**
CO2	***Outline*** the mechanical properties and appropriate measurement methods.	**K2**
CO3	***Summarize*** the static failure theories.	**K2**
CO4	***Illustrate*** the phase diagrams and comprehend the phase transformations in alloys.	**K2**
CO5	***Compare*** different heat treatment process and its applications.	**K2**
CO6	***Summarize*** the modern engineering materials and their properties	**K1**

Objectives

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.

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

UNIT I	**PROPERTIES OF METALLIC MATERIALS**	**9 Hours**

Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids:Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slipsystems, critically resolved shear stress.

Mechanical Property measurement: Tensile, compression and torsion tests; Young'smodulus, relations between true and engineering stress-strain curves, generalized Hooke'slaw, yielding and yield strength, ductility, resilience, toughness and elastic recovery;Hardness: Rockwell, Brinell and Vickers and their relation to strength.

UNIT II STATIC FAILURE THEORIES 9 Hours

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 non-destructive testing (NDT).

UNIT III ALLOYS AND PHASE DIAGRAMS 9 Hours

Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions.

Iron Iron-carbide phase diagram and microstructural aspects of ledeburite, austenite, ferrite and cementite, cast iron.

UNIT IV HEAT TREATMENT OF MATERIALS 9 Hours

Heat treatment of Steel: Annealing, tempering, normalizing 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

UNIT V MODERN ENGINEERING MATERIALS 9 Hours

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.

L = 45 Hours Tutorial = 0 Hours Total = 45 Hours

TEXT BOOKS

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.

REFERENCE BOOKS

1. Koch, C. C. Nanostructured materials: processing and applications: William Andrew Pub.

2.James F Shackelford, S “Introduction to materials Science for Engineers”, 6 th Macmillan Publishing Company, New York, 2004
3.William D CallisterJr, “Materials Science and Engineering – An Introduction”, John Wiley and Sons Inc., 6 th edition, New York, 2003
4.Jayakumar S, “Materials Science”, RK Publishers, Coimbatore, 2004
5. Bolton, W., Engineering materials technology: Butterworth-Heinemann.

E RESOURCES

1.NPTEL courses, http://www.nptel.iitm.ac.in/courses.php?disciplineId=112: related web and video resources under Mechanical Engineering &Metallurgy and Material Science categories
2.http://www.intechopen.com/books

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2
CO1	2	2	3	3	1	1	-	2	3	3	1	3	2	1
CO2	2	2	3	3	1	1	-	2	3	3	1	3	2	1
CO3	3	3	1	1	1	-	-	1	1	2	3	2	2	1
CO4	3	2	1	1	1	-	-	1	2	3	1	3	2	1
CO5	2	3	1	3	1	-	-	1	1	2	3	2	2	1
CO6	3	2	3	3	1	1	-	1	3	3	2	1	2	1
Tot	15	14	12	14	6	3	0	8	13	16	11	14	12	6

1 - Low, 2 – Medium, 3- High

Semester	**III**		
Subject Name	**Machine Drawing**		
Subject Code	**XME305**		
L –T –P –C **1- 0 – 1– 2**		**C:P:A** **1:1:0**	**L –T –P –H** **1- 0– 2– 3**
Course Outcome			**Knowledge Level**
CO1	To Understand the codes and practices.		**K2**
CO2	To apply tolerances and fits in the drawings.		**K2**
CO3	To remember the symbols of machine drawing		**K2**
CO4	To understand the working fasters		**K2**
CO5	To understand the cotter joint, knuckle joint, etc.,		**K2**
CO6	To understand the working components		**K2**
COURSE CONTENT			
UNIT I	**CODES AND PRACTICES**		**9 hrs**
	Indian standard code of practice for engineering drawing –general principles of presentation, conventional representations of threaded parts, springs, gear and common features. Abbreviations and symbols for use in technical drawings, Conventions for sectioning and dimensioning.		
UNIT II	**TOLERANCES**		**9 hrs**
	Tolerances –types –representation of tolerances on drawings, Geometric tolerance –form and positional tolerances –datum, datum features, fits –types –selection of fits –allowances		
UNIT III	**DRAWING SYMBOLS**		**9 hrs**
	Maximum material principal-symbols and methods of indicating it on drawing –		

	surface finish symbols –welding symbols and methods of indicating them on drawings	
UNIT IV	**WORKING DRAWINGS OF FASTENERS**	**9 hrs**
	Preparation of working drawing for the Fasteners like: Nuts, bolts screws, keys and keyways, joints –cotterjoint and knuckle joint.	
UNIT V	**WORKING DRAWINGS OF MACHINE COMPONENTS**	**9 hrs**
	Preparation of working drawings for the machine components like: Connecting rod, Plummer block, screw jack, cross head for horizontal and vertical engines, swivel bearing, machine vice, lathe tail stock, toolhead of a shaper, stop valve, safety valve, pressure relief valve.	
L = 45 hrs Total = 45 hr		

TEXT BOOKS

1. Machine drawing by Gopalakrishnan, Subash Publishers,2002

REFERENCES

1. Machine drawing , N.D. Bhatt, Charotar Publishing House, Anand
2. Machine drawing, N.Siddeswar, P.Kanniah, and V.V.S. Satry TataMcGraw Hill, 1980
3. Revised IS codes:
10711,10713,10714,9609,1165,10712,10715,10716,10717,11663,11668,
10968,11669,8043,8000

E RESOURCES

http://nptel.iitm.ac.in

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	2	3	1	1	2	3	3	2	
CO2	3	3	3	1	3	1	3	1	1	1	2	3	2	
CO3	3	3	3	1	3	1	3	1	1	1	2	3	2	
CO4	2	2	2	1	2	1	2	1	1	1	1	2	1	
CO5	1	1	1	0	1	0	1	0	0	0	1	1	1	
CO6	3	3	3	1	3	1	3	1	1	1	2	3	2	
TOT	15	15	15	6	15	6	15	5	5	6	11	15	10	

1 - Low, 2 – Medium, 3- High

Semester	**III**		
Subject Name	**ENTREPRENEURSHIP DEVELOPMENT**		
Subject Code	**XUM306**		
L –T –P –C **2- 0 – 0– 2**		**C:P:A** **2:0:0**	**L –T –P –H** **2- 0– 0 – 2**
Course Outcom			**Knowledge Level**
CO1	***Recognise*** and ***describe*** the role of innovation and motivation for an entrepreneur.		**K2**
CO2	***Self-assess*** and ***appraise*** your entrepreneurship interest with your chosen entrepreneur.		**K5**
CO3	***Outline*** the importance of generation of new ideas for entrepreneurship and ***illustrate*** market assessment.		**K4**
CO4	***Explain*** the competition in business and ***sketch/demonstrate/comply*** business model for dealing with competition.		**K2,K3**
CO5	***Describe*** and ***Explain*** venture creation and launching of small business and its management.		**K1,K2**
CO6	***Describe*** and ***Discuss*** various government policies and global opportunities for Entrepreneurship Development		**K1,K2**
COURSE CONTENT			
UNIT I	**INNOVATION AND ENTREPRENEURSHIP**		**5hrs**
	Definition of Innovation, Creativity and Entrepreneurship; role of innovation in entrepreneurship development (2)- Entrepreneurial motivation (1)-Competencies and traits of an entrepreneur (1)-Role of Family and Society; Entrepreneurship as a career and its role in national development (1).		
UNIT II	**SELF ASSESSMENT OF ENTREPRENEURIAL INCLININATION**		**4 hrs**
	Self-assessment of entrepreneurial inclination (1)-Presentation by students on their entrepreneurial inclination rating (2)-Case study of successful entrepreneurs (1)		
UNIT III	**NEW IDEA GENERATION TO MARKET ASSESSMENT**		**9 hrs**
	Importance of Idea generation-filtering-refinement (1)-opportunity recognition (1)- Description of chosen idea - value proposition, customer-problem-Solution		

	statement) (1)-benefits; development status; IP ownership (1)-Market Validation-Technology/ user/decision makers/ partners (1)-market need; segmentation (1)-market TAM,SAM and SOM (1)-case study on market segmentation by popular companies (1)	
UNIT IV	**CUSTOMER – COMPETITION- BUSINESS MODEL**	**9 hrs**
	Customer-Target primary customer research, Decision making unit/ process-Beach head market; Cost of Customer Acquisition (2)-Competition- comparative analysis, competitive advantages-; (2)-Business model (1) -Financial planning (1)-Pitch documentation and presentation (3)	
UNIT V	**VENTURE CREATION AND LAUNCHING OF SMALL BUSINESS AND ITS MANAGEMENT**	**9 hrs**
	New enterprise creation - organizational and legal matters (1)-Operational plan (1)-Sales and distribution plan (1)-Accounting (1)-Team recruitment and management (1)-Fund raising and management (1)-Profile of a startup – case studies (2).	
UNIT VI	**GOVERNMENT INITIATIVES AND GLOBAL OPPORTUNITIES**	**9 hrs**
	Incubators and accelerators - capacity building (2)-Startup policies- Startup India (2)-Support for MSME; GeMPortal(2) Funding–national and international sources(2)-Bilateral programmes by Govt. of India -Global reach for promoting cross-cultural entrepreneurship (1)	
L = 45 hrs T = 0 hrs P=0 hrs Total = 45 hrs		

REFERENCES

1.A.P.Aruna, " Lecture Notes on Entrepreneurship Development" , available as softcopy @ www.brain.net

2.Thomas W. Zimmerer, Norman M. Scarborough, "Essentials of Entrepreneurship and Small Business Management", Pearson; 3rd edition, 2001.

3.John Burnett, "Introducing Marketing", Open Text Book available at http://solr.bccampus.ca:8001/bcc/file/ddbe3343-9796-4801-a0cb-7af7b02e3191/1/Core%20Concepts%20of%20Marketing.pdf

4.Toubia, Olivier. "Idea Generation, Creativity, and Incentives", Marketing Science. Vol. 25. pp.411-425. 10.1287/mksc.1050.0166, 2006.

5.Alexander Osterwalder and Yves Pigneur, "Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers", Wiley; 1st edition, 2010.

6.Gerardus Blokdyk,"3C's model The Ultimate Step-By-Step Guide"5starcooks, 2018.

Table.1. CO PO mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1		1		1	1	1		1	1	1	1	
CO2		1		1	1	1		1	1	1	1	
CO3		**1**		**1**	**1**	**1**		**1**	**2**	**2**	**1**	
CO4		**1**		**1**	**1**	**1**		**1**	**1**	**1**	**1**	
CO5		**1**		**1**	**1**	**1**		**1**	**1**	**2**	**1**	

CO6		**1**		**1**	**1**	**1**		**1**	**1**	**2**	**1**	
Total		**6**		**6**	**6**	**6**		**6**	**6**	**9**	**5**	
Scaled to 0,1,2 and 3		2		2	2	2		2	2	2	1	

Total	0	1-6	7-12	13-18	L – Lecture; T-Tutorial;
Scale	0	1	2	3	P-Practical;
Relation	No	Low	Medium	High	SS – Self Study

Semester	**III**	
Subject Name	**Strength of Materials Laboratory**	
Subject Code	**XME308**	
L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 1– 1	**0:1:0**	**0- 0– 2 – 2**

Course Outcome	**Domain/Level** **C or P or A**
Define different mechanical properties and ***solve*** various deformation problems under different stress and loading conditions.	Coginitive (Remembering) (Applying) Psychomotor (Guided response)
Indentify appropriate Hardness method for different materials.	Coginitive (Understanding) Psychomotor (Guided response)
Examine deflection for different types of beam.	Coginitive (Understanding) Psychomotor (Perception)
Determine torsion value for different elements	Coginitive (Understanding) Psychomotor (Guided response)
Study about fatigue strength of Steel and ***Sketches*** stress strain relation	Coginitive (Understanding) Psychomotor (Guided response)

Objectives

(i) To understand the measurement of mechanical properties of materials

(ii) To understand the deformation behavior of materials

COURSE CONTENT

CO Relation

LIST OF EXPERIMENTS		**CO**
1.	Tensile test on mild steel using Universal Testing Machine.	1
2.	Compression test on brick/wooden specimen using Compression Testing Machine	1

3.	Brinell hardness test	2
4.	Rockwell hardness test	2
5.	Charpy and Izod Impact tests	2
6.	Deflection tests on simply supported beams	3
7.	Deflection tests on cantilever	3
8.	Torsion test on mild steel rod.	4
9.	Test on helical coiled springs	4
10.	Exercises on Mohr's circle	5
11.	Fatigue test on steel	5

TEXT BOOKS

S. Ramamrutham and R. Narayanan, (2003), Strength of Materials, Dhanpat Rai Publications.

REFERENCES

1. Rowland Richards, (2000), Principles of Solid Mechanics, CRC Press.
2.Timoshenko, S.P. and Young, D.H., (2000), Strength of Materials, East West Press Ltd
3. R.K. Bansal, (2000), Strength of Materials, Laxmi Publications

E-REFERENCES

1.http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	2	1	1	-	-	1	-	-1	1	2	
CO2	2	3	-	2	1	1	-	-	-	-	-1	1	2	
CO3	2	3	-	2	1	1	-	-	1	-	-	1	2	
CO4	2	3	2	1	1	1	-	-	1	-	-1	1	2	
CO5	2	3	-	2	1	1	-	-	-	-	-	1	2	
Tot	10	15	2	9	5	5			3		3	5	10	

Semester	**III**
Subject Name	**Inplant Training – I**
Subject Code	**XME310**

L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 1– 1	**0:1:0**	**0- 0– 0– 0**

Course Outcome	**Domain/Level** **C or P or A**

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.

XECHR1- Service Robotics with Drives and Sensors	**L**	**T**	**P**	**C**
	1	**0**	**2**	**3**
	L	**T**	**P**	**H**
	1	**0**	**4**	**5**

PREREQUISITE: -NIL-

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
After the completion of the course, students will be able to			
CO1	***Understand*** the Anatomy of a mobile robot	Cognitive	Knowledge Comprehension
CO2	Virtually ***Build*** and ***Program*** robots in Coppelia Sim	Psychomotor Affective	Application Synthesis
CO3	***Integrate*** Sensors and Motors with Arduino	Cognitive Psychomotor Affective	Application Synthesis Evaluate
CO4	***Develop*** Intelligent Behavior in service Robotsand will be able to ***program*** using LUA	Psychomotor Affective	Application Synthesis Analysis
CO5	***Understand*** the concept of drives and sensors	Cognitive	Knowledge Comprehens ion

UNIT I	**Principles of Robotics**	**3+6**

Introduction to Robotics – What is a robot , Field of Robotics , Robot Classification – Applications of Robots - Introduction to Coppelia Sim – Why we need simulations , How to make the best use of Simulation in Robotics , Difference between Proprietary and Open Source simulations , What is Coppelia Sim , Fundamentals of Coppelia Sim
, Building Blocks of Mobile Robot – Coppelia Sim – Station components of Coppelia Sim, Toolboxes in Coppelia - Work with Mobile Robots in Coppelia Sim –Robot Frames – Robot Assembly in Coppelia Sim – Building Blocks of a mobile Robot – Joints

- Primitive Shapes – Types of Locomotion – Differential Drive Principle and Locomotion – What is a Differential Drive Robot – Mathematical Modelling of Differential Drive Mechanics – Mobile Robot Principles – Limitations of Mobile Robots
- Various Mobile Robot Paradigms – Programming a Differential Drive robot – Programming in Coppelia Sim – What is Lua Programming language – Scripts in Coppelia Sim – Teleoperation of a Differential Drive Robot I – Control of Virtual mobile Robot in Coppelia Sim using Keyboard – Programming the control structure for Robot Teleoperation – Teleoperation of a Differential Drive Robot II – Program debugging and error correction in coppelia sim

Lab:

1. **Offline Programming with Coppelia Sim**
2. **Workspace building with Coppelia Sim**
3. **Modelling Differential Drive Robot in Coppelia Sim**
4. **Programming Differential Drive Robot in Coppelia Sim**
5. **Teleoperate a Mobile Robot**

UNIT II	**Robot Perception**	**3+12**

Introduction to Braitenberg Robots – Braitenberg Principle – Examples of Braitenberg Robots – Different Robot Paradigms – Working with Reactive Paradigm – Imparting Intelligent Behaviors using Braitenberg Principle – Examples of Braitenberg Robots –Introduction to Robot Perception – What is a Sensor – Characteristics of a Sensor – Different sensors for Service Robots – Working with Proximity sensors – Principles and Types of Proximity Sensors – Object Detection in Coppelia Sim – Proximity sensors for detecting obstacles – Data Acquisition from Robots – Case Study – Introduction to Robot Mapping – Using proximity sensors for Robot Mapping – Obstacle Avoidance in Coppelia Sim – Different Obstacle Avoidance algorithms – Working with Bug 1 and Bug 2 algorithms – Maze Building – Using Vision sensors for Obstacle detection and Avoidance – Introduction to Vision Sensors – Fundamentals of Vision sensors – Principles of Camera and Image formation – Applications of Vision sensors in Robotics – Image Processing in Coppelia Sim – Object Detection using Vision – Braitenberg Robots – Line following – Principles of Line following Sensors used in Line Following – Applications of Line following robots in Industry – Visual Servoing – What is Visual Servoing – Sensors used in visual Servoing – Fundamentals of Object tracking – Gesture Recognition – Detecting Gestures using Camera – Introduction to Python – Python Crash course – Connecting Python with Coppelia Sim
– Gesture Recognition in Python – Working with Lidar in Coppelia Sim – Fundamentals of LIDAR – Principle of a LIDAR – Application of LIDAR in Autonomous Robots – Data Acquisition using LIDAR

Lab:

6. **Robot Mapping**
7. **Performing Obstacle Avoidance in Coppelia Sim**
8. **Building and Programming a Line following robot in Coppelia Sim**
9. **Performing Visual Servoing in Coppelia Sim**
10. **Gesture Recognition Robot**
11. **Robot Mapping using LIDAR**

UNIT III	Aerial & Bio Inspired Robots	3+6

Introduction to Aerial Vehicles - Parts of a quadcopter & Flying Techniques - Piloting Way point programming - Building of Drone Frame - Aerial Mapping - Inspection of quarantine zones – Bioinspired Robots - Control of legged robot in Coppelia Sim - What is a gait? - Different gait motions in animals & humans - Assembly of legged robot - Calibration and control of legged robot - Programming of legged robot - What is a Humanoid Robot – Principle of Humanoid Robot – Handling Gaits in Humanoid Robots – Challenges in Biped Motion

Lab:

12. **Building a Mobile Robot Motion model**
13. **Programming and Controlling an Unmanned Aerial Vehicle**
14. **Gait Analysis and Control of Bio inspired Robots**
15. **Working with Humanoid Robots**

UNIT IV	Building Robots (Hardware)	3+9

Build Robots in Real Time – Arduino – Fundamentals of Arduino – Components in Prag Auxiliary Kit – Programming LED, Motors in Arduino – Working with a Potentiometer in Arduino – Programming sensors in Arduino – Build Robots in Real time – Robot Assembly – Assembling a Mobile Robot – Connecting Arduino with Ultrasonic Sensor – Connecting Arduino with Infra-red sensors – Understanding Omni Directional Motion in Mobile Robot – Building Braitenberg Robots in Real time – Robot Intelligence – Introduction to Teachable Machine – Beacon Based Navigation System – Robot Control with Gestures

Lab:

16. **Working with Arduino basics**
17. **Building a Bluetooth-controlled Robot**
18. **Build an Obstacle Avoidance Robot**
19. **Build a Line Following Robot**
20. **Build a Light Following Robot**

UNIT V	Drives and Sensors	3+9

Principles of Hydraulics- Construction of Hydraulic circuits-valves-direction control valve, pressure release valve, pressure regulate valve, oil tank & filters - Principles onof pneumatics- Construction of pneumatic circuits- valves-direction control valve ,pressure release valve, pressure regulate valve, air compressors & filters – Introduction to Industrial sensors-study of characteristics of inductive, capacitive,resistive, photoelectric sensors and ultrasonic sensor.

Lab:

21. **Hydraulic-Operation of single acting and double acting cylinders**
22. **Operation of electro hydraulics**
23. **Pneumatics-Operation of single acting and double acting cylinders**
24. **Operation of electro pneumatics**
25. **Sensors-inductive, capacitive, resistive**
26. **Sensors-photoelectric sensors and ultrasonic sensors**

LECTURE	TUTORIAL	PRACTICAL	AL HOURS
12	0	33	60

TEXT BOOKS:

Springer Handbook on Robotics Industrial Automation Technologies,e*dited By ,Chanchal Dey,Sunit Kumar Sen,* ISBN9780367496074,Published February 1, 2022 by CRC Press 376 Pages 301 B/W Illustrations

REFERENCES:

Introduction to Robotics by J.J. Craig, Addison-Wesley Publishing Company, 1986owozin and Lampert J.Buchli (eds.): "Mobile Robots - Moving Intelligence", Published by AdvancedRobotic Systems International Verlag, 2006
E-REFERENCES:
NPTEL :: Electrical Engineering - Industrial Automation and Control

Semester	**IV**
Subject Name	**PROBABILITY DISTRIBUTION AND STATISTICAL METHODS**
Subject Code	**XMA401**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 1 – 0– 4	**3:0.5:0.5**	**3- 1– 0 – 4**

PREREQUISITE: NIL

Learning Objectives

1. Appreciate the importance of probability and statistics in computing and research
2. Develop skills in presenting quantitative data using appropriate diagrams, tabulations and summaries
3. Use appropriate statistical method in the analysis of simple datasets.
4. Interpret and clearly present output from statistical analyses in a clear concise and understandable manner
5. The main objective of this course is to provide students with the foundations of probabilities and statistical analysis mostly used in varied applications in engineering and science like disease modeling, climate prediction and computer networks etc.

Course Outcome		**Domain/Level C or P or A**
CO1	**Explain** conditional probability, independent events; **find** expected values and Moments of Discrete random variables with their properties.	**K1. K2**
CO2	**Find** distribution function, Marginal density function, conditional density function and to **define** density function of conditional distribution functions normal, exponential and gamma distributions.	**K1**
CO3	**Determine** the statistical parameters of Binomial, Poisson and Normal and to find correlation, regression and Rank Correlation coefficient of two variables. Moments, skewness and Kurtosis.	**K2, P3**
CO4	**Explain** large sample test for single proportion, difference of proportion, single mean, difference of means and difference of standard deviations with simple problems.	**K2**
CO5	**Explain** small sample test for single mean, difference of mean and	**K2 , A1**

correlation coefficients, variance test, chi square test with simple problems.

CO6	**Analyze** the test of significance for comparing large sample test and small sample test	**K4**

UNIT I	**Basic Probability**	**12 HRS**

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.

UNIT II	**Continuous Probability Distributions & Bivariate Distributions**	**12 HRS**

Continuous random variables 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.

UNIT III	**Basic Statistics**	**12 HRS**

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

UNIT IV	**Applied Statistics**	**12 HRS**

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.

UNIT V	**Small Samples**	**12 HRS**

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

L = 45 hrs T = 15 hrs P=0 hrs Total = 60 hrs

TEXT BOOKS

1. B.S. Grewal, “Higher Engineering Mathematics”, Khanna Publishers, 43rd Edition, 2015.
2. N.P. Bali and M. Goyal, “A text book of Engineering Mathematics”, Laxmi Publications, 2010.
3. Veerarajan T., “Probability, Statistics and Random processes”, Tata McGraw-Hill, New Delhi, 2010.

REFERENCES BOOKS

1. P. G. Hoel, S. C. Port and C. J. Stone, “Introduction to Probability Theory”, Universal Book Stall, 2003.
2. S. Ross, “A First Course in Probability”, Pearson Education India, 2002.
3. W. Feller, “An Introduction to Probability Theory and its Applications”, Vol. 1, Wiley, 1968.
4. E. Kreyszig, “Advanced Engineering Mathematics”, John Wiley & Sons, 2006.

E REFERENCES

3. www.nptel.ac.in
4. Probability and Statistics by Prof.Someshkumar, Department of Mathematics, IIT Kharagpur. (http://nptel.ac.in/noc/noc_courselist.php)

Mapping of COs with GA

	GA 1	GA 2	GA 3	GA 4	GA 5	GA 6	GA 7	GA 8	GA 9	GA 10	GA 11	GA 12
CO 1	3	2	1						1	1		1
CO 2	3	2	1						1	1		1
CO 3	3	2	1	1					1	1		1
CO 4	3	2	1	1	1	1			1	1	1	1
CO 5	3	2	1	1	1	1	1		1	1	1	1
	15	10	5	3	2	2	1		5	5	2	5
Scaled Value	3	2	1	1	1	1	1		1	1	1	1

1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3 ***1 - Low, 2 – Medium, 3- High***

Semester	**IV**	
Subject Name	**APPLIED THERMODYNAMICS**	
Subject Code	**XME402**	
L –T –P –C **3- 1– 0– 4**	**C:P:A** **3.5:0:0.5**	**L –T –P –H** **3- 1– 0 – 4**

Course Outcome		**Domain/Level** **C or P or A**
CO1	Understanding of basic fuel types and Calculation of air Fuel mixtures or combustion	**K1**
CO2	Understanding of various vapour power cycles	**K1**
CO3	Understanding of various gas power cycles	**K1**
CO4	Understanding of basic principles of psychometric and solving the Problems of psychrometricc hart.	**K2**
CO5	Understanding phenomena occurring in high speed compressible flow	**K1**
CO6	Analyze energy conversion in various thermal devices such as combustors, aircoolers, nozzles, diffusers, steam turbines and reciprocating compressors.	**K2**

Objectives

(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 turbines

COURSE CONTENT

UNIT I	**Fuels and Stoichiometry**	**9 hrs**
	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	
UNIT II	**Power cycles**	**9 hrs**
	Vapor power cycles Rankine cycle with superheat, reheat and regeneration, enregy analysis. Super-critical and ultra super-critical Rankine cycle- Gas power cycles, Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle, effect of reheat, regeneration and intercooling- Combined gas and vapor power cycles-	
UNIT III	**Psychyrometry and Refrigeration**	**9 hrs**
	Properties of dry and wet air, use of pschyrometric chart, processes involving heating/cooling and humidification/dehumidification, dew point. Vapor compression refrigeration cycles, refrigerants and their properties	

UNIT IV	**Compressible flow and Shocks**	**9 hrs**
	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	
UNIT V	**Compressors and Steam turbines**	**9 hrs**
	Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors and Analysis of steam turbines, velocity and pressure compounding of steam turbines	
L = 45 hrs T = 15 hrs P=0 hrs Total = 60 hrs		

TEXT BOOKS / REFERENCES

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.

Mapping of COs with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	2	1	2	0	0	0	1	3	0	3	3
CO2	3	3	1	0	2	0	0	2	3	0	3	3
CO3	3	3	1	0	2	0	0	2	3	0	3	3
CO4	3	3	1	1	1	0	0	2	3	0	3	3
CO5	3	3	1	0	0	0	0	0	3	0	3	3
CO6	1	2	1	0	0	0	0	3	3	0	3	3
Total	16	16	6	3	5	0	0	10	18	0	18	18

1 - Low, 2 – Medium, 3- High

Semester	**IV**	
Course Name	**FLUID MECHANICS &FLUID MACHINES**	
Course Code	**XME403**	
L –T –P –C **3 – 1 – 0– 4**	**C:P:A** **3.5:0.5:0**	**L –T –P –H** **3–1– 0 – 4**

Course Outcome		**Domain/Level** **C or P or A**
CO1	Ability to **derive** / **solve** problems related to fluid properties, momentum equation and Bernoulli's equation.	**K3**
CO2	Ability to **derive** / **solve** problems related to incompressible pipe and channel flow.	**K3**
CO3	Ability to **derive** / **solve** problems related to bondary layer problem and friction problems.	**K3**
CO4	Ability to **derive** / **solve** problems related to dimensional analysis and similitude.	**K3**
CO5	Ability to **derive** / **solve** problems related to hydraulic pumps and its performance.	**K3**
CO6	Ability to **derive** / **solve** problems related to hydraulic turbines and its performance.	**K3**

Objectives

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

COURSE CONTENT

UNIT I	**BASIC CONCEPTS AND PROPERTIES OF FLUIDS**	**9 Hours**
	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 itsapplications	
UNIT II	**IN COMPRESSIBLE FLUID FLOW**	**9 Hours**
	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	
UNIT III	**DIMENSIONAL ANALYSIS**	**6 Hours**

	Need for dimensional analysis – methods of dimension analysis – Similitude – types of similitude Dimensionless parameters – application of dimensionless parameters – Model analysis	
UNIT IV	**HYDRAULIC PUMPS**	**8 Hours**
	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	
UNIT V	**HYDRAULIC TURBINES**	**8 Hours**
	Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube- Specific speed, unit quantities, performance curves for turbines – governing of turbines	
L = 45 Hours	**Tutorial = 15 Hours**	**Total = 60 Hours**

TEXT BOOKS / REFERENCE BOOKS

1. Streeter. V. L., and Wylie, E.B., Fluid Mechanics, McGraw Hill, 2003.
2. Rathakrishnan. E, Fluid Mechanics, Prentice Hall of India (II Ed.), 2007.
3. Ramamritham. S, Fluid Mechanics, Hydraulics and Fluid Machines, Dhanpat Rai & Sons, Delhi, 2008.
4. Som, S.K., and Biswas, G., "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw-Hill, 2nd Edition, 2004.
5. Kumar. K.L., Engineering Fluid Mechanics (VII Ed.) Eurasia Publishing House (P) Ltd., New Delhi, 2005.
6. Bansal, R.K., Fluid Mechanics and Hydraulics Machines, Laxmi Publications (P) Ltd., New Delhi, 2008.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1	3	1	1	1	1	1	1	1		2
CO2	3	3	2	1	3	1	1	2	2	2	1	2		2
CO3	3	3	2	1	3	1	1	2	2	2	1	2		2
CO4	3	3	0	1	3	1	0	2	1	1	0	1		2
CO5	3	3	1	2	3	1	1	2	2	2	1	2		2
CO6	3	3	2	2	3	1	1	2	2	2	1	2		2

Tot	18	18	8	8	18	6	5	11	12	12	5	10		12

1 - Low, 2 – Medium, 3- High

Semester	**IV**		
Course Name	**INSTRUMENTATION AND CONTROL**		
Course Code	**XME404**		
L –T –P –C **3 – 0 – 0– 3**		**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0– 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	**Ability to Explain** the measurement of various quantities using instruments, their performance terminology - accuracy & range, and the techniques for controlling devices.	**K2**
CO2	**Ability to Describe** the instrumentation system and its elements along with their functional requirements.	**K3**
CO3	**Ability to Differentiate** various control systems with their application, merits and demerits.	**K3**
CO4	**Ability to Demonstrate** various drives used Mechatronics system with thei features	**K3**
CO5	**Ability to Choose** various Controllers in control system appropriate to their system requirements	**K3**
CO6	**Understanding** the instrumentation system models and their functions	**K2**

Objectives

- To understand the importance of measurements , measurement system and their performance terminologies
- To get the knowledge of instrumentation system and their various elements.
- To understand the concepts of control systems, various controllers applications and various control methods with various mechatronics applications.
- To learn and understand the various drives used in mechatronics system with their respective applications.
- To understand the instrumentation system models and their functions

COURSE CONTENT

UNIT I	**MEASUREMENT SYSTEMS AND CHARACTERISTICS**	**9 Hours**
	Measurement systems and performance terminology – accuracy, range, resolution, error sources.	
UNIT II	**INSTRUMENTATION SYSTEMS AND ELEMENTS**	**9 Hours**
	Instrumentation system elements – sensors for common engineering measurements; Signal processing and conditioning; correction elements- actuators: pneumatic, hydraulic, electric	
UNIT III	**DRIVES AND ACTUATORS**	**9 Hours**
	Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper	

	motor, Piezoelectric and Magnetostrictive Actuators. Drive circuits, Hardware Structure, Software Design and Communication, Programmable Logic Devices.	
UNIT IV	**CONTROLLERS**	**9 Hours**
	Control systems – basic elements, open and closed loop control, design of block diagram; control method. P, PI, PID, when to choose what, tuning of controllers	
UNIT V	**MODELS**	**9 Hours**
	System models, transfer function and system response, frequency response; Nyquist diagrams and their use.	
L = 45 Hours	**Tutorial = 0 Hours**	**Total = 45 Hours**

TEXT BOOKS / REFERENCE BOOKS

1.Instrumentation and control systems by W. Bolton, 2nd edition, ISBN: 0750664320 • Pub. Date: August 2004 • Publisher: Elsevier Science & Technology Books

2.Thomas G. Beckwith, Roy D. Marangoni, John H. LienhardV , Mechanical Measurements (6th Edition) 6th Edition, Pearson Education India, 2007

3.Gregory K. McMillan, Process/Industrial Instruments and Controls Handbook, Fifth Edition, McGraw-Hill: New York, 1999.

4.Instrumentation and control systems by V.Sukumaran,V.Muralidharan

5.Journal of control system and control instrumentation

6. Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.)

7. Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	1	1	1	1	1	1	2	1	1	2	1
CO2	2	1	1	1	1	1	1	1	1	2	1	1	2	1
CO3	2	1	1	1	1	1	1	1	1	2	1	1	2	1
CO4	2	1	1	1	1	1	1	1	1	2	1	1	2	1
CO5	2	1	1	1	1	1	1	1	1	2	1	1	2	1
CO6	2	1	1	1	1	1	1	1	1	2	1	1	2	1
Total	12	6	6	6	6	6	6	6	6	12	6	6	12	6

1 - Low, 2 – Medium, 3- High

Semester	**IV**
Subject Name	**Economics for Engineers**
Subject Code	**XUM405**

L –T –P –C	**C:P:A**	**L –T –P –H**
3 - 0 – 0– 3	**2.64:0.24:0.12**	**3- 0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	***Explain*** the concepts of economics in engineering and ***identify*** element of cost to prepare cost sheet	C(Understand) P(Perception)
CO2	***Calculate and Explain*** the Break-even point and marginal costing	C(Apply, Understand) P(Perception)
CO3	***Summarize*** and ***Use*** value engineering procedure for cost analysis	C(Understand) A(Receive)
CO4	***Estimate*** replacement problem	C(Understand)
CO5	***Compute, Explain*** and ***make Use of*** different methods of depreciation	C(Understand, Apply)

COURSE CONTENT

UNIT I	**INTRODUCTION TO ECONOMICS**	**8 hrs**

Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics- types of costing, element of costs, preparation of cost sheet and estimation, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost

UNIT II	**BREAK-EVEN ANALYSIS&SOCIAL COST BENEFIT ANALYSIS**	**12 hrs**

Margin of Safety, Profit, Cost & Quantity analysis-Product Mix decisions and CVP analysis, Profit/Volume Ratio (P/V Ratio), Application of Marginal costing, Limitations

Social Cost Benefit Analysis: compare different project alternatives, Calculate direct, indirect and external effects; Monetizing effects; Result of a social cost benefit analysis.

UNIT III	**VALUE ENGINEERING &COST ACCOUNTING**	**10 hrs**

Value engineering – Function, aims, Value engineering procedure - Make or buy decision

Business operating costs, Business overhead costs, Equipment operating costs

UNIT IV	**REPLACEMENT ANALYSIS**	**7 hrs**

Replacement analysis –Types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset.

UNIT V	**DEPRECIATION**	**8 hrs**

Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the year's digits method of depreciation, sinking fund method of depreciation, Annuity method of depreciation, service output method of depreciation.

L = 45 hrs T = 0 hrs P=0hrs Total = 45 hrs

TEXT BOOKS

1. Sp Gupta, Ajay Sharma & Satish Ahuja, "Cost Accounting", V K Global Publications, Faridabad, Haryana, 2012
2. S.P.Jain&Narang, "Cost accounting – Principles and Practice", Kalyani Publishers, Calcutta, 2012
3. PanneerSelvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2001.
4. William G.Sullivan, James A.Bontadelli& Elin M.Wicks, "Engineering Economy", Prentice Hall International, New York, 2001.

REFERENCES

1. Luke M Froeb / Brian T Mccann, " Managerial Economics – A problem solving approach" Thomson learning 2007
2. Truett&Truett, "Managerial economics- Analysis, problems & cases " Wiley India 8th edition 2004.
3. Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2002.
4. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2002

E-REFERENCES - 1. http://nptel.iitm.ac.in/video.php

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	0	1	0	0	1	1	1	2	2	3
CO2	2	2	1	2	0	0	2	1	1	2	3	3
CO3	2	2	1	3	0	0	2	2	1	2	2	3
CO4	1	2	1	2	0	0	0	1	1	1	2	3
CO5	1	2	0	1	0	0	1	1	0	1	2	3
Total	7	10	3	9	0	0	6	6	4	8	11	15

1 - Low, 2 – Medium, 3- High

Semester	**IV**	
Subject Name	**DISASTER MANAGEMENT**	
Subject Code	**XUM406**	
L –T –P –C **0- 0 – 0– 0**	**C:P:A** **3:0:0**	**L –T –P –H** **3- 0– 0 – 3**

Course Outcome After the completion of the course, students will be able to		**Domain/Level** **C or P or A**
CO1	Understand the concepts of disasters, their significance and types	**K2**
CO2	Understand the relationship between vulnerability, disasters, disaster prevention and risk reduction	**K2**
CO3	Able to understanding of preliminary approaches of Disaster Risk Reduction (DRR)	**K2**
CO4	Develop awareness of institutional processes in the country	**K2**
CO5	Develop rudimentary ability to respond to their surroundings with potentialdisaster response in areas where they live, with due sensitivity	**K3**

COURSE CONTENT

UNIT I	**Introduction to Disasters**	**6 HRS**
	Importance &Significance, Types of Disasters, Climate Change, DM cycle	
UNIT II	**Risk Assessment**	**12 HRS**
	Risk, Vulnerability, Types of Risk, Risk identification, Emerging Risks, Risk Assessment, Damage Assessment, Risk modelling.	
UNIT III	**Disaster Management**	**10 HRS**
	Phases, Cycle of Disaster Management, Institutional Framework, Incident Command System, DM Plan, Community Based DM, Community health and safety, Early Warning and Disaster Monitoring, Disaster Communication, Role of GIS and Remote Sensing, Do's and Don'ts in various disasters.	
UNIT IV	**Disaster Risk Management in India**	**10 HRS**
	Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness), Disaster Management Act and Policy – Other related policies, plans, programmes and legislation	
UNIT V	**Disaster Management: Applications and Case Studies**	**7 HRS**
	Case Studies on Landslide Hazard Zonation, Earthquake Vulnerability Assessment of Buildings and Infrastructure, Drought Assessment, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding, Forest Fire, Man Made disasters, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.	

L = 45 hrs T = 0 hrs P=0 hrs Total = 45 hrs

TEXT BOOKS

1. Singhal J.P. Disaster Management, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
2. Tushar Bhattacharya, Disaster Science and Management, McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361)
3. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011
4. KapurAnu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010

REFERENCES

1. Siddhartha Gautam and K LeelakrishaRao, "Disaster Management Programmes and Policies", Vista International Pub House, 2012
2. Arun Kumar, "Global Disaster Management", SBS Publishers, 2008
3. PardeepSahni, AlkaDhameja and Uma medury, "Disaster mitigation: Experiences and reflections", PHI, 2000
4. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
5. Government of India, National Disaster Management Policy,2009

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- NIDM Publications at http://nidm.gov.in- Official Website of National Institute of Disaster Management (NIDM), Ministry of Home Affairs, Government of India
- http://cwc.gov.in, http://ekdrm.net, http://www.emdat.be, http://www.nws.noaa.gov, http://pubs.usgs.gov, http://nidm.gov.ini http://www.imd.gov.ini

Mapping of CO with PO's

	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1			2	1	1		1		1		1	1		
CO 2	1	1	3	2	3		1	1						
CO 3					2		1		1					
CO 4	1	1	2	2	2		1				1	1		
CO 5	2	3		2	3		1	2	1			2		
Total	4	5	7	7	11		5	3	3		2	4		
Scaled Value	1	1	2	2	3		1	1	1		1	1		

Semester	**IV**	
Subject Name	**Thermal Engineering Laboratory**	
Subject Code	**XME407**	
L –T –P –C **0- 0 – 1– 1**	**C:P:A** **0:1:0**	**L –T –P –H** **0- 0– 2 – 2**

Course Outcome		**Domain/Level** **C or P or A**
CO1	**Measure** flash and fire point of fuels.	**P4**
CO2	**Measure** viscosity of fuels.	**P4**
CO3	**Trace** the position of internal combustion engine and draw port and valve timing diagram	**P3**
CO4	**Measure** the Performance of different type of Diesel engines	**P4**
CO5	**Measure** the Performance of different type of Petrol engines	**P4**
CO6	**Explain** the basic concepts of boiler	**P2**

Objectives:

[1] Determine the valve and port timing diagram of SI engine & CI engine and Analyse the influence of variations in TDC and BDC operations

[2] Calculate the IP, BP, brake thermal efficiency and Calculate & Compare the performance characteristics of engine.

[3] Experiment on IC engine load variations with Air fuel ratio.

[4] Apply the concept of Morse test on SI engine.

[5] Determine the flash and fire point of fuels.

[6] Determine the viscosity of fuels

[7] Study the principle of various parameters in boilers.

COURSE CONTENT

		CO Relation
1	Determination of flash and fire point open cup apparatus	**CO1**
2	Determination of flash and fire point closed cup apparatus	**CO1**
3	Determination of viscosity of given oil using Redwood viscometer	**CO2**
4	Drawing valve timing diagram of four stroke diesel engine	**CO3**
5	Drawing port timing diagram of two stroke cycle petrol engine	**CO3**
6	Performance test on single cylinder four stroke diesel engine- mechanical loading	**CO4**
7	Performance test on single cylinder four stroke diesel engine- eddy current loading	**CO4**
8	Retardation test on a diesel engine at slow speed	**CO4**

9	Performance test on four stroke twin cylinder diesel engine with hydraulic dynamometer loading	**CO4**
10	Performance test on four stroke petrol engine	**CO5**
11	Morse test on four stroke four cylinder petrol engine with hydraulic dynamometer loading	**CO5**
12	Study of boiler	**CO6**

TEXT BOOKS

1. Heywood J. B, "Internal Combustion Engine Fundamentals", McGraw Hill Book Co. NY, 1989
2. Rajput, R.K., Thermal Engineering, 6th Edition, Laxmi Publications, 2007
3. Ballaney, P.L., "Thermal Engineering" , Khanna Publishers, 24th Edition, 2003.
4. K.K. Ramalingam, Internal Combustion Engine Fundamentals, Scitech Publications, 2002.

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1. Rudramoorthy, R., Thermal Engineering, 4th Edition, Tata McGraw Hill, New Delhi, 2006.
2. Kothandaraman , C.P., Domkundwar .S and A.v.Domkundwar", a course in thermal Engineering", Dhanpal Rai & sons, fifth edition, 2002.
3. R.B.Mathur and R.P. Sharma, Internal combustion Engines.

E-REFERENCES

1. https://nptel.ac.in/courses/112/103/112103262/

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	2	1		1	1	2	2	1	1	3
CO2	1	1	2	1	2	1		1	1	2	2	1	1	3
CO3	1	1	2	1	1			1	1	1	1	1	2	2
CO4	3	3	2	1	3	1		2	2	1	3	3	3	3
CO5	3	3	2	1	3	1		2	2	1	3	3	3	3
CO6	1		1	1	1				1	1	1	1	2	3
Total	10	9	11	6	12	4	0	7	8	8	12	10	12	17

Semester	**IV**	
Subject Name	**FLUID MECHANICS AND MACHINES LABORATORY**	
Subject Code	**XME408**	
L –T –P –C **0- 0 – 1– 1**	**C:P:A** **0:1:0**	**L –T –P –H** **0- 0– 2–2**

COURSE OBJECTIVES

This Course will provide

1. Hands on experience on various Instruments in Fluid Mechanics lab.
2. We can test the flow on various through various instruments.
3. Verification of Bernoulli's theorem

CO	CO STATEMENT	Knowledge Level
CO1	Ability to measure discharge through the flow measuring equipment – orifice meter, venturi meter.	**P3**
CO2	Ability to measure losses in pipe flow.	**P3**
CO3	Ability to measure factors affecting the efficiency of a centrifugal pump, reciprocating pump, gear oil pump.	**P3**
CO4	Ability to measure the factors related to the efficiency of Pelton wheel, Francis turbine, Kaplan turbine.	**P3**
CO5	Ability to measure the flow through pipes and notches.	**P3**
CO6	Ability to verify Bernoulli's equation through apparatus.	**P2**

COURSE CONTENT

CO	COURSE DESCRIPTION
1	Determination of the Coefficient of discharge of given orifice meter and venturi mete
2	Determination of friction factor and losses for a given set of pipes.
3	Conducting experiments and drawing the characteristic curves of centrifugal pump / submersible pump
3	Conducting experiments and drawing the characteristic curves of reciprocating pump.
3	Conducting experiments and drawing the characteristic curves of Gear pump.
4	Conducting experiments and drawing the characteristic curves of Pelton wheel.
4	Conducting experiments and drawing the characteristics curves of Francis turbine.
4	Conducting experiments and drawing the characteristic curves of Kaplan turbine.
5	Determination of static and dynamic pressure on pitot tube.
5	Tests on flow through notches.
5	Tests on flow through orifice and external mouthpiece.
6	Verification of Bernoulli's theorem.

L = 0 hrs T = 0 hrs P=30hrs Total =30 hrs

TEXT BOOKS /REFERENCE BOOKS

1. Streeter. Bedford, and Wylie, Fluid Mechanics, McGraw Hill, 9th edition, 2017.
2. Rathakrishnan. E, Fluid Mechanics, Prentice Hall of India (II Ed.), 2007.
3. Ramamritham. S, Fluid Mechanics, Hydraulics and Fluid Machines, Dhanpat Rai &

Sons, Delhi, ninth edition, 2014.
4. Som, S.K., and Biswas, G., "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw-Hill, 3rd Edition, 2017.
5. Kumar. K.L., Engineering Fluid Mechanics (VII Ed.) Eurasia Publishing House (P) Ltd., New Delhi, 2005.
6. Bansal, R.K., Fluid Mechanics and Hydraulics Machines, Laxmi Publications (P) Ltd., New Delhi, 10th edition, 2018.

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http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1	3		2		3		1	2	2	
CO2	3	3	1	1	3		2		3		1	2	2	
CO3	3	3	1	3	2		2		2		1	3	3	
CO4	3	3	1	3	2		3		3		1	3	2	
CO5	3	2	2	2	3		2		1		0	3	2	
CO6	3	2	2	2	2		1		1		0	2	2	
TOT	18	16	8	12	15	0	12	0	13	0	4	15	13	0

1 -Low, 2 – Medium, 3- High

XECHR2- Industrial Robotics and Automation	L	T	P	C
	1	0	2	3
	L	T	P	H
	1	0	4	5

PREREQUISITE:

	COURSE OUTCOMES	DOMAIN	LEVEL
After the completion of the course, students will be able to			
CO1	***Understand*** the Anatomy of an Industrial Robot	Cognitive	Knowledge Comprehension
CO2	***Operate*** Industrial Robot (Robot Jogging, OnlineProgramming)	Psychomotor Affective	Comprehension Application
CO3	***Virtually Commission*** a Robot Work cell usingABB Robot Studio	Psychomotor Affective	Application Synthesis
CO4	***Program*** an Industrial Robot using RapidProgramming Language	Psychomotor Affective	Application Synthesis
CO5	***Understand*** the construction of logic circuits using PLC	Cognitive	Knowledge Comprehension

UNIT I	**Fundamentals of Industrial Robotics**	**3+6**

Basics of Industrial Robot - What is an Industrial Robot? - Building blocks of Industrial Robots - Robot Modes & Manual Motion Types - Major Stakeholders of Industrial Robotics - Robotics Environment & Career - Offline Simulation Tool - Industrial Robot Operation - Usage and Applications of Industrial Robots - Automatic Motion Types – Introduction to Robot Studio - Importing robot and virtual controller - Robot Specification - Robot Jogging - What is a Teach Pendent? - Creating targets & paths - Robot Frames - Modes of operation - Industrial Robot Programming Language - Types of Robot Programming - Various Robot Programming languages - Motion Commands in RAPID - Path planning

Lab:

1. **Fundamentals of Robot Studio**
2. **Robot Jogging in ABB Robot Studio**
3. **Robot Modes of Operation**
4. **Online Programming using Virtual Teach Pendant**
5. **Creating & Teaching Targets and Paths**

UNIT II	**Virtual Commissioning using Industrial Robot**	**3+12**

What is Virtual Commissioning - What is Robot Dispensing - Import Robot & - Components – Dispensing - Dispensing Robot Work cell - Auto Path and Tool Orientation Correction - Path Planning for Dispensing - Material Handling - Robot Work cell - Smart Components Design - Gripper Integration with Robot - Pick & Place with ABB Smart Gripper - Material stacking - Logical Design and Virtual Controller - End Effector Communication - Material Stacking and Station Logic

Lab:

6. **Virtual Commissioning of Robot Dispensing work cell**
7. **Auto path in ABB Robot Studio**
8. **Virtual Commissioning of Material Handling Operation**
9. **Virtual Commissioning of Material Stacking Operation**

UNIT III	**Build Robot Work cells using ABB Powerpacs**	**3+6**

What is a Powerpac – Working on conveyor Tracking - What is Conveyor Tracking? - Introduction to parallel Robots - Logic Formulation of Conveyor Tracking - Conveyor Tracking in ABB Robot studio - Robot Powerpacs – Palletizing Introduction to Palletizing operation - Component Checklist in Palletizing work cell - Virtual commissioning of a Robot Palletizing Work cell - Cycle time analysis - Robot Powerpacs - 3D printing - Introduction to Rapid Prototyping - Various Rapid Prototyping Techniques - Fundamentals of 3D printing - Virtual commissioning of a robot 3D printing work cell - Robot Powerpacs - Arc welding - Introduction to Arc welding - Characteristics of Arc welding operation - Applications of Industrial Robots in Arc welding Operation - Virtual Commissioning of Robot Arc welding Work cell **Lab:**

10. **Conveyor Tracking in ABB Robot studio**
11. **Building a Palletizing operation using Palletization powerpac**
12. **Optimizing operation Cycle time**
13. **Building a robot 3D printing operation using 3D printing powerpac**
14. **Building an Arc welding operation using Arc welding powerpac**

UNIT IV	**Robot Operation**	**3+9**

Robot Operation – Understanding the anatomy of industrial robot - Robot work envelope - Robot specifications - Remote operation of Manipulator - What is lead through programming? - Joint Interpolation and Linear Interpolation - Jogging of robots - Online programming - Path planning using lead through programming - Robot End Effector – Performing the robot application – Creating Tool Centre Point –Optimizing Cycle Time – Working with IRC5 – Working with Emergency and General Stops - Robot Safety Procedures - Robot Maintenance & Servicing

Lab:

15. **Robot Jogging of ABB Robot using Teach pendant**
16. **Robot Safety & Maintenance**
17. **Creating and calibrating Tool center point**
18. **Working with Industrial Robot Controller 5**
19. **Online Programming with Teach Pendant**
20. **Building Robot Application using ABB Robot**

UNIT V	**Programmable Logic Controllers**	**15**

Introduction to Indra Logic – Understanding the construction of basic logic circuits – AND,OR,NOT etc – Logic circuit simulation- set, rest, latching, sub programming - Introduction to Hardware kit L20DB .Function-user define function and library function-timers –Ontimer,OFF timer, Counters-UP counter and Down counter,Triggers-Riseing trigger and falling triggers

Lab:

21.Traffic light signal control
22.Oil tank filling station
23.Double acting cylinders
24.Integration of sensors with PLC
25.Smart room

LECTURE	TUTORIAL	PRACTICAL	AL HOURS
12	0	33	60

TEXT BOOKS:

Introduction to Robotics by J.J. Craig, Addison-Wesley Publishing Company, 1986 owozin and Lampert

REFERENCES:

Programming and Virtual Commissioning Reference Material by Prag RoboticsABB Robot Studio Official Documentation
The Robotics Primer, Maja J. Mataric, MIT Press, 2007

E-REFERENCES:

Robot Modeling and Control", Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, 2005
NPTEL :: Electrical Engineering - Industrial Automation and Control

Semester	**V**	
Subject Name	**Heat Transfer**	
Subject Code	**XME501**	
L –T –P –C **3 - 1 – 0– 4**	**C:P:A** **3.5:0.25:0.25**	**L –T –P –H** **3- 1– 0 – 4**

Course Outcome		**Domain/Level** **C or P or A**
CO1	Understand the basic modes of heat transfer	**K2**
CO2	Compute temperature distribution in steady-state and unsteady-state heat conduction.	**K1**
CO3	Interpret and analyse forced and free convection heat transfer.	**K3**
CO4	Understand the principles of radiation heat transfer and basics of mass transfer.	**K2**
CO5	Apply the LMTD and NTU methods for heat exchangers.	**K3**
CO6	Understand the basic concepts of mass transfer	**K2**

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) Rigorous treatment of governing equations and solution procedures for the three modes will be 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 CONTENT

UNIT I	**CONDUCTION**	**9+3 hrs**
	Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer- approximate solution to unsteady conduction heat transfer by the use of Heissler charts.	
UNIT II	**CONVECTION**	**9+3 hrs**
	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 forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.	
UNIT III	**RADIATION**	**9+3 hrs**
	Interaction of radiation with materials, definitions of radiative properties, Stefan	

	Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method.	
UNIT IV	**HEAT EXCHANGERS**	**9+3 hrs**
	Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and ε-NTU methods .Boiling and Condensation heat transfer, Pool boiling curve.	
UNIT V	**MASS TRANSFER**	**9+3 hrs**
	Introduction mass transfer, Similarity between heat and mass transfer	
L = 45 hrs T = 15 hrs P=0hrs Total = 60 hrs		

TEXT BOOKS

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, John Wiley, Sixth Edition, 2007.
4. MassoudKaviany, Principles of Heat Transfer, John Wiley, 2002
5. Yunus A Cengel, Heat Transfer: A Practical Approach, McGraw Hill, 2002.

E-REFERENCES

1. http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	1	-	-	1	-	-	1		2
CO2	3	2	-	2	1	1		-	-	-	-	1		2
CO3	3	2	-	2	1	1		-	-	-	-	1		2
CO4	2	3	3	2	1	1	1	-	1	-	-	1		2
CO5	2	3	3	2	1	1	1	-	1	-	-	1		2
CO6	3	2	2	1	1	1	1	-	-	-	-	1		2
Total	16	14	14	11	6	6	3		3			6		12

1 - Low, 2 – Medium, 3- High

Semester	**IV**
Course Name	**SOLID MECHANICS**
Course Code	**XME502**

L –T –P –C	**C:P:A**	**L –T –P –H**
3 – 1 – 0– 4	**3.5:0.25:0.25**	**3–1– 0 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	Understand the basic concept of stress and strain	**K2**
CO2	Apply Cauchy relation in stresses and its directions	**K3**
CO3	Understand constitutive relations for simple geometries	**K2**
CO4	Apply the deformation concepts for plane stress and plane strain problems	**K3**
CO5	Apply the deformation concepts for complex cases	**K3**
CO6	Understand energy and potential methods.	**K2**

Objectives:

The objective is to present the mathematical and physical principles in understanding the linear continuum behavior of solids.

COURSE CONTENT

UNIT I	**STRAIN AND STRESS**	**9+3 = 12 Hours**

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

UNIT II	**CONSTITUTIVE EQUATIONS**	**9+3 = 12 Hours**

Constitutive equations: Generalized Hooke's law, Linear elasticity, Material symmetry; Boundary Value Problems: concepts of uniqueness and superposition.

UNIT III	**PLANE STRESS AND PLANE STRAIN**	**9+3= 12 Hours**

Plane stress and plane strain problems, introduction to governing equations in cylindrical and spherical coordinates, axisymmetric problems.

UNIT IV	**APPLICATION TO COMPLEX CASES**	**9+3 = 12 Hours**

Application to thick cylinders, rotating discs, torsion of non-circular cross-sections, stress concentration problems, thermo-elasticity, 2-d contact problems.

UNIT V	**ENERGY METHODS**	**9+3 = 12 Hours**

Solutions using potentials. Energy methods. Introduction to plasticity.

L = 45 Hours **Tutorial = 15 Hours** **Total = 60 Hours**

TEXT BOOKS

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

international, 1969.

REFERENCES

1. S. M. A. Kazimi, Solid Mechanics, First Edition, Tata McGraw Hill Publications, 2001.

E-REFERENCES

1. https://nptel.ac.in/courses/112107147
2. https://nptel.ac.in/syllabus/105101003

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	2	1	-	-	-	1	-	-	-	2	
CO2	3	2	-	2	1	-	-	-	1	-	-	-	2	
CO3	3	2	-	2	1	-	-	-	1	-	1	1	2	
CO4	3	1	-	1	1	-	-	1	1	-	1	1	2	
CO5	3	2	-	2	1	-	-	-	1	-	-	-	2	
CO6	3	3	3	3	2	-	-	2	1	-	3	3	2	
	18	12	3	12	7			3	6		5	5	12	

1 - Low, 2 – Medium, 3- High

Semester	**V**	
Subject Name	**MANUFACTURING PROCESSES**	
Subject Code	**XME503**	
L –T –P –C **3- 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3- 0– 0 – 3**

Course Outcome		**Domain/Level** **C or P or A**
CO1	Summarize the metal casting processes.	**K2**
CO2	Understand various Metal Forming processes and Powder Metallurgy.	**K2**
CO3	Relate the various cutting force components for machining operation.	**K2**
CO4	Compare various additive manufacturing and joining process	**K2**
CO5	Explain electrical energy and chemical based unconventional machining process	**K2**
CO6	Explain mechancial and thermal energy based unconventional machining process	**K2**

Objectives:

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

UNIT I	**CASTING AND METAL FORMING PROCESSES**	**10 hrs**
	Casting and moulding: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses. 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.	
UNIT II	**METAL CUTTING**	**10 hrs**
	Single and multi-point cutting; Orthogonal cutting, various force components: Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, Cutting tool materials, Cutting fluids, Coating. Lathe, drilling machine, milling machine, shaper, slotter and planer. Machine tool operations - Turning, Drilling, Milling, Shaping and finishing processes. Introduction to CNC machining	
UNIT III	**ADDITIVE AND JOINING PROCESSES**	**9 hrs**
	Rapid prototyping and rapid tooling – 3D printing. Physics of welding - arc and gas welding processes - advantages and limitations - Design considerations in welding. Solid and liquid state joining processes - Adhesive bonding. Brazing and soldering.	

UNIT IV	**MECHANICAL AND THERMAL ENERGY BASED UNCONVENTIONAL MANUFACTURING PROCESSES**	**8 hrs**
	Introduction to Unconventional Machining Techniques – Types, comparison with conventional machining techniques Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining. Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic, Machining, principles and process parameters	
UNIT V	**ELECTRICAL AND ELECTROCHEMICAL ENERGY BASED UNCONVENTIONAL MANUFACTURING PROCESSES**	**8 hrs**
	Electrical Discharge Machining, principle and processes parameters, dielectric, power and control circuits, wire EDM. Electro-chemical machining (ECM), etchant & maskant, process parameters.	
L = 45 hrs T = 0 hrs P=0 hrs Total = 45 hrs		

TEXT BOOKS

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (6th Edition)-Pearson India,2018
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems
3. Degarmo, Black &Kohser, Materials and Processes in Manufacturing

REFERENCES

1. Paul Degarma E, Black J.T. and Ronald A. Kosher, Elighth Edition, Materials and
2. Processes, in Manufacturing Prentice – Hall of India, 2003.
3. Sharma, P.C., A Text book of Production Technology, S. Chand and Co. Ltd., 2004.
4. P.N. Rao, Manufacturing Technology- Foundry, Forming and Welding, TMH-2003; 2nd Edition, 2003
5. Roy. A. Lindberg, Processes and Materials of Manufacture, PHI / Pearson Education, 2006.
6. Benedict. G.F. "Nontraditional Manufacturing Processes", Marcel Dekker Inc., New York, 1987.
7. Mc Geough, "Advanced Methods of Machining", Chapman and Hall, London, 1998
8. Paul De Garmo, J.T.Black, and Ronald.A.Kohser, "Material and Processes in Manufacturing" Prentice Hall of India Pvt. Ltd., 8thEdition, New Delhi , 2001.

E-REFERENCES

1. http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	2	-	-	2	-	1	2	3	3	
CO2	3	3	3	1	2	-	-	2	-	1	2	3	3	
CO3	3	3	3	1	2	-	-	2	-	1	2	3	3	
CO4	3	3	3	-	2	-	-	2	-	1	2	3	3	
CO5	3	3	3	-	2	-	-	2	-	1	2	3	3	
CO6	3	3	3	-	2	-	-	2	-	1	2	3	3	
	18	18	18	2	12	-	-	12	-	6	12	18	18	

1 - Low, 2 – Medium, 3- High

Semester	**V**
Subject Name	**KINEMATICS AND THEORY OF MACHINES**
Subject Code	**XME504**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 1 – 0– 4	**4:0:0**	**3- 1– 0– 4**

Course Outcome		**Domain/Level C or P or A**
CO1	Define various components of mechanisms	**K1**
CO2	Develop mechanisms to provide specific motion	**K3**
CO3	Outline the velocity and acceleration diagrams of various mechanisms	**K2**
CO4	Outline the cam profile for the specific follower motion	**K2**
CO5	Analyse forces in various gears	**K4**
CO6	Select appropriate power transmission for specific application	**K5**

Objectives:

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

COURSE CONTENT

UNIT I	**BASICS OF MECHANISMS**	**9+3 hrs**

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

UNIT II	**KINEMATICS OF PLANE MECHANISMS**	**9+3 hrs**

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- Coriolis component of acceleration- introduction to linkage synthesis- three position graphical synthesis for motion and path generation

UNIT III	**CAMS**	**9+3 hrs**

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.

UNIT IV GEARS 9+3 hrs

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

UNIT V FRICTION IN BEARING CLUTHES AND BRAKES 9+3 hrs

Surface contacts- sliding and rolling friction- friction drives- bearings and lubrication- friction clutches- belt and rope drives- friction in brakes

L = 45 hrs T = 15hrs Total = 60 hrs

TEXT BOOKS

1. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
2. CleghornW.L. , Mechanisms of Machines, Oxford University Press, 2005.
3. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGrawHill, 2009.
4. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East-West Pvt. Ltd, New Delhi, 1988.

REFERENCES

1. Rao.J.S. and Dukkipati.R.V. 'Mechanisms and Machine Theory', Wiley-Eastern Ltd., New Delhi, 2003.
2. John Hannah and Stephens R.C., 'Mechanics of Machines', Viva Low-Prices StudentEdition, 2003.

E-REFERENCES

1. http://nptel.iitm.ac.in/courses

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	2	1	-	2	1	-	2	3	2	
CO2	3	1	1	-	2	1	-	2	1	-	2	3	2	
CO3	3	2	3	-	2	1	-	2	1	-	2	3	2	
CO4	3	2	3	-	2	1	-	1	1	-	2	3	2	
CO5	3	2	3	-	3	1	-	2	2	-	2	3	2	
CO6	3	2	2	-	3	1	-	2	1	-	2	3	2	
	18	**10**	**13**	**-**	**14**	**6**	**-**	**11**	**7**	**-**	**12**	**18**	**12**	

1 - Low, 2 – Medium, 3- High

Semester	**V**	
Subject Name	**Heat Transfer and Refrigeration Laboratory**	
Subject Code	**XME507**	
L –T –P –C **0- 0 – 1– 1**	**C:P:A** **0:1:0**	**L –T –P –H** **0- 0– 2 – 2**

Course Outcome		**Domain/Level** **C or P or A**
CO1	***Measure*** the Thermal conductivity under varying conditions	**K2,P3**
CO2	***Determine*** the Heat transfer coefficient using appropriate apparatus	**K2,P3**
CO3	***Measure*** the effectiveness of different Heat exchanger	**K2,P3**
CO4	***Determine*** Stefan-Boltzmann constant.	**K2,P3**
CO5	***Determine*** the Emissivity of grey Surface.	**K2,P3**
CO6	***Determine*** performance characteristics of a Vapour compression refrigeration system and vapour adsorption refrigeration system	**K2,P4**

Objectives:

1. Understand the various forms of heat transfer and their applications in real life problems.
2. Analyze different methods to calculate the heat transfer coefficient in various heat transfer problems.
3. Analyze the theoretical knowledge and apply it in conducting experiments in heat transfer and Refrigeration studies.

COURSE CONTENT

		CO Relation
1	Thermal conductivity measurement by guarded plate method	**CO1**
2	Thermal conductivity of pipe insulation using lagged pipe apparatus	**CO1**
3	Natural convection heat transfer from a vertical cylinder	**CO2**
4	Forced convection inside tube	**CO2**
5	Heat transfer from pin-fin Apparatus - natural convection mode	**CO2**
6	Heat transfer from pin-fin Apparatus - forced convection mode	**CO2**
7	Effectiveness of Parallel flow heat exchanger	**CO3**
8	Effectiveness of Counter flow heat exchanger	**CO3**
9	Determination of Stefan-Boltzmann constant	**CO4**
10	Determination of emissivity of a grey surface	**CO5**
11	Determination of the performance characteristics of a vapour compression system	**CO6**
12	Study of vapour adsorption refrigeration system	**CO6**

TEXT BOOKS

1. Sachdeva R C, “Fundamentals of Engineering Heat and Mass Transfer” New Age International, 1995.
2. Yadav R “Heat and Mass Transfer” Central Publishing House, 1995.
3. Holman J.P “Heat and Mass Transfer” Tata McGraw-Hill, 2000.
4. Rajput, R.K., Thermal Engineering, 6th Edition, Laxmi Publications, 2007
5. Ballaney, P.L., “Thermal Engineering” , Khanna Publishers, 24th Edition, 2003

1. Nag P.K, “ Heat Transfer”, Tata McGraw-Hill, New Delhi, 2002
2. Kothandaraman C.P “Fundamentals of Heat and Mass Transfer” New Age International, New Delhi, 1998
3. Rudramoorthy, R., Thermal Engineering, 4th Edition, Tata McGraw Hill, New Delhi, 2006.

E-REFERENCES

1. http://nptel.iitm.ac.in/courses

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	2	1	1	-	-	1	-	-	1		2
CO2	2	3	-	2	1	1	-	-	-	-	-1	1		2
CO3	2	3	-	2	1	1	-	-	1	-	-	1		2
CO4	2	3	2	1	1	1	-	-	1	-	-1	1		2
CO5	2	3	2	1	1	1	-	-	1	-	-1	1		2
CO6	2	3	-	2	1	1	-	-	-	-	-1	1		2
Tot	12	18	4	10	6	6			4		4		6	12

1 - Low, 2 – Medium, 3- High

Semester	**V**	
Subject Name	**Kinematics and Theory of Machines Lab**	
Subject Code	**XME508**	
L –T –P –C **0- 0 – 1– 1**	**C:P:A** **0:1:0**	**L –T –P –H** **0- 0– 2 – 2**

Course Outcome		**Domain/Level** **C or P or A**
CO1	***Recall*** basics of different types of mechanisms and ***Sketches*** the velocity and acceleration in planar mechanisms.	**K3, P5**
CO2	***Construct*** cam profile for specific follower motion.	**K3**
CO3	***Describes*** and ***Solve*** problems in gears and gear trains.	**P7**
CO4	***Calculate*** the inertia forces in reciprocating and rotating masses and turning moments in flywheels.	**K4, P7**
CO5	**Balance** reciprocating and rotating masses and ***analyze*** free vibration systems and ***measure*** the frequency of damped and forced vibration systems.	**K4,P4**
CO6	***Recognize*** the gyroscopic effect in mechanical applications and ***identifying*** the equilibrium speed using governors.	**K1, P7**

Objectives:

To understand the principles in mechanisms used for governing of machines.

To impart the knowledge about the effect of forces on the machines and the methods to control them.

COURSE CONTENT

		CO Relation
1	Drawing of some common mechanisms	**CO1**
2	Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms	**CO1**
3	Drawing displacement, velocity and acceleration diagrams	**CO1**
4	Drawing of various cam profiles and motion curves	**CO2**
5	Cam - Study of jump phenomenon	**CO2**
6	Constructing simple and epicyclic gear trains	**CO3**
7	Determination of velocity ratios - simple, compound, Epicyclic and differential gear trains.	**CO3**
8	Determination of Mass moment of inertia of Fly wheel and Axle system.	**CO4**
9	Transverse vibration of free Beam.	**CO4**
10	Whirling of shaft-Determination of critical speed of shaft with concentrated loads.	**CO5**
11	Balancing of reciprocating and rotating masses.	**CO5**
12	Motorised Gyroscope - Determination of gyroscopic couple.	**CO6**
13	Governors - Determination of sensitivity, effort, etc. for Watt, Porter, Proell, Hartnell governors	**CO6**

TEXT BOOKS

1. Ambekar A.G, "Mechanism and Machine Theory" Prentice Hall of India, New Delhi, 2007.
2. Shigley J.E. ,Pennock G.R.and Uicker.J.J., 'Theory of Machines and Mechanisms', Oxford University Press,2003.

REFERENCES

1. Thomas Bevan, 'Theory of Machines', CBS Publishers and Distributors, 2008.
2. Ghosh.A, and A.K.Mallick, 'Theory of Mechanisms and Machines', Affiliated East-West Pvt. Ltd., New Delhi, 2007.
3. Rao.J.S. and Dukkipati.R.V. 'Mechanisms and Machine Theory', Wiley-Eastern Ltd., New Delhi, 2003.
4. John Hannah and Stephens R.C., 'Mechanics of Machines', Viva Low-Prices Student
5. Edition, 2003.

E-REFERENCES

1. http://nptel.iitm.ac.in/courses

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	2	1	1	-	-	1	-	-	1	2	
CO2	2	3	-	2	1	1	-	-	-	-	1	1	2	
CO3	2	3	-	2	1	1	-	-	-	-	1	1	2	
CO4	2	3	-	2	1	1	-	-	1	-	-	1	2	
CO5	2	3	2	1	1	1	-	-	1	-	1	1	2	
CO6	2	3	-	2	1	1	-	-	-	-	1	1	2	
Tot	**12**	**18**	**2**	**11**	**6**	**6**	**-**	**-**	**3**	**-**	**4**	**6**	**12**	

1 - Low, 2 – Medium, 3- High

Semester	**V**
Subject Name	**Inplant Training – II**
Subject Code	**XME509**

L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 0– 1	**0:1:0**	**0- 0– 0 – 0**

Course Outcome	**Domain/Level**
	C or P or A

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.

XECHR3-Fundamentals of ROS and Embedded in Robotics	**L**	**T**	**P**	**C**
	1	**0**	**2**	**3**
	L	**T**	**P**	**H**
	1	**0**	**4**	**5**

PREREQUISITE:

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
After the completion of the course, students will be able to			
CO1	***Design*** Robot architecture based on the Environment condition	Psychomotor	Application Synthesis
CO2	***Understand*** uncertainty in sensors and ***develop*** sensor models	Cognitive Psychomotor	Knowledge Comprehension Application
CO3	***Perform*** Path planning and navigation in unknown environment	Psychomotor	Application Synthesis
CO4	***Build*** Robot Software using Robot OperatingSystem	Psychomotor Affective	Application Synthesis
CO5	**Understand** the programming concept infirebird V kit	Cognitive Psychomotor	Knowledge Comprehension Application

UNIT I	**Essentials for Robot Operating System**	**3+6**

Introduction to Mobile Robots - What is a Mobile Robot? - Different Types of Mobile Robot - Applications of Mobile Robots - Architecture of a Mobile Robot - Challenges in Mobile Robotics - Different Robot Drives – Wheeled Robotics - Characteristics of a Wheeled Robot - Different Types of Mobile Robot Drives - Holonomic and Non- Holonomic Motion - Various Steering Mechanisms – Robot Paradigms - What is a Robot Paradigm? - Working with Reactive Paradigm - Introduction to Deliberative Paradigm - Working with Hybrid Paradigm – Introduction to ROS - What is Simulation? - Need for Simulation - Simulation Environments for Robotics - What is ROS? - Features of ROS - ROS - Types, Distributions & Programming languages – Software Installation - Installing Virtual Machine - Installing Ubuntu - Installing ROS

- Checking of ROS Installation - Installing VS Code - Explain Basic Movement – Linux Basics - Understanding File Hierarchy and Navigation - Understanding File Permissions - File and Folder Handling - Administrative Management - Package Management – C++ basics - Enabling C++ Extensions - Datatypes & Variables – Loops

- Conditional Statements

Lab:

1. **Crash course on Linux management**
2. **Foundations of C++**
3. **Crash Course on Python**

UNIT II	**Fundamentals of Robot Operating System**	**4+6**

Fundamentals of ROS - Creating Catkin Workspace - Understanding Packages - Create ROS Package - Building Environment in Gazebo - Installation of TurtleBot Packages -Import In-built Robots in ROS - Installing Teleoperation Dependencies - Teleoperation

of Mobile Robot in ROS - Understanding ROS Nodes - Intuition of ROS Topics - ROS Services and Parameters - ROS Launch - Introduction to ROS Message and SRV - ROS Publisher and Subscriber - Build Custom Robot in ROS - Principle of Differential Drive Robot - Building URDF File and Robot Base - Building Robot Wheels - Joining Wheels and Base - Test URDF File - Creating Launch File and Launching Code - Visualization using RViz - Creating Macro-Based Files - Programming Robot Macro File - Programming Gazebo Macro File - Converting Macro File to URDF - Creating Launch Files and Folder - Creating Launch File for Gazebo - Creating Launch File for Environment - Creating Robot World - Launching Gazebo Environment - Programming Mobile Robot Macro File - Teleoperation of Mobile Robots

Lab:

4. **Fundamental Operations of Robot operating system**
5. **Teleoperation of Turtle Bot in ROS**
6. **Building a URDF file for Mobile Robot**
7. **Foundations of Rviz and Gazebo**
8. **Programming Gazebo Macro files**
9. **Programming Differential Robot Macro file**

UNIT III	**Robot Perception in Robot Operating System**	**5+9**

Introduction to Robot Perception - What is Robot Perception? - Sensor Classification Characterizing sensor performance - Representing Uncertainty - Introduction to Proximity sensors - Modifying Robot Macro File for SONAR - Modifying Gazebo Macro File for SONAR - Executing SONAR Robot – Robot Vision in ROS - Vision Sensors for Robotics - Basic Image Processing Operations in OpenCV - What is CV Bridge? - Video Processing in ROS - Understanding Template Matching - Template Matching using CV Bridge – Uncertainty in Robot Sensors – Handling Sensors using - Probability – Robot Localization - What is Localization? - Challenges in Robot Localization – What is Kalman Filter – Kalman Gain - Kalman Filter Localization Adaptive Monte Carlo Localization – Introduction to Robot Mapping - What is Robot Mapping? - Map Representation - Autonomous Mapping techniques - Introduction to - Occupancy Grid maps - Creating Launch File

Lab:

10. **Obstacle detection and Avoidance in Robot Operating System**
11. **Foundations of Robot Vision in ROS**
12. **Template matching in ROS**
13. **Kalman Filter Localization in ROS**
14. **Building Map using LIDAR and Gmapping Package**
15. **Adaptive Monte Carlo Localization in Robot Operating System**

UNIT IV	**Path planning and Navigation**	**5+12**

Path planning and Navigation - What is Robot Path planning? - Road Map path planning - Visibility Graphs - Potential Field Path planning - Obstacle Avoidance - Working with Bug Algorithms - Dynamic Window approach - Understanding Navigation Architectures - Navigation Stack in ROS – Introduction to SLAM - What is Simultaneous Localization and Mapping - Challenges in Simultaneous Localization and Mapping - Various SLAM Techniques - Performing Simultaneous Localization and mapping in ROS – Working with Visual SLAM - Understanding Visual Odometry

– Challenges in Simultaneous localization and Mapping

Lab:

16. **Path Planning of Mobile Robot using Local planner**
17. **Working with Dynamic Window approach in ROS**
18. **Working with Navigation stack in ROS**
19. **Application of SLAM in ROS**
20. **Visual Odometry in ROS**

UNIT V	**Embedded system programming using e-yantra**	**10**

Introduction to Eyantra team-Architecture of Fire bird V kit-sensors in firebird V kit-encoders- Introduction to embedded system coding and burning of code.

Lab:

21.Line tracking robot
22.Programming for s curved motion
23.Programming for obstacle detection
24.Material handling system
25.Service/Survey bot

LECTURE	**TUTORIAL**	**PRACTICAL**	**AL HOURS**
17	**0**	**33**	**60**

TEXT BOOKS:

Introduction to Autonomous Mobile Robots, 2nd Edition, Roland Siegwart, Illah R. Nourbakhsh, and Davide Scaramuzza, MIT Press, 2011

REFERENCES:

Modern Robotics: Mechanics, Planning, and Control, Kevin M. Lynch and Frank C.Park, Cambridge University Press, 2017, ISBN 9781107156302 Planning Algorithms, Steven M. LaValle, Cambridge University Press, 2006 Computational Principles of Mobile Robotics, Gregory Dudek and Michael Jenkin, Cambridge University Pres, 2010
E-REFERENCES:
Thrun, Burgard, Fox: Probabilistic Robotics, MIT Press, 2005 NPTEL :: Electrical Engineering - Industrial Automation and Control

XECHR4- Artificial Intelligence and Computer Vision forRobotics	**L**	**T**	**P**	**C**
	1	**0**	**2**	**3**
	L	**T**	**P**	**H**
	1	**0**	**4**	**5**

PREREQUISITE:

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
After the completion of the course, students will be able to			
CO1	Student can ***define*** and ***describe*** intelligence and ***explain*** how it can be imparted in Machines	Cognitive	Comprehens ion Knowledge Analysis
CO2	***Build, Deploy and Tune*** Machine LearningModels	Psychometer Affective	Application Synthesis Analysis
CO3	***Build*** and ***Integrate*** Vision pipelines with Digitalimage processing techniques	Cognitive Psychomotor Affective	Application Synthesis
CO4	***Extract*** and ***Detect*** Features from Images, Videosand ***compare*** feature extraction methods	Cognitive Psychomotor Affective	Application Evaluation
CO5	***Develop*** Deep learning Based Robot Applications	Psychometer Affective	Application Synthesis

UNIT I	**Foundations of Artificial Intelligence**	**3+6**

Introduction to Artificial Intelligence - What is Artificial Intelligence? - Different paradigms in Artificial Intelligence - Applications of Artificial Intelligence in Robotics – Elements of Artificial Intelligence - What is an Agent - Different types of Agents - What is an Environment - Nature of the environments – Search Algorithms in Robotics What is Search - Uninformed Search - Different Uninformed Search Algorithms - Implementation of BFS algorithm in Python - Greedy search algorithm - A* Algorithm Finding Optimal Path using Search algorithms - Robot Navigation using A* Algorithm – What is State estimation? – Noise in Robot Sensors – Working with particle Filters

Lab:

1. **Implementation of Breadth First Search Algorithm in Python**
2. **Robot Navigation using A* algorithm**
3. **Implementation of Particle filter in Python**

UNIT II	**Nuances for Machine Learning**	**3+9**

Introduction to Machine learning - What is Machine Learning? - Paradigms in Machine learning - Difference between classical AI and Machine Learning - Applications of Machine Learning - Introduction to Python Packages – NumPy - What is NumPy? - Arrays in NumPy - Creating Vectors – Matrices - Matrix Operations - Trace, Determinant, Inverse - Sparse Matrix - n-dimensional array - Introduction to Python Packages – Pandas - Introduction to Data frames, Data structures - Data sorting - Data Iteration - Handling Text data - Introduction to Machine Learning - Basics of Machine Learning - Types of Machine Learning - Machine Learning Algorithms - Mathematical foundations - Supervised Learning – Classification - Difference between regression and classification - Introduction to Logistic Regression and support vector machine -Mathematical foundations-Logistic Regression - Programming of Logistic Regression in Python-scikit learn

Lab:

4. **Essentials of Python for Machine Learning – NumPy**
5. **Essentials of Python for Machine Learning – Pandas**
6. **Building a Logistic Regression Model in Python**
7. **Building a Support Vector Machines Model in Python**

UNIT III	**Computer Vision for Robotics**	**2+6**

Fundamentals of Computer Vision - Introduction to Computer vision - Applications of Computer vision - Difference between computer vision and Digital Image Processing - Introduction to Image formation - Introduction to vision sensors - Whatis an Image? - How is an Image formed? - Image formation using Lens - Pinhole & Perspective projection – Depth of Field - Image parameters - Primitives and Transformations - Geometric Image formation - Camera Model – Image sensing - Image sensing Pipeline - Types of Image sensors - Characteristics of an Image sensor - Sensing Color - Camera response and stereo imaging - Fundamentals of Image operations - Image Processing - Installation of OpenCV - Reading Images - Reading Videos - Changing Color spaces - Image Resizing - Color Change - Pixel Manipulation

-Blurring Image – Blending - Subtraction – Image – Thresholding & Filtering - What is Thresholding - Working and Types of Thresholding - Introduction to Simple Thresholding - Programming Simple Thresholding – Color - What is Adaptive Thresholding - Types of Adaptive Thresholding - Adaptive Thresholding - Gaussian & Mean - What is an Image Filter - Noise in Images = Working with Gaussian Filter - Working with Sobel Filter - Working with Prewitt Filter

Lab:

8. **Fundamentals of Image Processing in OpenCV**
9. **Image Thresholding and Filtering**
10. **Morphological Operations in OpenCV**

UNIT IV	**Feature Extraction and Object Recognition**	**3+12**

Feature Extraction - Introduction to Feature extraction - Various Feature Extraction Techniques - What is Edge detection? - Various Edge detection techniques - Boundary Detection – Skeletonization - Introduction to Histogram of Gradients - Understanding Feature Matching Using HOG - Introduction to SIFT detector - Image Stitching - Motion Detection - What is Motion Detection? - Motion field - Introduction to Optical Flow - Optical Flow constraint equation - Introduction to Dense Optical Flow - Applications of Optical Flow - Image Recognition I – What is Image recognition – Challenges in Image Recognition – Feature Extraction - Introduction to Dimensionality Reduction - Principle Component Analysis - Creating final Dataset for Image Recognition - Introduction to Support Vector Machines - Mathematical Intuition of SVM - Generation of Eigen Faces using PCA - Image recognition using SVM in Python

- Confusion Matrix

Lab:

11. **Feature Extraction using Edge detection in Open CV**
12. **Implementation of Scale Invariant Fourier Transform in Open CV**
13. **Implementation of FAST in OpenCV**
14. **Implementation of Dense Optical Flow in OpenCV**
15. **Image Recognition using PCA and SVM**

UNIT V	**Deep Learning for Robotics**	**4+12**

Artificial Neural Networks for Images - What is an Artificial Neural Network - Structure of a Neural Network - Introduction to Deep Learning - Applications of Deep Learning in Robotics - Perceptron Network - Activation function - Backpropagation algorithm - Applications of Deep learning for Computer vision - Introduction to Convolutional Neural networks - Structure of CNN - Implementation of Object detection using CNN - Robot Vision - Lane Detection - What is Lane Detection? - Video Analysis of Lanes - Video Pre-processing - Implementation of Lane Detection - Robot Vision - Collision Avoidance - What is Collision Avoidance? - Various sensors for - Detecting obstacles - Vision sensors for Collision and Obstacle detection - Implementation of collision detection and avoidance using vision - Image Segmentation - What is Image segmentation - Applications of Image segmentation - Region of Interest - Various algorithms for Image segmentation – Scene Segmentation using Deep learning

Lab:

16. **Building an Object Detection model using CNN**
17. **Working on Fundamentals of NVIDIA Jetson Nano**
18. **Lane Detection using Deep Learning**
19. **Collision Detection and Avoidance using Deep Learning**
20. **Scene Segmentation using Deep Learning**

LECTURE	**TUTORIAL**	**PRACTICAL**	**AL HOURS**
15	**0**	**45**	**60**

TEXT BOOKS:

Deep Learning, An MIT Press book, Ian Goodfellow and Yoshua Bengio and AaronCourville http://www.deeplearningbook.org

Machine Learning, Tom Mitchell

REFERENCES:

Computer Vision: Algorithms and Applications, by Richard Szeliski
Machine Learning: A Probabilistic Perspective, Kevin P. Murphy Computer Vision: A Modern Approach, by David Forsyth and Jean Ponce

E-REFERENCES:

Machine Learning, Tom Mitchell

Semester	**VI**
Subject Name	**Manufacturing Technology**
Subject Code	**XME601**

L –T –P –C	**C:P:A**	**L –T –P –H**
4- 0 – 0– 4	**4:0:0**	**4- 0– 0 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	**Construct** the Degrees of freedom, principles of location and clamping, principles of jig design, fool proofing, elements of jigs, locates fixture design.	**K6**
CO2	**Explain** the basic principles of measurements classify the various linear and angular measuring equipments.	**K5**
CO3	**Distinguish** their principle of operation and applications.	**K4**
CO4	***Explain*** the Assembly of different components.	**K1**
CO5	***Explain*** and demonstrate the basic concepts of PERT- CPM and their applications in product planning control.	**K2**
CO6	***Explain*** the basic concepts of optimization and To F***ormulate*** and Solve linear programming problems.	**K2**

Objectives

(i) To provide knowledge on machines and related tools for manufacturing various components.

(ii) To understand the relationship between process and system in manufacturing domain.

(iii) To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.

COURSE CONTENT

UNIT I **JIGS, FIXTURES AND PRESS TOOLS** **12 hrs**

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

UNIT II **FORM MEASUREMENT** **16 hrs**

Dimensions, forms and surface measurements, Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; 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 microscale machining, Inspection and workpiece quality

UNIT III **ASSEMBLY PRACTICES** **6 hrs**

Manufacturing and assembly, process planning, selective assembly, Material handling and devices

UNIT IV **LINEAR MODELS,PROJECT SCHEDULING BY PERT-CPM** **8 hrs**

Linear programming, objective function and constraints, graphical method, Simplex and duplex algorithms, transportation assignment, Travelling Salesman problem; Network models: shortest route, minimal spanning tree, maximum flow model- Project networks:

CPM and PERT, critical path scheduling

UNIT V PRODUCTION PLANNING& CONTROL 8 hrs

Forecasting models, aggregate production planning, materials requirement planning. Inventory Models: Economic Order Quantity, quantity discount models, stochastic inventory models, practical inventory control models, JIT. Simple queuing theory models

L = 50 hrs T = 0 hrs P=0hrs Total = 50 hrs

TEXT BOOKS

1. Donaldson C and Le Cain C H, "Tool Design", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2004.
2. Jain R.K., "Engineering Metrology", Khanna Publishers, 2005
3.Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)-Pearson India, 2014
4. Taha H. A., Operations Research, 6th Edition, Prentice Hall of India, 2003.
5. Shenoy G.V. and Shrivastava U.K., Operations Research for Management, Wiley Eastern, 1994.
6.Automation, Production Systems, & CIM by Grover; Prentice Hall 2. CAD CAM by C. McMahon and J. Browne; published by Addison-Wesley.

REFERENCES

1. Bhattacharyya A, "Metal Cutting Theory and Practice", New Central Books Agency (P) Ltd, Calcutta, 2000.
2. Fundamentals of Operations Research, Advanced Operation Research Prof.G.Srinivasan, Department of Management Studies, Indian Institute of Technology, Madras.
3.Modern Production/ Operations Management, E. S. Buffa and R. K. Sarin, John Wiley International, 1994.

E-REFERENCES

http://nptel.iitm.ac.in/courses

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	1	-	-	1	-	-	1	3	
CO2	2	2	-	-	-	1	1	-	-	-	-	1	3	
CO3	2	2	-	-	-	1	1	-	-	-	-	1	3	
CO4	2	1	-	-	2	1	1	-	-	-	-	1	3	
CO5	2	1	-	-	1	1	1	-	1	-	-	1	3	
CO6	1	-	-	-	1	1	-	-	1	-	-	1	3	
Tot	11	7	-	-	4	6	4	-	3	-	-	6	18	

1 - Low, 2 – Medium, 3- High

Semester	**VI**	
Subject Name	**Design of Machine Elements**	
Subject Code	**XME602**	
L –T –P –C **3 – 1 – 0– 4**	**C:P:A** **3:1:0**	**L –T –P –H** **3–1– 0 – 4**
Course Outcome		**Domain/Level** **C or P or A**

CO1	Describe the design process, material selection, calculation of stresses and stress concentrations under variable loading.	**K3**
CO2	Design the Shafts, Keys and Bearings.	**K3**
CO3	Design helical, leaf, disc and torsional springs	**K3**
CO4	Analyze Couplings, Fasteners and welded joints.	**K3**
CO5	Apply BIS standards and catalogues in design and selection of belts and chain for requirement, Select suitable drive combination based on requirement.	**K3**
CO6	Select appropriate friction drives and positive drives based on the applications.	**K3**

Objectives

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

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

COURSE CONTENT

UNIT I	**Steady Stresses and Variable Stresses in Machine Members**	**6+0**
	Design considerations - limits, fits and standardization, Review of failure theories for static and dynamic loading (including fatigue failure)	
UNIT II	**Shafts and bearings**	**9+3**
	Design of shafts under static and fatigue loadings, Analysis and design of sliding and rolling contact bearings	
UNIT III	**Energy storing Elements**	**6+3**
	Helical compression, tension, torsional and leaf springs	
UNIT IV	**Temporary and Permanent Joints**	**9+3**
	Threaded fasteners, pre-loaded bolts and welded joints, Analysis and applications of power screws and couplings	
UNIT V	**Transmission elements**	**15+6**
	Spur, helical, bevel and worm gears; belt and chain drives, Analysis of clutches and brakes	
L =45 hrs T=15hrs Total = 60 hrs		

TEXT BOOKS

[1] Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
[2] Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.

REFERENCES

[1] Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
[2] Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994. [5] R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998

E-REFERENCES

1. https://nptel.ac.in/downloads/112105125/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	2	2	1	2	2	1	2	2	2	2	
CO2	3	2	3	1	2	1	2	2	1	2	2	2	2	
CO3	3	2	3	1	2	1	2	2	1	2	2	2	2	
CO4	3	2	3	1	2	1	2	2	1	2	2	2	2	
CO5	2	1	1	1	1	1	1	1	1	1	1	1	1	
CO6	1	1	1	0	1	0	1	1	0	1	1	1	1	
TOT	14	10	14	6	10	5	10	10	5	10	10	10	10	

1 - Low, 2 – Medium, 3- High

Semester	**VI**
Subject Name	**XGS605**
Subject Code	**PROFESSIONAL SKILLS**

L –T –P –C	**C:P:A**	**L –T –P –H**
1- 0 – 2– 3	**2.6:0.4:0**	**1- 0– 4 – 5**

Course Outcome		**Domain/Level C or P or A**
CO1	***Ability*** to understand communications	**K1**
CO2	***Apply*** the known skills for career	**K3**
CO3	***Identify*** inner strength	**K1**
CO4	***Construct*** the attitude as a professional	**K6**
CO5	***Practicing*** Etiquettes	**P3**
CO6	***Ability*** to prepare the contents	**K1**

COURSE CONTENT

UNIT I	**Communication**	**9 HRS**

1.1 – Brainstorming
1.2 – LSRW

UNIT II	**Career Skills**	**9 HRS**

2.1 – Resume & CV preparing Skills
2.2 – Interview Skills
2.3 – Exploring Career Opportunities

UNIT III	**Team Skills**	**9 HRS**

3.1 – Listening as a Team Skill
3.2 – Team Building at work place

UNIT IV	**Professional Skills**	**9 HRS**

4.1 – Attitude and Goal Setting
4.2 – Verbal and Non Verbal Communications

UNIT V	**Professional Etiquettes**	**9 HRS**

Social Etiquettes
Cultural Ethics at work place

Suggested Readings:

(i) Er. A. K. Jain, Dr. Pravin S. R. Bhatia, Dr. A. M. Sheikh Professional Communication Skills S. Chand Publications, 2015

(ii) Alan Pannett. *Key Skills for Professionals: How to Succeed in Professional Services*, Kogan Page; 1st edition, 2013

Semester	**VI**
Subject Name	**CYBER SECURITY**
Subject Code	**XUM606**

L –T –P –C	C:P:A	L –T –P –H
0- 0 – 0– 0	0:0:0	3- 0– 0 – 3

Course Outcome		Domain/Level C or P or A
CO1	Understand the fundamentals of Cyber Security and the technologies.	**K2**
CO2	Understand the organizational structure of Cyber security	**K2**
CO3	Understand the Cyber Security policy development	**K2**
CO4	Understand the Indian IT act and the initiatives	**K2**
CO5	Understand and Apply the Cyber security practices	**K2, K3**

The objective of this course

- To give knowledge on the cyber space and its security. To learn about application of I law to various energy conversion devices
- To understand the cyber security structure of organization
- To Understand the security policy of Organisation
- To aware of the Cyber security initiatives and IT Act.
- To make the students to know cyber security Practices.

COURSE CONTENT

UNIT I	**INTRODUCTION**	**9HRS**
	Cyber Security – Cyber Security policy – Domain of Cyber Security Policy – Laws and Regulations – Enterprise Policy – Technology Operations – Technology Configuration - Strategy Versus Policy – Cyber Security Evolution – Productivity – Internet – E commerce – Counter Measures – Challenges	
UNIT II	**CYBER SECURITY OBJECTIVES AND GUIDANCE**	**9HRS**
	Cyber Security Metrics – Security Management Goals – Counting Vulnerabilities – SecurityFrameworks – E Commerce Systems – Industrial Control Systems – Personal Mobile Devices – Security Policy Objectives – Guidance for Decision Makers – Tone at the Top – Policy as a Project– Cyber Security Management – Arriving at Goals – Cyber Security Documentation – The Catalog Approach – Catalog Format – Cyber Security Policy Taxonomy.	
UNIT III	**CYBER SECURITY POLICY CATALOG**	**9HRS**
	Cyber Governance Issues – Net Neutrality – Internet Names and Numbers – Copyright andTrademarks – Email and Messaging - Cyber User Issues - Malvertising - Impersonation –Appropriate Use – Cyber Crime – Geo location – Privacy - Cyber Conflict Issues – Intellectual property Theft – Cyber Espionage – Cyber Sabotage – Cyber Welfare- Computer Forensics – Steganography	
UNIT IV	**CYBER SECURITY INITIATIVES AND IT ACT**	**9HRS**
	Counter Cyber Security Initiatives in India, Cyber Security Excercsie, Cyber Security Incident Handling, Cyber Security Assurance, IT Act, Hackers-Attacker-Counter measures ,Web Application Security , Digital Infrastructure Security ,Defensive Programming. Traditional Problems Associated with Computer Crime, Introduction	

to Incident Response.

UNIT V **SECURITY PRACTICES** **9HRS**

Guidelines to choose web browsers, Securing web browser ,Antivirus ,Email security ,Guidelines for setting up a Secure password ,Two-steps authentication ,Password Manager ,Wi-Fi Security ,Guidelines for social media security ,Tips and best practices for safer Social Networking.

Basic Security for Windows, User Account Password Introduction to mobile Smartphone Security ,Android Security ,IOS Security Online Banking Security ,Mobile Banking Security ,Security of Debit and Credit Card ,UPI Security Security of Micro ATMs e-wallet Security Guidelines Security Guidelines for Point of Sales(POS)

L = 45 hrs T = 0 hrs P=0 hrs Total = 45 hrs

TEXT BOOKS / REFERENCES

1. Jennifer L. Bayuk, J. Healey, P. Rohmeyer, Marcus Sachs , Jeffrey Schmidt, Joseph Weiss "Cyber Security Policy Guidebook" John Wiley & Sons 2012.
2. Rick Howard "Cyber Security Essentials" Auerbach Publications 2011.
3. Cyber Laws & Information Technology, Jothi Rathan,Vijay Rathan,Bhrath Pubishers,7th Edition January 2019.
4.Modern Cyber security Practices by Pascal Ackerman, BPB Publications,2020
5. Dan Shoemaker Cyber security The Essential Body Of Knowledge, 1st ed. Cengage Learning 2011
6. Rhodes-Ousley, Mark, "Information Security: The Complete Reference", Second Edition, McGraw-Hill, 2013.

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https://www.coursera.org/specializations/cyber-security
www. nptel.ac.in
http://professional.mit.edu/programs/short-programs/applied-cybersecurity
https://us.norton.com/internetsecurity-how-to-cyber-security-best-practices-for-employees.html
https://www.meity.gov.in/content/cyber-laws

Mapping of COs with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	0	0	0	0	0	2	0	3	0	0	0	0	0	0
CO2	0	0	0	0	0	0	2	0	1	0	0	0	0	0
CO3	3	0	0	0	0	2	3	0	1	0	0	0	3	0
CO4	0	0	0	0	0	0	0	0	0	2	0	0	0	0
CO5	3	0	0	0	0	0	0	0	0	0	0	0	3	0
Total	6	0	0	0	0	4	5	3	2	2	0	0	6	0

1 - Low, 2 – Medium, 3- High

Semester	**VI**
Subject Name	**Machine Tools and Metrology Laboratory**
Subject Code	**XME607**

L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 1– 1	**0.1:0.9:0**	**0- 0– 2 – 2**

Course Outcome		**Domain/Level C or P or A**
CO1.	***Experiment*** and ***Measure*** various machining operations and its cutting forces involved	**K2, K3 P5,P7**
CO2	**Create** and **choose** the CNC suitable part programming for the corresponding job.	**K2 P5**
CO3	***Experiment*** the sample with EDM.	**K2 P7**
CO4	***Understand*** the operation of pick and place robot.	**K2 P5**
CO5	**Explain** the basic principles of measurements classify the various linear measuring equipments and **distinguish** their principle of Operation and applications.	**K5 P7**
CO6	**Explain** the basic principles of measurements classify the various angular measuring equipments and **distinguish** their principle of operation and applications.	**K5 P7**

Objectives

1. To provide an understanding of advanced manufacturing methods.
2. To get an idea of the dimensional & form accuracy of products

COURSE CONTENT

		CO Relation
1.	Taper turning and external thread cutting using lathe	**CO1**
2.	Contour milling using vertical milling machine	**CO1**
3.	Spur gear cutting in milling machine	**CO1**
4.	Measurement of cutting forces in Milling/ Turning process	**CO1**
5.	CNC part programming	**CO2**
6.	Drilling of a small hole using wire EDM	**CO3**
7.	Microprocessor controlled pick & place robot	**CO4**
8.	Use of Tool Maker’s Microscope	**CO5**
9.	Comparator and sine bar	**CO5**
10.	Surface finish measurement equipment	**CO6**
11.	Bore diameter measurement using micrometer and telescopic gauge	**CO6**
12.	Use of Autocollimator	**CO6**

TEXT BOOKS

1. Hajra Choudhury S.K and Hajra Choudhury. A.K., “Elements of Workshop Technology, Volume I and II”, Media Promoters and Publishers Private Limited, Mumbai.
2. HMT – “Production Technology”, Tata McGraw-Hill, 1998.Dr. B.C.Punmia, “Surveying – Volume I”, Laxmi Publications, New Delhi, 2005
3. Jain R.K., “Engineering Metrology”, Khanna Publishers, 2005
4. Mikell. P. Groover, Automation Production Systems, and Computer Integrated Manufacturing, Prentice Hall of India Ltd., New Delhi, 1998.
5. Pandey P.C. and Shan H.S. “Modern Machining Processes” Tata McGraw-Hill, New Delhi, 2007.

REFERENCES

1. Paul Degarma E, Black J.T. and Ronald A. Kosher, Materials and Processes, in Manufacturing Prentice – Prentice Hall of India.
2. Sharma, P.C., A Text book of Production Technology, S. Chand and Co. Ltd.,
3. Milton C.Shaw, ‘Metal Cutting Principles’, Oxford University Press, Second edition,2005.
4. Rao, P.N. “Manufacturing Technology”, Metal Cutting and Machine Tools, Tata McGraw–Hill, New Delhi, 2003.
5. Gupta S.C, “Engineering Metrology”, Dhanpat rai Publications, 2005
6. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi, (1994).
7. Benedict. G.F. “Nontraditional Manufacturing Processes”, Marcel Dekker Inc., New York, 1987.

E-REFERENCES

1.http://nptel.iitm.ac.in/courses

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	2	1	1	-	-	1	-	-	1	3	
CO2	2	3	-	2	1	1	-	-	-	-	-	1	3	
CO3	2	3	-	2	1	1	-	-	1	-	-	1	3	
CO4	2	3	2	1	1	1	-	-	1	-	-	1	3	
CO5	2	3	-	2	1	1	-	-	-	-	-	1	3	
CO6	2	3	-	2	1	1	-	-	-	-	-	1	3	
Tot	12	18	2	11	6	6			3			6	18	

1 - Low, 2 – Medium, 3- High

Semester	**VI**	
Subject Name	**TOOL DESIGN AND DRAWING LABORATORY**	
Subject Code	**XME608**	
L –T –P –C **0- 0 – 1– 1**	**C:P:A** **0:1:0**	**L –T –P –H** **0- 0– 2 – 2**

Course Outcome		**Domain/Level** **C or P or A**
CO1	Design of Press tool-cutting type tools	**K2** **P5**
CO2	Compare, progressive tool with compound tool	**K2** **P5**
CO3	Design of Non cutting dies (Bending and drawing dies)	**K2** **P5**
CO4	Design of fixture for different applications	**K2** **P5**
CO5	Design of limit gauges for the given component	**K2** **P5**
CO6	Model the drawing using CAD software	**K3**

Objectives:

[1] To give exposure to tool design and draw it manually and using software

COURSE CONTENT

		CO Relation
1.	Design and drawing of Blanking and Piercing Tools	**CO1**
2.	Design of Progressive Tool - Compound Tool	**CO2**
3.	Design V bending and Edge bending tools	**CO3**
4.	Design of Draw dies - Shallow drawing and deep drawing	**CO3**
5.	Design of Plate jig (turn over type) and Indexing jig	**CO4**
6.	Design of Milling fixture	**CO4**
7.	Design of Grinding fixture	**CO4**
8.	Design of Plain plug gauge as per IS 3455, IS 6137, IS 6244, IS 6246 and IS 7018 : Part 2	**CO5**
9.	Design of snap gauge as per IS 3477 / Design of plain ring gauges as per IS 3485	**CO5**
10.	Drawing of any three of the above designs using CAD software	**CO6**

TEXT BOOKS

1.J.R.Paquin, Die design fundamentals, Industrial Press Inc, 1990.

2.Donaldson, Tool Design , Tata McGraw-hill Book company, 23rd edition, 2006

4. Indian Standard Specifications IS 3455, IS 6137, IS 6244, IS 6246 ,IS 7018 : Part 2, IS 3477 and IS 3485.

REFERENCES

1.Donald F. Eary., Edward A. Reed, Techniques of Press working sheet metal, Prentice-Hall,Inc.,Second Edition, 1974.
E-REFERENCES
http://nptel.iitm.ac.in/courses

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	2	1	1	-	-	1	-	-	1	0	
CO2	2	3	-	2	1	1	-	-	-	-	-1	1	0	
CO3	2	3	-	2	1	1	-	-	1	-	-	1	1	
CO4	2	3	2	1	1	1	-	-	1	-	-1	1	1	
CO5	2	3	-	2	1	1	-	-	-	-	-1	1	1	
CO6	2	3	3	2	2	1	2	2	2	1	3	2	3	
Tot	12	18	5	11	7	6	2	2	5	1	6	7	6	

1 - Low, 2 – Medium, 3- High

Semester	**VII**
Subject Name	**Automation in manufacturing**
Subject Code	**XME702**

L –T –P –C	**C:P:A**	**L –T –P –H**
3 – 0 – 0– 3	**3:0:0**	**3–0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	Define automation and classify different types of automation along with recent trends of automation in manufacturing.	C (Rem), C(U)
CO2	Classify and describe computer aided technologies in manufacturing.	C (Rem), C(U)
CO3	Classify and explain different automation technologies and building blocks of systems.	C (Rem), C(U)
CO4	Describe product modelling and simulation techniques in manufacturing	C (Rem), C(U)
CO5	Define additive manufacturing and explain the recent advancements in additive manufacturing.	C (Rem), C(U)

Objectives

1. To understand the importance of automation in the of field machine tool based manufacturing

2. To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC

3. To understand the basics of product design and the role of manufacturing automation

COURSE CONTENT

UNIT I **BASIC CONCEPTS AND PROPERTIES OF FLUIDS** **9 hrs**

Introduction: Why automation- Current trends-CAD, CAM, CIM- Rigid automation- Part handling, Machine tools- Flexible automation- Computer control of Machine Tools and Machining Centers-NC and NC part programming, CNC-Adaptive Control- Automated Material handling. Assembly-Flexible fixturing.

UNIT II **COMPUTERS IN MANUFACTURING** **9hrs**

Computer Aided Design- Fundamentals of CAD - Hardware in CAD-Computer Graphics Software and Data Base-Geometric modelling for downstream applications and analysis methods- Computer Aided Manufacturing- CNC technology- PLC- Micro-controllers- CNC-Adaptive Control

UNIT III **AUTOMATION** **9 hrs**

Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies

UNIT IV **MODELLING AND SIMULATION** **9 hrs**

Introduction to Modelling and Simulation-Product design- process route modelling- Optimization techniques-Case studies & industrial applications.

UNIT V **Additive Manufacturing** **9 hrs**

Additive Manufacturing-3Dprinting-Classification of 3D printers-components of basic 3D printer-Preparation of geometry for 3D printing-STL, STEP file generation-Managing of inter exchangeable formats for 3D printing, open source resources for 3D printing.

L = 45 hrs Total = 45 hrs

TEXT BOOKS

1. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall.
2. Serope Kalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th edition,Pearson

REFERENCES

1. Yoram Koren, Computer control of manufacturing system, 1st edition.
2. Ibrahim Zeid , CAD/CAM : Theory & Practice, 2nd edition.

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Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	2	1	-	-	-	1	-	-	-	3	
CO2	3	2	-	2	1	-	-	-	1	-	1	1	3	
CO3	3	1	-	1	1	-	-	1	1	-	1	1	3	
CO4	3	2	-	2	1	-	-	-	1	-	-	-	3	
CO5	3	3	3	3	2	-	-	2	1	-	3	3	3	
	15	10	3	10	6			3	5		5	5	15	

1 - Low, 2 – Medium, 3- High

Semester	**VII**
Subject Name	**Cyber Security**
Subject Code	**XUM706**

L –T –P –C	**C:P:A**	**L –T –P –H**
3 – 0 – 0– 0	**3:0:0**	**3–0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	Able to ***understand*** the Cyber Security Policy, Laws and Regulations	C(Remember)
CO2	Able to ***discuss*** the Cyber Security Management Concepts	C(Understand)
CO3	Able to ***understand*** *t*he Cyber Crime and Cyber welfare	C(Understand)
CO4	Able to ***discuss*** on issues related to Information Security Concepts	C(Understand)
CO5	Able to ***understand*** various security threats	C(Understand)

COURSE CONTENT

UNIT I	**INTRODUCTION**	**9 hrs**

Cyber Security – Cyber Security policy – Domain of Cyber Security Policy – Laws and Regulations – Enterprise Policy – Technology Operations – Technology Configuration - Strategy Versus Policy – Cyber Security Evolution – Productivity – Internet – E commerce – Counter Measures – Challenges

UNIT II	**CYBER SECURITY OBJECTIVES AND GUIDANCE**	**9hrs**

Cyber Security Metrics – Security Management Goals – Counting Vulnerabilities – Security Frameworks – E Commerce Systems – Industrial Control Systems – Personal Mobile Devices – Security Policy Objectives – Guidance for Decision Makers – Tone at the Top – Policy as a Project– Cyber Security Management – Arriving at Goals – Cyber Security Documentation – The Catalog Approach – Catalog Format – Cyber Security Policy Taxonomy.

UNIT III	**CYBER SECURITY POLICY CATALOG**	**9 hrs**

Cyber Governance Issues – Net Neutrality – Internet Names and Numbers – Copyright and Trademarks – Email and Messaging - Cyber User Issues - Malvertising - Impersonation – Appropriate Use – Cyber Crime – Geo location – Privacy - Cyber Conflict Issues – Intellectual property Theft – Cyber Espionage – Cyber Sabotage – Cyber Welfare

UNIT IV	**INFORMATION SECURITY CONCEPTS**	**9 hrs**

Information Security Overview: Background and Current Scenario - Types of Attacks - Goals for Security - E-commerce Security - Computer Forensics – Steganography

UNIT V	**SECURITY THREATS AND VULNERABILITIES**	**9 hrs**

Overview of Security threats -Weak / Strong Passwords and Password Cracking - Insecure Network connections - Malicious Code - Programming Bugs - Cyber crime and Cyber terrorism - Information Warfare and Surveillance

L = 45 hrs Total = 45 hrs

REFERENCES

1. Jennifer L. Bayuk, J. Healey, P. Rohmeyer, Marcus Sachs , Jeffrey Schmidt, Joseph Weiss "Cyber Security Policy Guidebook" John Wiley & Sons 2012.
2. Rick Howard "Cyber Security Essentials" Auerbach Publications 2011.
3. Richard A. Clarke, Robert Knake "Cyberwar: The Next Threat to National Security & What to Do About It" Ecco 2010
4. Dan Shoemaker Cyber security The Essential Body Of Knowledge, 1st ed. Cengage Learning 2011
5. Rhodes-Ousley, Mark, "Information Security: The Complete Reference", Second Edition, McGraw-

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1. https://www.coursera.org/specializations/cyber-security
2. www. nptel.ac.in
3. http://professional.mit.edu/programs/short-programs/applied-cybersecurity

CO PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO 1	3	2	2	3	0	1	2	0	1	0	1	1
CO 2	3	2	1	3	0	1	2	0	1	0	1	1
CO 3	3	2	1	3	0	1	2	1	1	0	1	1
CO 4	3	2	1	2	0	1	2	1	1	0	1	1
CO 5	3	2	1	2	0	1	2	0	1	0	1	1
Tot	15	10	6	13	0	5	10	2	5	0	5	5

1 - Low, 2 – Medium, 3- High

Semester	**VII**
Subject Name	**Mechanical Engineering Laboratory VI (Special Machines)**
Subject Code	**XME707**

L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 1– 1	**0:1:0**	**0- 0– 2– 2**

Course Outcome	**Domain/Level** **C or P or A**
Experiment with shaper and drilling machine ***Experiment*** on grinding ***Experiment*** on milling ***Experiment*** on CNC Machine tools ***Understand*** the operation of pick and place robot and EDM	Coginitive (Remembering) (Applying) Psychomotor (Guided response) (Perception)

Objectives

1. To provide an understanding of advanced manufacturing methods.
2. To get an idea of the dimensional & form accuracy of products

COURSE CONTENT

		CO Relation
1.	Shaping a block	CO1
2.	Radial drilling on a block	CO1
3.	Cylindrical grinding	CO2
4.	Surface grinding	CO2
5.	Contour milling using milling machine	CO3
6.	Spur gear cutting in milling machine	CO3
7.	CNC part programming – Step and taper turning	CO4
8.	CNC part programming – Threading	CO4
9.	Drilling of a small hole using wire EDM	CO5
10.	Microprocessor controlled pick & place robot	CO5

TEXT BOOKS

1. Hajra Choudhury S.K and Hajra Choudhury. A.K., "Elements of Workshop Technology, Volume I and II", Media Promoters and Publishers Private Limited, Mumbai.
2. HMT – "Production Technology", Tata McGraw-Hill, 1998.Dr. B.C.Punmia, "Surveying – Volume I", Laxmi Publications, New Delhi, 2005
3. Mikell. P. Groover, Automation Production Systems, and Computer Integrated Manufacturing, Prentice Hall of India Ltd., New Delhi, 1998.
4. Pandey P.C. and Shan H.S. "Modern Machining Processes" Tata McGraw-Hill, New Delhi, 2007.

REFERENCES

1. Paul Degarma E, Black J.T. and Ronald A. Kosher, Materials and Processes, in Manufacturing

Prentice – Prentice Hall of India.
2. Sharma, P.C., A Text book of Production Technology, S. Chand and Co. Ltd.,
3. Milton C.Shaw, 'Metal Cutting Principles', Oxford University Press, Second edition,2005.
4. Rao, P.N. "Manufacturing Technology", Metal Cutting and Machine Tools, Tata McGraw–Hill, New Delhi, 2003.
6. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi, (1994).
7. Benedict. G.F. "Nontraditional Manufacturing Processes", Marcel Dekker Inc., New York, 1987.

E-REFERENCES

1.http://nptel.iitm.ac.in/courses

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	2	1	1	-	-	1	-	-	1	3	
CO2	2	3	-	2	1	1	-	-	-	-	-	1	3	
CO3	2	3	-	2	1	1	-	-	1	-	-	1	3	
CO4	2	3	2	1	1	1	-	-	1	-	-	1	3	
CO5	2	3	-	2	1	1	-	-	-	-	-	1	3	
Tot	10	15	2	9	5	5			3			5	15	

1 - Low, 2 – Medium, 3- High

Semester	**VII**		
Subject Name	**Project phase – I**		
Subject Code	**XME708**		
L –T –P –C		**C:P:A**	**L –T –P –H**
0- 0 – 8– 4		**0:8:0**	**0- 0– 8 – 8**
Course Outcome			**Domain/Level**
			C or P or A

Objectives:

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 is expected to be completed in the seventh semester and the fabrication and demonstration will be carried out in the eighth semester.

Semester	**VII**		
Subject Name	**Inplant Training – III**		
Subject Code	**XME709**		
L –T –P –C		**C:P:A**	**L –T –P –H**
0- 0 – 4– 2		**0:4:0**	**0- 0– 4 – 4**
Course Outcome			**Domain/Level**
			C or P or A

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.

Total hrs – 90

XMEM03 **Non Destructive Testing** **L T P C**
0 0 2 0

Introduction and Radiography

Introduction to NDT – need – advantages and limitations Radiography – Sources – IR192, cobalt 60 – X-ray film – processing – testing methods – film interpretation

Ultrasonic testing

A,B,C scan, immersion Testing, Normal and Angle Probe Testing

Magnetic particle

Testing Methods – particles - wet, dry and fluorescent

Dye penetrant testing

Surface preparation –Testing procedure - types of penetrant.

Other NDT methods

Thermography, Image processing TOFD and Phased Array - leak testing – Halogen, Helium

Semester	**VIII**

Subject Name	**Project phase – II**	
Subject Code	**XME804**	
L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 6– 6	**0:6:0**	**0- 0– 12 – 12**
Course Outcome		**Domain/Level**
		C or P or A

Objectives:

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 is expected to be completed in the seventh semester and the fabrication and demonstration will be carried out in the eighth semester.

SYLLABUS FOR

M.Tech Renewable Energy (FT) – 2023-24 – ACADEMIC YEAR

Semester	**I**	
Course Name	**Solar Energy Systems**	
Course Code	**YRE101**	
L –T –P –C **3 – 0 – 0– 3**	**C:P: A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	***Identify*** proper solar radiation site	**K3**
CO2	***Design*** solar flat plate collectors	**K3**
CO3	***Design*** solar concentric collectors	**K3**
CO4	***Apply*** concepts related to solar energy storage systems	**K3**
CO5	***Apply*** the concepts for selection of PV systems	**K3**
CO6	***Apply*** the economics concepts for PV systems	**K3**

COURSE CONTENT

UNIT I	**SOLAR RADIATION**	**9 Hours**

Source of radiation – Sun earth relationship- extra terrestrial radiation.– Atmospheric attenuation – terrestrial radiation-radiation on a horizontal surfaces and inclined planes-relations between horizontal radiation and inclined surfaces – relations between monthly, daily and hourly radiation and components of the radiations– solar charts – Critical radiation-Measurement of global, direct and diffuse solar radiation- pyroheliometer, pyranometer, pyrogeometer, net pyradiometer-sunshine recorder – an overview of solar radiation data in India.

UNIT II	**SOLAR COLLECTORS – FLAT PLATE COLLECTORS**	**9 Hours**

Design considerations – classification- Flat plate collectors- air heating collectors liquid heating – Temperature distributions- Heat removal rate- Useful energy gain – Losses in the collectors-for efficiency of flat plate collectors – selective surfaces – tubular solar energy collectors analysis of concentric tube collector – testing of flat plate collectors. Solar green house. Solar tracking. solar kilns

UNIT III	**CONCENTRIC SOLAR COLLECTORS AND THERMAL APPLICATION**	**9 Hours**

Concentric collectors-Limits to concentration – concentrator mounting – tracking mechanism - performance analysis focusing solar concentrators: Heliostats. Solar powered absorption A/C system (Ammonia/water) solar water pump, solar chimney, solar drier, solar dehumidifier, solar still, solar cooker.

UNIT IV	**SIMULATION AND ENERGY STORAGE**	**9 Hours**

Simulation in Solar Process Design- TRANSYS- Design of active systems- f chart methods for liquid and air heaters- phi bar, of chart method - sensible, latent heat and thermo-chemical storage- pebble bed etc. materials for phase change- Glauber's salt-organic compounds -solar ponds.

UNIT V	SOLAR PV SYSTEM	9 Hours

Photovoltaic cell – characteristics -maximum power- tracking-cell arrays-power electric circuits for output of solar panels--inverters-batteries-charge regulators, Construction concepts. Latest trends in PV systems, Life cycle analysis of solar energy system time value of money, evaluation of carbon credit of solar energy system.

Lecture =45 Hours **Tutorial = 0 Hours** **Total = 45 Hours**

TEXT BOOKS

1. DuffieJ.A and Beckman, W.A., "Solar Engineering of Thermal Processes", 2nd Edition, John Wiley& Sons Inc., Newyork, 1991
2. G.N. Tiwari."Solar Energy ; Fundamentals ,design,modelilg and applications " Third RePrint , Narosa Publishing House, New Delhi,2006

REFERENCE BOOKS

1. Edward E.Anderson, "Fundamentals for Solar Energy Conversion", Addison Wesley pubCO.,1983.
2. Fank Kreith,,Jan F.Kreider,:Principles of solar Engg", 1978.
3. Koushika M.D," Solar Energy Principles and Applications", IBT publications and distributors, 1988.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	3	2	3
CO2	3	3	2	2	3	2	3
CO3	3	3	2	2	3	2	3
CO4	3	3	2	2	3	2	3
CO5	3	3	2	2	3	2	3
CO6	3	3	2	2	3	2	3
Tot	18	18	12	12	18	12	18

1 - Low, 2 – Medium, 3- High

Semester	**I**	
Course Name	**WIND, OCEAN, HYDRO AND GEOTHERMAL ENERGY SYSTEMS**	
Course Code	**YRE102**	
L –T –P –C **3 – 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	CO STATEMENT	Knowledge Level
CO1	***Identify*** the wind resource assessment methods.	**K3**
CO2	***Develop*** the wind flow models.	**K3**
CO3	***Select*** the optimum design for variable operations of wind turbine	**K3**
CO4	***Choose*** the suitable site for the layout of wind farm.	**K3**
CO5	***Identify*** the electrical and control systems for wind energy conversion.	**K3**
CO6	***Categorize*** the ocean energy systems and geothermal energy systems	**K4**

Objectives

- Understand and apply basic concepts of hydrogen energy and storage cells.
- Apply the concept of nuclear energy for power generation by optimizing the design and following safety norms.
- Understand the concept of nuclear waste management and use proper techniques for efficient management.

COURSE CONTENT

UNIT I	**WIND RESOURCE AND ASSESSMENT**	**9 Hours**
	Introduction – Modern Wind Turbines – Betz Constant, Limit - Wind Resource – Wind vs. Traditional Generation – Technology Advancements – Material Usage – Wind Energy Penetration Levels – Applications. Wind Resource Assessment – Introduction – Characteristics of Steady Wind – Weibull Wind Speed Distribution Function – Vertical Profiles of the steady Wind – Wind Rose – Energy Pattern Factor – Energy Content of the Wind Resource Assessment.	
UNIT II	**AERODYNAMICS**	**9 Hours**
	Introduction – Aerofoil – Wind Flow Models – Axial Momentum Theory – Momentum Theory for a Rotating Wake – Blade Element Theory – Strip Theory – Tip Losses – Tip Losses Correction – Drag Translator Device – Wind Machine Characteristics.	
UNIT III	**WIND TURBINE, SITING AND WIND FARM DESIGN**	**10 Hours**
	Introduction – Classification of Wind Turbines – Turbine Components – Wind Turbine Design – Rotor Torque and Power – Optimum Design for Variable Operation – Influence of Reynolds Number – Cambered Aerofoils – Load Calculation – Cost Modelling – Power Control – Braking Systems – Turbine Blade design – Rotor Hub. Wind Flow Modelling – Capacity Factor – Planning of Wind Farm – Sitting of Wind Turbines – Ecological Indicators – Site Analysis – Methodology – Layout of Wind Farm – Initial Site Selection – Measure Correlate Predict (MCP) Technique – Micrositing – Wake Models.	

UNIT IV	**ECONOMICS, ELECTRICAL AND CONTROL SYSTEMS**	**9 Hours**
	Cost Calculation – Annual Energy Output (AEO) –Capital Recovery Factor – Depreciation – Life Cycle Costing – Environmental Impact - Biological Impact – Surface Water and Wetlands – Visual Impact – Sound Impact – Communication Impact. Classification of Generators – Synchronous Generators – Induction Generator – Variable Speed Generators – Control Systems – Power Collection Systems – Earthing of Wind Farms – Embedded Wind Generation.	
UNIT V	**HYDRO, OCEAN AND GEOTHERMAL ENERGY SYSTEMS**	**8 Hours**
	Introduction- Hydro Energy-Hydel Power Plant-Performance evaluation, Wave energy -Tidal changes – Ecological changes – Types Tidal Power – Energy from Sea – Tidal Turbines – Tidal Power Generation - Ocean thermal energy conversion (OTEC) - construction and operational problems – history of OTEC development Alternative energy technology - Problems and solutions - Recent Trends and Developments. A compulsory seminar / assignment on design / case study/analysis /application in any one of the Wind energy, Tidal and OTEC -Geothermal energy systems.	

Lecture = 45 Hours **Tutorial = 0 Hours** **Total = 45 Hours**

TEXT BOOKS

1. Siraj Ahmed "Wind Energy Theory and Practice". June 2013.
2. S.N.Bhadra, D.Kastha, S.Banerjee,"Wind Electrical Systems", Oxford University,Press,2014.
3. Joshua Earnest and Tore Wizelius, "Wind Power Plants and Project Development", PHI Learning Pvt. Ltd., New Delhi, 2011.
4. J. F. Manwell, J. G. McGowan and A. L. Rogers, "Wind Energy Explained – Theory, Design and Application", Wiley, 2009.
5. E.L Wakil "Power plant technology", McGrawGill Publishers,New York
6. G. D Rai "Non Conventional Energy sources" Khanna publishers. New Delhi

REFERENCES

1. Freris. L. L., "Wind Energy Conversion Systems", Prentice Hall 1990.
2. Earnest Joshua, "Wind Power Technology", Second edition, PHI Learning Pvt. Ltd., New Delhi, 2015.
3. Spera D. A., "Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering", ASME Press, New York, 2009.
4. Voker Quashning, "Understanding Renewable Energy Systems", Earthscan, Second edition, 2016.
5. Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi, "Wind Energy Handbook" JOHN WILEY & SONS, LTD , Second Edition,2011.
6. S.Rao & B.B.Parulekar,"Energy Technology", 3rd edition,Khanna publishers,1995.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	3	3	3
CO2	3	3	2	2	3	3	3

CO3	3	3	2	2	3	3	3
CO4	3	3	2	2	3	3	3
CO5	3	3	2	3	2	2	3
CO6	3	3	2	2	2	2	3
Tot	18	18	12	13	16	16	18

1 - Low, 2 – Medium, 3- High

Semester	**I**		
Course Name	**PROCESS MODELLING IN ENERGY SYSTEMS**		
Course Code	**YRE103**		
L –T –P –C **3 – 0 – 0– 3**		**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	***Solve*** problems related to modelling	**K3**
CO2	***Solve*** problems related to different types of models such as lumped, distributed models and steady, dynamic state models	**K3**
CO3	***Solve*** problems related to various systems involving variety of elements.	**K3**
CO4	***Solve*** problems related to model building	**K3**
CO5	***Solve*** problems using numerical methods	**K3**
CO6	***Solve*** problems related to differential equation and finite element method	**K3**

Objectives

- To understand different types of models, systems and its elements
- To solve different types of modelling related problems
- To solve problems related to model building
- To solve problems related to numerical methods and finite element method.

COURSE CONTENT

UNIT I	**MODELLING**	**7 Hours**
	Introduction to modelling, a systematic approach to model building, classification of models. Modelling Techniques-Response function and Numerical methods- Conservation principles, thermodynamic principles of process systems	
UNIT II	**MODELS, SYSTEMS AND ELEMENTS**	**11 Hours**
	Introduction to development of steady state and dynamic lumped and distributed parameters models based on first principles, Analysis of ill-conditioned systems, Block diagrams and computer simulation, Modelling of process elements consisting of Mechanical (translational and rotational) electro- Mechanical, fluid flow, thermal and chemical reaction system elements.	
UNIT III	**MODEL DEVELOPMENT**	**9 Hours**
	Development of grey box models. Empirical model building. Statistical model calibration and validation. Population balance models. Examples.	
UNIT IV	**NUMERICAL METHODS**	**9 Hours**
	Runge Kutta Methods for system of IVPs, numerical stability, Adams-Bashforth multistep method, solution of stiff ODEs, shooting method, BVP: Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.	
UNIT V	**DIFFERENTIAL EQUATIONS AND FINITE ELEMENT METHODS**	**9 Hours**

	Parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions – Two dimensional parabolic equations – ADI method; First order hyperbolic equations – method of characteristics, different explicit and implicit methods; Wave equation: Explicit scheme- Stability of above schemes.

Lecture = 45 Hours **Tutorial = 0 Hours** **Total = 45 Hours**

TEXT BOOKS

1. K.M. Hangos and I.T Cameron," Process Modelling and Model analysis".academic Press 2001.
1. W. L. Luyben, "Process Modelling, Simulation and control for Chemical Engineers" 2nd Edn, McGraw Hill Book Co, New York,2013
2. W.F. Ramirez "Computational Methods for Process Simulation", 2nd Edition, Butterworths,1997
3. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", Cengage Learning, India Edition, New Delhi, 2009.
4. Morton K.W. and Mayers D.F., "Numerical solution of partial differential equations", Cambridge University press, Cambridge, 2002.

REFERENCES

1. Mark E. Davis," Numerical Methods and Modelling for Chemical Engineers" John Wiley & Sons, 1984.
2. Singiresu S. Rao "Applied Numerical Methods for Engineers and Scientists" Prentice Hall, Upper saddle River, NJ 2001
3. Francis Vanek, Louis D. Albright," Energy systems Engineering" McGraw- Hill book Company, N.Y 2008
4. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**2**	**2**	**3**	**2**	**3**
CO2	**3**	**3**	**2**	**2**	**3**	**2**	**3**
CO3	**3**	**3**	**2**	**2**	**3**	**2**	**3**
CO4	**3**	**3**	**2**	**2**	**3**	**2**	**3**
CO5	**3**	**3**	**2**	**2**	**3**	**2**	**3**
CO6	**3**	**3**	**2**	**2**	**3**	**2**	**3**
Tot	**18**	**18**	**12**	**12**	**18**	**12**	**18**

1 - Low, 2 – Medium, 3- High

Semester	**I**
Subject Name	**SOLAR ENERGY LABORATORY**
Subject Code	**YRE106**

L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 2– 2	**0:1:0**	**0- 0– 2 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	***identify*** the performance of various solar collectors.	**P3**
CO2	***identify*** the performance of various solar gadgets like air dryer, cooker and solar PV panels.	**P3**
CO3	***Experiment*** the Charging characteristics of a battery using Solar PV panel and various effects on it.	**P3**
CO4	***identify*** the direct normal, global horizontal irradiance and also solar tracking accuracy using solar energy gadgets.	**P3**
CO5	***Optimize*** the flow rate for maximum heat absorption using various samples.	**P3**
CO6	***Simulate*** PV cell using Matlab / Simulink software.	**P3**

Objectives

- Study the performance of solar thermal energy applications flat plate and concentric type collectors.
- Study the performance solar photovoltaic (PV) panels at different combinations and conditions.
- Study and Optimize the performance of various Solar energy gadgets.
- Model the Solar PV cell using software.

COURSE CONTENT

CO Relation

LIST OF EXPERIMENTS		**CO**
1.	Performance evaluation of solar flat plate collector	1
2.	Performance evaluation of concentrating solar collector	1
3.	Performance evaluation of solar box cooker	2
4.	Performance evaluation air dryer	2
5.	Performance evaluation of a solar PV panel in series and parallel combination	2
6.	Charging characteristics of a battery using PV panel	3
7.	Effect of tilt angle and Effect of shadow on solar PV panel	3
8.	Solar Energy Measurements - Pyrheliometer	4
9.	Solar Energy Measurements - Pyranometer	4
10.	Parabolic Trough -Flow Rate	4
11.	External Compound Parabolic Collector (XCPC) - Oil and Water	5

12.	Mathematical modeling of photovoltaic cell/module/arrays with tags in Matlab /Simulink	6

TOTAL HOURS - 30

TEXT BOOKS

1. DuffieJ.A and Beckman, W.A., "Solar Engineering of Thermal Processes", 2nd Edition, John Wiley& Sons Inc., Newyork, 1991
2. G.N. Tiwari."Solar Energy ; Fundamentals ,design,modelling and applications " Third RePrint , Narosa Publishing House, New Delhi,2006

REFERENCES

1. Edward E.Anderson, "Fundamentals for Solar Energy Conversion", Addison Wesley pub CO., 1983.
2. Fank Kreith,,Jan F.Kreider,:Principles of solar Engg", 1978.
3. Koushika M.D," Solar Energy Principles and Applications", IBT publications and distributors, 1988.
4. Kaushik S.C, Tiwari G. N and Nayak J.K,"Thermal control in passive solar buildings" .IBT Publishers & Distributors, 1988.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	3	1	2	2	3
CO2	2	3	3	1	2	2	3
CO3	2	3	3	1	2	2	3
CO4	2	3	3	1	2	2	3
CO5	2	3	3	1	2	2	3
CO6	2	3	3	1	2	2	3
Tot	12	18	18	6	12	12	18

COURSE CODE	COURSE NAME	L	T	P	C
YRM107	RESEARCH METHODOLOGY AND IPR	2	0	0	2

After completion of the course, a student will be able to

1. Identify and formulate a research problem, collect data, identify research gap for the identified problem
2. Able to consolidate literature survey and provide inference on own words
3. Describe Patents, Designs, Trade and Copyright
4. Appraise, discuss and categorize Patent Rights
5. Identify and describe new developments in IPR

UNIT I **6**

Meaning of research problem, Sources of research problem, Criteria-Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT II **6**

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT III **6**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT IV **6**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT V **6**

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

LECTURE	TUTORIAL	TOTAL
30	0	30

REFERENCES

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebel, "Product Design", McGraw Hill, 1974.
7. Asimov, "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1				1	3	3	3
CO2				1	3	3	3
CO3				1	3	3	3
CO4				1	3	3	3
CO5				3	3	3	3

COURSE CODE	COURSE NAME	L	T	P	C
YEGOE1	ENGLISH FOR RESEARCH PAPER WRITING	2	0	0	0

UNIT I — **6**

Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and vagueness

UNIT II — **6**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

UNIT III — **6**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT IV — **6**

key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

UNIT V — **6**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions. useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

LECTURE	TUTORIAL	TOTAL
30	0	30

REFERENCES

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1			3	1	3	2	2
CO2			3	1	2	3	3
CO3			3	1	2	3	3
CO4			3	1	3	3	3
CO5			3	3	2	3	3

Semester	**I**	
Course Name	**Process Modelling and Simulation Laboratory**	
Course Code	**YRE109**	
L –T –P –C **0 – 0 – 2– 2**	**C:P:A** **0:1:0**	**L –T –P –H** **0–0– 2 – 4**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	*Code* root-finding algorithms	**K6**
CO2	*Code* integration algorithms	**K6**
CO3	*Simulate* Continuously Stirred Tank Reactor (CSTR) under gravity conditions	**K3**
CO4	*Simulate* Continuously Stirred Tank Reactor (CSTR) under 3D isothermal (open loop and closed loop) conditions	**K3**
CO5	*Simulate* Continuously Stirred Tank Reactor (CSTR) under 3D isothermal and nonisothermal conditions	**K3**
CO6	*Simulate* an inhouse biomass energy related problem.	**K3**

LABORATORY EXERCISES

1. Iterative bubble point calculation using “Newton-Raphson” optimization algorithm.
2. Iterative bubble point calculation using “interval-halving” algorithm.
3. First-order explicit Euler integration of a given function.
4. Runge-kutta integration algorithm of a given function.
5. Simulation of Gravity-flow tank simulation
6. Simulation of Three-isothermal CSTR (Open loop)
7. Simulation of Three-isothermal CSTR (closed loop)
8. Simulation of nonisothermal CSTR (Open loop)
9. Simulation of Root locus program for three-CSTR process.
10. Study of biomass gasification plant
11. Preparation of Process modelling system for biomass gasification plant
12. Simulation of Process modelling system for biomass gasification plant under varying load conditions.

Lecture = 0 Hours **Tutorial = 0 Hours** **Practical =30 Hours** **Total = 30 Hours**

REFERENCES

1.W. L Luyben, “Process Modelling, Simulation and control for chemical Engineers” 2 nd Edn,

McGraw Hill Book Co, New York,1990

Mapping of COs with POs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	3	3	1	0	2	2
CO2	3	3	3	1	0	2	2
CO3	3	3	3	1	0	2	2
CO4	3	3	3	1		2	2
CO5	3	3	3	1	0	2	2
CO6	3	3	3	1	0	2	2
Total	18	18	18	6	0	12	12

Semester	**II**
Course Name	**BIO ENERGY SYSTEMS**
Course Code	**YRE201**

L –T –P –C **3 – 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO	**CO STATEMENT**	**Knowledge Level**
CO1	***Identify*** different Biofuel types and explain their properties	**K3**
CO2	***Summarize*** the Government Policies and status of bio fuel in India.	**K3**
CO3	***Categorize*** Biomass types and explain their properties and applications	**K4**
CO4	***Develop*** bioenergy conversion through biochemical route.	**K3**
CO5	***Develop*** bioenergy conversion through thermochemical route.	**K3**
CO6	***Plan*** to improve the thermal efficiency by designing suitable systems for heat recovery and co-generation	**K3**

Objectives

- Describe the fundamentals of biofuel types and their generations.
- Identify the sources and definitions used for biomass and basic biomass conversion.
- Clearly define the extent of bioenergy use worldwide and the incentives or disincentives for use in India.
- Detail the digestion and fermentation Technologies in biogas plants.
- Detail the combustion and Gasification Technologies in common use.
- Describe the power generation scenario, the layout components of power plant and analyze Cogeneration cycle.

COURSE CONTENT

UNIT I	**BIO FULES**	**9 Hours**
	Bio fuels: types, Properties and sources- Bio fuels first, second and third generation production processes and technologies- Bio diesel comparison with diesel - Biofuel applications – Bio diesel and Ethanol as a fuel for I.C. engines – Relevance with Indian Economy - Bio-based Chemicals and Materials - Commercial and Industrial Products - Govt. Policy and Status of Bio-fuel technologies in India.	
UNIT II	**CHARACTERISATION OF BIOMASS**	**9 Hours**
	Biomass: Sources and Classification. – Properties - Energy plantation - Preparation of biomass. Size reduction- Briquetting of loose biomass - Drying, storage and handling of biomass. Conversion of biomass. Biomass processing for liquid and gaseous fuel production. Effect of particle size, temperature, on products obtained – Processing of various biomass for gas production for Thermal	

	and Electrical application.	
UNIT III	**BIOGAS TECHNLOGY**	**9 Hours**
	Feed stock for biogas production, animal residues, Aqueous wastes containing biodegradable organic matter- Microbial and biochemical aspects- factors and operating parameters for biogas production- Kinetics and mechanism-Dry and wet fermentation. Digesters-types-digesters for rural application – High rate digesters for industrial waste water treatment	
UNIT IV	**GASIFICATION OF BIOMASS**	**9 Hours**
	Thermo chemical Principles: Effect of pressure, temperature and introducing, steam and oxygen. Design and operation of fixed and fluidized bed Gasifier, circulating fluidized bed gasifiers, Safety aspects, operating characteristics of moving bed and fluidized bed gasifier- different types- advantages and disadvantages- performance analysis of gasifiers.	
UNIT V	**COMBUSTION OF BIOMASS & COGENERATION SYSTEMS**	**9 Hours**
	Combustion of woody biomass – theory, calculations and design of equipment, Cogeneration in biomass processing industries. – Economic Case studies: Combustion of rice husk. Use of bagasse for cogeneration.	
Lecture =45 Hours	**Tutorial = 0 Hours**	**Total = 45 Hours**

TEXT BOOKS

1. Chakraverthy A, "Biotechnology and Alternative Technologies for Utilisation of Biomass or Agricultural Wastes", Oxford & IBH publishing Co, 1989.
2. Mittal K.M "Biogas Systems: "Principles and Applications" New age international publishers (P) Ltd 1996, Nijaguna, B.T Biogas Technology, New age International publishers (P) Ltd

REFERENCE BOOKS

1. Venkata Ramana P and Srinivas S.N, "Biomass Energy Systems", ISBN 81-85419-25-6, Tata Energy Research Institute, 1996.
2. Klass D.L and Emert G.M, "Fuels from Biomass and Wastes", Ann Arbor Since Publ. Inc. Michigan, 1985.
3. O.P.Chawla, "Advances in Bio-gas Technology" I.C.A.R., New Delhi, 1970.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	1	2	1
CO2	2	1	1	3	3	3	3
CO3	2	2	2	1	2	1	3
CO4	2	2	2	1	2	1	3
CO5	2	2	2	1	2	1	3
CO6	3	3	2	1	3	2	2
Total	14	12	10	9	13	10	15

YRE 202 - COMPUTATIONAL FLUID DYNAMICS 3 0 0 3

UNIT - I GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD 10

Classification, Initial and Boundary conditions, Initial and Boundary value problems. Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT - II CONDUCTION HEAT TRANSFER 8

Steady one-dimensional conduction, Two and Three-dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

UNIT - III INCOMPRESSIBLE FLUID FLOW 7

Governing Equations, Stream Function - Vorticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, Finite deference approach.

UNIT - IV CONVECTION HEAT TRANSFER AND FEM 10

Steady One-Dimensional and Two-Dimensional Convection - Diffusion, Unsteady one-dimensional convection -Diffusion, Unsteady two-dimensional convection - Diffusion - Introduction to finite element method - Solution of steady heat conduction by FEM - Incompressible flow - Simulation by FEM.

UNIT - V TURBULENCE MODELS 10

Algebraic Models - One equation model, K-I Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

L:45; T:15; Total :60

TEXT BOOK

1. Anderson ,D.A Tannehill, I I and Pletcher , R,H “Computational Fluid Mechanics and Heat transfer” Narosa Publication House, NewYork, USA,1984

REFERENCES:

1. Muralidhar, K.,and Sundararajan,T., "Computational Fluid Flow and Heat Transfer", Narosa PublishingHouse ,New Delhi1995.
2. Ghoshdasdidar, P.S.,"Computer Simulation of flow and heat transfer" Tata McGraw-Hill PublishingCompany Ltd., 1998.
3. Anderson, D.A.,Tannehill, I.I., and Pletcher, R.H., “Computational Fluid Mechanics and Heat Transfer”,Hemishphere Publishing Corporation, New York, USA, 1984.
4. Flectcher, C.A.J., "Computational Techniques for Different Flow Categories, Springer-Verlage 1987.

Semester	**II**
Course Name	**ELECTRICAL ENERGY TECHNOLOGY**
Course Code	**YRE203**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0– 0– 3	**3:0:0**	**3- 0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	***Demonstrate*** the power system and its fundamentals.	K2
CO2	***Illustrate*** the various electric energy conversion devices and its applications.	K2
CO3	***Classify*** various Solid-state Power Converters and drives and its importance.	K2
CO4	***Demonstrate*** the various Hybrid Power generation methods and its importance.	K2
CO5	***Demonstrate*** the various Smart grid systems and its importance.	K2
CO6	***Relate*** various Power quality improvements methods and its significances.	K2

The objective of this course

- To learn about work various power system components.
- To learn about application of various electric energy conversion devices
- To classify about various Power converters and drives.
- To understand the various methods of hybrid power generation and power quality improvement.

COURSE CONTENT

UNIT I	**POWER SYSTEM FUNDAMENTALS**	**7 HRS**
	Single line representation – power flow study – power factor improvement, Protection, types of relays, symmetrical components, asymmetrical components, Introduction: Hybrid power system. HVDC - introduction, various coupling methods.	
UNIT II	**ELECTRIC ENERGY CONVERSION DEVICES**	**9 HRS**
	Transformers – Parallel operation, auto transformers, DC machines, Applications of DC machines – performance equation - generator characteristics - motor characteristics – applications of Synchronous machines - alternators – Induction machines.	
UNIT III	**SOLID-STATE POWER CONVERTERS AND DRIVES**	**9 HRS**
	Controlled rectifiers, choppers, inverters, voltage regulators and cyclo - converters. Speed control of dc motors and ac motors – converter fed chopper –fed control	

	Inverter –ac voltage regulators, VFD.	
UNIT IV	**HYBRID POWER GENERATION**	**6 HRS**
	Types of hybrid systems, Integration issues - Steady state performance of Wind-driven induction generators. Grid connected solar photo voltaic system - line commutated converters - Boost converters- selection of inverter. Three phase AC voltage controllers for wind power plants - uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.	
UNIT V	**SMART GRIDS**	**3 HRS**
	Micro Grids, Intelligent Grids, Smart grids, Phase Monitoring Unit (PMU), Case studies	
UNIT V	**POWER QUALITY IMPROVEMENT**	**11 HRS**
	Introduction – Characterisation of Power Quality, impacts, Types of Harmonic filters: passive, Active and hybrid filters. Custom power devices: Load compensation using STATCOM / DSTATCOM, Voltage regulation. FACT controlled devices, DVR. UPQC control strategies, UPFC, P-Q theory, Status of application of custom power devices.	
Lecture = 45 hrs Tutorial = 0 hrs Practical=0 hrs Total = 45 hrs		

TEXT BOOKS

1. John J Graigner and W.D Stevenson “Power system analysis” McGrawHill publishinig company, 1994.
2. T.JE. Miller “FACT controlled device” Johan willey Publications.
3. M.H.Rasheed “Power Electronics” Tata Mc Graw Hill.
4. Arindam Ghosh “Power Quality Enhancement Using Custom Power Devices”, kluwer Academic Publishers, 2002.

Mapping of COs with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	3	2	1	3
CO2	3	2	3	2	2	1	2
CO3	3	2	3	2	2	1	2
CO4	3	2	3	3	2	1	3
CO5	3	1	3	3	2	1	3
CO6	3	3	3	2	2	1	2
Total	**18**	**12**	**18**	**15**	**12**	**6**	**15**

Semester	**II**	
Course Name	**Computational Fluid Dynamics Laboratory**	
Course Code	**YRE206**	
L –T –P –C **0 – 0 – 2– 2**	**C:P:A** **1:0:0**	**L –T –P –H** **0–0– 2 – 4**

CO	**CO STATEMENT**	**Knowledge Level**
CO1	*Simulate* lid-driven cavity and convection process	**K3**
CO2	*Simulate* incompressible laminar fluid flow problems in pipe	**K3**
CO3	*Simulate* incompressible turbulent fluid flow problems in pipe	**K3**
CO4	*Simulate* wind turbine models in compressible fluid flow environment	**K3**
CO5	*Simulate* draining tank, falling ball experiments and CSTR.	**K3**
CO6	*Explain* various convection aspects of Renewable Energy systems.	**K3**

List of Experiments

1. Simulation of lid-driven cavity.
2. Simulation of heat convection for 3D radiator.
3. Incompressible laminar fluid flow simulation in elbow pipe.
4. Incompressible laminar fluid flow simulation in T-shaped pipe.
5. Incompressible turbulent fluid flow simulation in elbow pipe.
6. Incompressible turbulent fluid flow simulation in T-shaped pipe.
7. Wind Turbine simulation.
8. Draining of a 3D fluid filled tank.
9. Falling ball experimental simulation.
10. Simulation of 3D CSTR.
11. Study of Natural convection in Renewable energy systems.
12. Study of forced convection in Renewable Energy systems.

Lecture = 0 Hours **Tutorial = 0 Hours** **Practical =30 Hours**

Total = 45 Hours

REFERENCES

1. https://cfd-training.com/2018/08/12/turbulent-flow-in-a-90-bend/
2. https://www.openfoam.com/documentation/tutorial-guide/

Mapping of COs with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	3	1	1
CO2	3	3	2	2	3	1	1
CO3	3	3	2	2	3	1	1
CO4	3	3	2	2	3	1	1
CO5	3	3	2	2	3	1	1
CO6	3	3	2	2	3	1	1
Total	18	18	12	12	18	6	6

1 - Low, 2 – Medium, 3- High

Semester	**I**
Subject Name	**BIO ENERGY LABORATORY**
Subject Code	**YRE207**

L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 2– 2	**0:1:0**	**0- 0– 2 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	***Calibrate*** the performance of Flue gas analysis and properties of given sample.	**P3**
CO2	***identify*** the chemical, Biological oxygen demand and calorific values of given fuel.	**P3**
CO3	***identify*** the Effect P_H levels on total dissolved solids	**P3**
CO4	***identify*** effect of milling time and particle size.	**P3**
CO5	***identify*** High Heating Value of given sample.	**P3**
CO6	***Demonstrate*** the operations in briquetting, biomass gasifier and biomethanation plant.	**P3**

Objectives

- Study the performance of Flue gas analysis
- Study the performance Bio fuels Flash point, Fire point and Calorific value

COURSE CONTENT

CO Relation

LIST OF EXPERIMENTS		**CO**
1.	Flue gas analysis – IC engine and gasifier	1
2.	Determine the Density and Specific Gravity of a given sample	1

3.	Proximate and Ultimate analysis of given sample	1
4.	Analysis of chemical oxygen demand (COD)	2
5.	Analysis of biological oxygen demand (BOD)	2
6.	Determining the Flash point, Fire point and Calorific value of Biofuel	2
7.	Effect of P_H on total dissolved solids (TDS)	3
8.	Determine the effect of milling time on the Particle size and size reduction of given sample using Ball milling machine	4
9.	Determine the higher heating value (HHV) of unleaded gasoline (or a similar fuel supplied by the instructor) using the adiabatic oxygen bomb calorimeter.	5
10.	Briquetting operation demonstration and study	6
11.	Biomethanation plant demonstration and study	6
12.	2kW Biomass gasifier demonstration and study	6

TOTAL HOURS - 30

TEXT BOOKS

1. Chakraverthy A, "Biotechnology and Alternative Technologies for Utilisation of Biomass or Agricultural Wastes", Oxford & IBH publishing Co, 1989.
2. Mittal K.M "Biogas Systems: "Principles and Applications" New age international publishers (P) Ltd 1996, Nijaguna, B.T Biogas Technology, New age international publishers (P) Ltd

REFERENCES

1. Venkata Ramana P and Srinivas S.N, "Biomass Energy Systems", ISBN 81-85419-25-6, Tata Energy Research Institute, 1996.
2. Klass D.L and Emert G.M, "Fuels from Biomass and Wastes", Ann Arbor Since Publ. Inc. Michigan, 1985.
3. O.P.Chawla, "Advances in Bio-gas Technology" I.C.A.R., New Delhi, 1970.

Mapping of COs with POs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	1	3	3	1	2	1
CO2	3	3	2	2	1	2	1
CO3	3	3	2	2	1	2	1
CO4	3	3	3	3	1	2	3
CO5	3	2	3	3	1	2	1
CO6	3	3	2	2	1	2	1
Tot	18	15	15	15	6	12	8

COURSE CODE	COURSE NAME	L	T	P	C
YPSOE1	CONSTITUTION OF INDIA	2	0	0	0

UNIT I HISTORY AND PHIOLOSOPHY	**6**
History of Making of the Indian Constitution: History-Drafting Committee, (Composition & Working) Philosophy of the Indian Constitution: Preamble-Salient Features	
UNIT II CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES:	**6**
Fundamental Rights -Right to Equality-Right to Freedom-Right against Exploitation-Right to Freedom of Religion-Cultural and Educational Rights-Right to Constitutional Remedies-Directive Principles of State Policy-Fundamental Duties.	
UNIT III ORGANS OF GOVERNANCE:	**6**
Parliament-Composition-Qualifications and Disqualifications-Powers and Functions-Executive-President-Governor-Council of Ministers-Judiciary, Appointment and Transfer of Judges, Qualifications-Powers and Functions	
UNIT IV LOCAL ADMINISTRATION	**6**
District's Administration head: Role and Importance, -Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy	
UNIT V ELECTION COMMISSION:	**6**
Election Commission: Role and Functioning. -Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.	

LECTURE	TUTORIAL	TOTAL
30	0	30

REFERENCES

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1				3		1	1
CO2				3		1	1
CO3				3		1	1
CO4				3		1	1
CO5				3		1	1

Semester	III	
Course Name	DISSERTATION PHASE – I	
Course Code	YRE301	
L –T –P –C 0 – 0 –10– 10	C:P:A 2:0.5:0.5	L –T –P –H 0–0– 20– 20

CO Number	CO STATEMENT	Knowledge Level
CO1	***Identify*** an open ended problem in the area of renewable energy which requires further investigation –(Identification of relevant project title)	K3
CO2	***Describe*** the methodology/modelling for solving and proceeding the problem	K3
CO3	***Select*** the optimal model of the project work from the proposed different solutions.	K3
CO4	***Design*** the project model with relevant detailed subassemblies and technical drawings with detailed action plan for implementation.	K3
CO5	***Identify*** the methods and materials required for manufacturing the project work	K3
CO6	***Prepare*** a consolidated technical report of the project apart from developing a presentation	K3

Objectives

- To collect various literatures in the research interest area, study, understand the works already prevailing in the interested project work area.
- To get the knowledge about various elements of research works, various methods in proceeding the project work and selecting suitable one with action plan
- Understand and able to apply the basics concepts of design in the role of making the project into reality.
- To prepare a project report and presentation with the collected data ,with available details

LOOK INTO THE FOLLOWING DETAILS TO MEET THE OUTCOMES

IDENTIFICATION OF PROJECT WORK AREA

Overview of various renewable energy topics for performance improvement, optimality, etc. Hydropower systems-Wind energy systems, Solar energy systems, and other systems about Project Feasibility-Literature review collections

SELECTION OF RELEVANT PROJECT TITLE

Based on the detailed literature review, Identification of gap area and formulation of suitable project title

DESIGN THE PROJECT WORK MODEL WITH DETAILED DRAWINGS / CHARECTERIZATION METHODS

Design the project model with its assemblies into sketches /technical drawings with dimensions with CAD tools. For performance and analysis characterization projects , needs to identify the characterization sequences

IDENTIFICATION OF METHODS AND MATERIALS REQUIRED TO MANUFACTURE THE PROJECT

Identification of suitable methods and bill of materials, cost involved and suitable manufacturing method, to make the design model into reality and performing the activities , Execution of the activities production and running of the system.

DATA COLLECTION, ANALYSIS, PROJECT REPORT PREPARATION

Checking the working of the system/model, Fundamental knowledge of data collection, analysis, interpretation of data with details and project report writing and making ready the power point presentation
TEXT BOOKS / REFERENCE BOOKS
1. Old approved project reports of our department and other department project report copies. 2. Refer other university and engineering college project reports.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	1	1	1	1	1
CO2	2	2	1	1	1	1	1
CO3	2	2	1	1	1	1	1
CO4	2	2	1	1	1	1	1
CO5	2	2	1	1	1	1	1
CO6	2	2	1	1	1	1	1
Total	12	12	6	6	6	6	6

1 - Low, 2 – Medium, 3- High

Semester	**IV**		
Course Name	**DISSERTATION PHASE – II**		
Course Code	**YRE401**		
L –T –P –C **0 – 0 –16– 16**		**C:P:A** **0:1.5:1.5**	**L –T –P –H** **0–0– 32– 32**

CO	**CO STATEMENT**	**Knowledge Level**
CO1	*build* individual parts or samples related to project	**P5**
CO2	*Assemble* individual parts to finished assembly related to project	**P5**
CO3	*Perform* characterization study or design calculation on objects related to project.	**A5**
CO4	*Compose* the important findings as scientific drawing, chart, plot and table	**P7**
CO5	*Prepare* a consolidated technical report of the project	**A4**
CO6	*Present* a consolidated technical report of the project	**A2**

Objectives

- To prepare sample / parts related to project work.
- To characterize prepared samples or parts related to project work.
- To compose important findings as scientific data.
- To prepare and present technical report of the project.

Mapping of COs with POs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	2	1	2	1	1	1	1
CO2	3	2	2	2	1	1	1
CO3	2	3	2	1	1	1	1
CO4	3	3	2	2	3	1	1
CO5	3	1	3	3	2	1	1
CO6	3	1	2	3	1	1	1
Total	16	11	13	12	9	6	6

1 - Low, 2 – Medium, 3- High