Model Curriculum for UG Degree Course

In

Mechanical Engineering

2023

Mechanical Engineering Department

School of Engineering and Technology

H.N.B Garhwal University, Srinagar, Uttarakhand 246174

www.hnbgu.ac.in

SEMESTER- WISE LIST SUBJECTS (AS PER NEP 2020)

SEMESTER I

S. No.	Category	Course Code	Course Title	L	T	P	Contact Hrs./Week	Credits
1.	Basic Science/ Multidisciplinary	SET/SH/BT/C101	Mathematics I	3	1	-	4	4
2.		SET/SH/BT/C102	Physics	3	1	-	4	4
3.	Core Basic Engineering Subjects	SET/EE/BT/C103	Basic Electrical Engineering	3	1	-	4	4
4.		SET/EC/BT/C104	Basic Electronics	3	1	-	4	4
5.		SET/IT/BT/C105	Fundamental of Information Technology	3	1	-	4	4
6.	Core/ Basic Engineering Subjects Labs	SET/SH/BT/C107	Physics Lab	-		1	2	1
7.		SET/ME/BT/C108	Engineering Graphics and Workshop Practice	-	-	1	2	1
8.	Extracurricular Courses/ CC	VAC-1/AECC106	*Understanding and Connecting with Environment	2	-	-	2	2
9.	Skill Course	SET/ME/SC/C110	Machining Practice Lab-I (Skill Enhancement Course)	-	-	1	4	2
Total				17	5	3	30	26

*Common syllabus for all UG courses of the university.

SEMESTER II

S. No.	Category	Course Code	Course Title	L	T	P	Contact Hrs./Week	Credits
1.	Basic Science/ Multidisciplinary	SET/SH/BT/C201	Mathematics II	3	1	-	4	4
2.		SET/SH/BT/C203	Chemistry	3	1	-	4	4
3.	Core Basic Engineering Subjects	SET/ME/BT/C202	Basic Mechanical Engineering	3	1	-	4	4
4.		SET/ME/BT/C204	Engineering Mechanics	3	1	-	4	4
5.		SET/CS/BT/C205	C Programming	3	1	-	4	4
6.	Core/ Basic Engineering Subjects Labs	SET/SH/BT/C208	Chemistry Lab	-	-	1	2	1
7.		SET/CS/BT/C209	C Programming Lab	-	-	1	2	1
8.	Extracurricular Courses/ CC	AECC206/ VAC-2	*Life Skills and Personality Development	2	-	-	2	2
9.	Skill Course	SET/ME/SC/C210	Machining Practice Lab-II (Skill Enhancement Course)	-	-	1	4	2
Total				17	5	3	30	26

*Common syllabus for all UG courses of the university.

SEMESTER III

S. No.	Category	Course Code	Course Title	L	T	P	Contact Hrs./ Week	Credits
1.	Basic Science/ Multidisciplinary	SET/SH/BT/C301	Mathematics III	3	1	-	4	4
2.	Core Subjects	SET/ME/BT/C302	Solid Mechanics	3	1	-	4	4
3.		SET/ME/BT/C303	Fluid Mechanics	3	1	-	4	4
4.		SET/ME/BT/C304	Engineering Thermodynamics	3	1	-	4	4
5.	Interdisciplinary Subject	SET/ME/BT/C305	Engineering Materials and Applications	3	1	-	4	4
6.	Core Subjects Based Labs	SET/ME/BT/C306	Fluid Mechanics Lab	-	-	1	2	1
7.		SET/ME/BT/C307	Engineering Material & Testing Lab.	-	-	1	2	1
8.	Extracurricular Courses/ CC	VAC-3	Indian Knowledge System-I*	2	-	-	2	2
9.	Skill Course	SET/ME/BT/S308	Programming for Problem Solving	-	-	1	4	2
TOTAL				17	5	3	30	26

*University will prepare a course with focus on Indian Knowledge System-I.

SEMESTER IV

S. No.	Category	Code	Course Title	L	T	P	Contact Hrs./Week	Credits
1.	Core Subjects	SET/ME/BT/C401	Kinematics of Machines	3	1	-	4	4
2.		SET/ME/BT/C402	Manufacturing Technology	3	1	-	4	4
3.		SET/ME/BT/C403	IC Engines	3	1	-	4	4
4.		SET/ME/BT/C404	Applied Thermodynamics	3	1	-	4	4
5.	Interdisciplinary Subject	SET/ME/BT/C405	Measurement, Metrology & Control	3	1	-	4	4
6.	Core Subjects Based Labs	SET/ME/BT/C406	Manufacturing Technology Lab.	-	-	1	2	1
7.		SET/ME/BT/C407	Measurement, Metrology & Control Lab.	-	-	1	2	1
8.	Extracurricular Courses/ CC	AMDSC-2	*Basic Yoga Practices	2	-	-	2	2
9.	Skill Course	SET/ME/BT/S408	Machine Design, AutoCAD 2D-3D	-	-	1	4	2
TOTAL				17	5	3	30	26

* University will prepare a course with focus on Basic Yoga Practices

SEMESTER V

S. No.	Category	S. No.	Course Title	L	T	P	Contact Hrs./Week	Credits
1.	Core Subjects	SET/ME/BT/C501	Machine Design-I	3	1	-	4	4
2.		SET/ME/BT/C502	Dynamics of Machines	3	1	-	4	4
3.		SET/ME/BT/C503	Refrigeration & Air Conditioning	3	1	-	4	4
4.			@Program Elective-I	3	1	-	4	4
5.	Open Elective / Inter-disciplinary Subject		#Open Elective-I	3	1	-	4	4
6.	Core Subjects Based Labs	SET/ME/BT/C504	Machine & Mechanism Lab.	-	-	1	2	1
7.		SET/ME/BT/C505	Refrigeration & Air Conditioning Lab.		-	1	2	1
8.	Extracurricular/ Courses/ Compulsory course	SET/ME/BT/M505	*Culture, traditions and moral values/ Yoga Practices	-	-	1	4	2
9.	Skill Course	SET/ME/BT/S506	Mini Project-I	-	-	2	4	2
TOTAL				15	5	4	32	26

@Course offered by the department from the Program Elective- I list as given below.
#Courses offered by any other department/ Department of School of Engineering and Technology.
*University will prepare a course with focus on Indian/ Regional culture studies. In case no syllabus is prepared by the university then yoga Practices course will be offered.

	S. No.	Code	Course Title
Program Elective- I	1.	SET/ME/BT/E507	Mechatronics
	2.	SET/ME/BT/E508	Engineering Tribology
	3.	SET/ME/BT/E509	CNC Machines And Programming
	4.	SET/ME/BT/E510	Nanotechnology

	S. No.	Code	Course Title
Open Elective- I	1.	SET/ME/BT/OE511	Python
	2.	SET/ME/BT/OE512	Industrial Engineering and Management
	3.	SET/ME/BT/OE513	Numerical Methods in Engineering
	4.	SET/ME/BT/OE514	Human resource management

SEMESTER VI

S. No.	Category	Code	Course Title	L	T	P	Contact Hrs./Week	Credits
1.	Core Subjects	SET/ME/BT/C601	Machine Design-II	3	1	-	4	4
2.		SET/ME/BT/C602	Fluid Machinery	3	1	-	4	4
3.		SET/ME/BT/C603	Heat & Mass Transfer	3	1	-	4	4
4.			@Program Elective-2	3	1	-	4	4
5.	Open Elective/ Inter-disciplinary Subject		#Open Elective-2	3	1		4	4
6.	Core Subjects Based Labs	SET/ME/BT/C604	Heat & Mass Transfer Lab.	-	-	1	2	1
7.		SET/ME/BT/C605	Fluid Machinery Lab			1	2	1
8.	Life Skills and personality development	SET/ME/BT/M606	* Communication Skills Course/ Technical Seminar	-	-	1	4	2
9.	Skill Course	SET/ME/BT/S607	Mini Project-II	-	-	1	4	2
TOTAL					15	5	4	32

@Course offered by the department from the Program Elective- II list as given below.
#Courses offered by any other department of School of Engineering and Technology.
*University will prepare communication course in Modern/Indian languages from which student will select one language course. The course will be more on applied side with giving students a chance to develop their soft skills. In case no syllabus is prepared by the university then Technical Seminar course will be offered.

	S. No.	Code	Course Title
Program Elective- II	1.	SET/ME/BT/E608	Operation Research Techniques
	2.	SET/ME/BT/E609	Advanced Machine Tools and Operations
	3.	SET/ME/BT/E610	Maintenance Engineering
	4.	SET/ME/BT/E611	Smart Materials

	S. No.	Code	Course Title
Open Elective-2	1.	SET/ME/BT/OE612	Machine Learning
	2.	SET/ME/BT/OE613	Entrepreneur Essential
	3.	SET/ME/BT/OE614	Work Study and Ergonomics
	4.	SET/ME/BT/OE615	Flexible Manufacturing System

SEMESTER VII

S. No.	Category	Code	Course Title	L	T	P	Contact Hrs./Week	Credits
1.	Core Subjects	SET/ME/BT/C701	Automobile Engineering	3	1	-	4	4
2.			@Program Elective-3	3	1	-	4	4
3.			@Program Elective-4	3	1	-	4	4
4.	Core Subjects Based Labs	SET/ME/BT/C702	Automobile Engineering	-	-	1	2	1
5.		SET/ME/BT/C703	Industrial Training Seminar	-	-	1	2	1
6.	Life Skills and personality development	SET/SH/BT/L701	*Essential Management Practices	2	-	-	2	2
7.	Skill Course	SET/ME/BT/S704	Major Project Preparation	-	-	1	8	4
TOTAL				11	3	3	26	20

@Course offered by the department from the Program Elective- II list as given below.
#Courses offered by any other department of School of Engineering and Technology.
*University will prepare a course with focus on Essential Management Practices

Programme Electives (PEL): Total **2** to be taken, at least one from each group – *Technology* and *Industry Sector*, based on Project topic and individual interest. Illustrative courses are listed here.

S.N.	PEL (Technology)	Code	PEL (Industry Sector)	Code
1	Finite Element Method	SET/ME/BT/E705	CAD/CAM and Robotics	SET/ME/BT/OE709
2	Renewable Energy Engineering	SET/ME/BT/E706	Product Design and Development	SET/ME/BT/OE710
3	Additive Manufacturing	SET/ME/BT/E707	Unconventional Manufacturing Processes	SET/ME/BT/OE711
4	Computational Fluid Dynamics	SET/ME/BT/E708	Turbo Machines	SET/ME/BT/OE712

SEMESTER VIII

S. No.	Category	Code	Course Title	L	T	P	Contact Hrs./Week	Credits
1.	Core Subjects	SET/ME/BT/C801	Power Plant Engineering	3	1	-	4	4
2.			@Program Elective-5	3	1	-	4	4
3.			@Program Elective-6	3	1	-	4	4
4.	Life Skills and personality development	SET/SH/BT/L801	*Disaster Management	-	-	1	4	2
5.	Skill Course	SET/ME/BT/S802	Major Project	-	-	1	12	6
Total				9	3	2	28	20

@Course offered by the department from the Program Elective- II list as given below.
#Courses offered by any other department of School of Engineering and Technology.
* University will prepare a course with focus on Disaster Management

Programme Electives (PEL): Total **2** to be taken, at least one from each group – *Technology* and *Industry Sector*, based on Project topic and individual interest. Illustrative courses are listed here.

S.N.	PEL (Technology)	Credit	PEL (Industry Sector)	Credit
1	Advance Welding Technology	SET/ME/BT/E802	Composite Material	SET/ME/BT/OE806
2	Gas Dynamics and Jet Propulsion System	SET/ME/BT/E803	Computer Integrated Manufacturing Systems	SET/ME/BT/OE807
3	Solar Thermal Power Engineering	SET/ME/BT/E804	Optimization Techniques in Engineering	SET/ME/BT/OE808
4	Experimental Stress Analysis	SET/ME/BT/E805	Biomedical Engineering	SET/ME/BT/OE809

Curriculum of Mechanical Engineering

Semester 1	Credit	Semester 2	Credit
1. Mathematics I	4	1. Mathematics II	4
2. Physics	4	2. Chemistry	4
3. Basic electrical engineering	4	3. Basic mechanical engineering	4
4. Basic electronics	4	4. Engineering mechanics	4
5. Fundamental of information technology	4	5. C programming	4
6. Physics lab	1	6. Chemistry lab	1
7. Engineering graphics and workshop practice	1	7. C programming lab	1
8. Understanding and connecting with environment	2	8. Life skills and personality development	2
8. Basic electrical engineering lab	2	9. Basic electronics lab	2
Total credits	**26**	**Total credits**	**26**
Semester 3	**Credit**	**Semester 4**	**Credit**
1. Mathematics III	4	1. Kinematics of Machines	4
2. Solid mechanics	4	2. Manufacturing Technology	4
3. Fluid mechanics	4	3.IC Engines	4
4. Engineering thermodynamics	4	4. Applied Thermodynamics	4
5. Engineering materials and applications	4	5. Measurement, Metrology & Control	4
6. Fluid mechanics lab	1	6. Manufacturing Technology Lab	1
7. Engineering materials and testing lab	1	7 Measurement, Metrology & Control Lab	1
8. Indian Knowledge System-I*	2	8. Indian Knowledge System-II	2
9. Programming for problem solving	2	9. Machine design and AutoCAD 2D-3D	2
Total credits	**26**	**Total credits**	**26**
Semester 5	**Credit**	**Semester 6**	**Credit**
1.Machine Design-I	4	1.Machine Design-II	4
2. Dynamics of Machines	4	2. Fluid Machinery	4
3. Refrigeration & Air Conditioning	4	3. Heat & Mass Transfer	4
4. Program Elective-I	4	4. Program Elective-2	4
5. Open Elective-I	4	5.Open Elective-2	4
6. Machine & Mechanism Lab.	1	6. Heat & Mass Transfer Lab.	1
7. Refrigeration & Air Conditioning Lab.	1	7. Fluid Machinery Lab	1
8. Culture, traditions and moral values/ Yoga Practices	2	8. Communication Skills Course/	2
9. Mini project 1	2	Technical Seminar	
		9. Mini Project-II	2
Total credits	**26**	**Total credits**	**26**
Semester 7	**Credit**	**Semester 8**	**Credit**
1. Automobile Engineering	4	1. Power Plant Engineering	4
2. Program Elective-3	4		4
3. Program Elective-4	4		4
4. Automobile &HMT Lab	1	2. Program Elective-5	2
5. Industrial Training Seminar	1	3. Program Elective-6	6
6. Essential Management Practices	2	4. Disaster Management	
7. Major Project Preparation	4	5. Major Project	
Total credits	**20**	**Total credits**	**20**

DETAILED SYLLABI AS PER NEP-2020

SEMESTER I

S. No.	Category	Course Code	Course Title	L	T	P	Contact Hrs./Week	Credits
1.	Basic Science/ Multidisciplinary	SET/SH/BT/C101	Mathematics I	3	1	-	4	4
2.		SET/SH/BT/C102	Physics	3	1	-	4	4
3.	Core Basic Engineering Subjects	SET/EE/BT/C103	Basic Electrical Engineering	3	1	-	4	4
4.		SET/EC/BT/C104	Basic Electronics	3	1	-	4	4
5.		SET/IT/BT/C105	Fundamentals of Information Technology	3	1	-	4	4
6.	Core/ Basic Engineering Subjects Labs	SET/SH/BT/C107	Physics Lab	-		1	2	1
7.		SET/ME/BT/C108	Engineering Graphics and Workshop Practice	-	-	1	2	1
8.	Extracurricular Courses/ CC	VAC-1	*Understanding and Connecting with Environment	2	-	-	2	2
9.	Skill Course	SET/IE/BT/S106	Basic Electrical Engineering Lab	-	-	1	4	2
Total				17	5	3	30	26

*Common syllabus for all UG courses of the university.

MATHEMATICS-I

SET/SH/BT/C101 MATHEMATICS-I		
Course Objective	To provide essential knowledge of basic tools of Differential Calculus, Vector Calculus and Matrix Algebra for engineering students.	
Course Outcomes	Implementation of calculus in designing the different structural and mechanical components while matrix algebra is applied in the study of electrical circuits, quantum mechanics and optics.	
Module Name	**Content**	**No. of Hrs.**
Differential Calculus	Limit, continuity and differentiability of single and two variables, mean value theorems, indeterminateforms;partialderivatives,totalderivative,Euler‟sformula,Taylorseries(in oneandtwovariables),maximaandminima,Extremaoffunctionofseveralvariables, Lagrange‟s method.	**15**
Vector Calculus	Interpretation of vectors and scalars, directional derivatives, line, surface and volume integrals, gradient, divergence and curl of a vector and their physical interpretation, Gauss‟s divergence, Green‟s and Stoke' stheorem.	**12**
Matrices	Vector space, basis, matrices, determinants, Elementary row and column transformation, linear dependence and independence, rank of matrix, consistency of system of linear equation and solution of linear system of equations. Characteristic equation, Cayley- Hamilton theorem, eigen values and eigen vectors, diagonalization, complex matrices.	**15**
	Total No. of Hours	**42**
Textbooks	1. R. K. Jain and S. R. K. Iyengar “Advanced Engineering Mathematics”, Narosa Publications. 2. B. S. Grewal, “Higher Engineering Mathematics”, Khanna Publishers. 3. H. K. Das, “Advanced Engineering Mathematics”, SChand. 4. Erwin Kreyszig, “Advanced Engineering Mathematics”.	

PHYSICS

Course objective:

1. To introduce the student to the basic of wave optics, lasers, and demonstrate their applications in technology.
2. To make students aware about quantum physics phenomena.
3. Give the beginning student an appreciation of recent developments in materials science &engineering within the framework of this class.
4. To review physics in the context of materials science & engineering.
5. Give an introduction to the relation between processing, structure, and physical properties.

SET/SH/BT/C102 PHYSICS		
Module Name	**Contents**	**No. of Hrs.**
Optics	Interference: Coherent Sources, Conditions of Interference, Fresnel‟s Biprism Experiment, Interference in Thin Films, Newton‟s Rings; Single and n-Slit Diffraction, Diffraction Grating, Raleigh‟s Criterion of Resolution, Resolving Power of Telescope, Phenomenon of Double Refraction, Ordinary and Extra-ordinary Rays, Nicol Prism, Circularly and Elliptically Polarized Light, Fresnel Theory, Optical Activity, Specific Rotation; Laser: Principle of Laser Action, Einstein‟s Coefficients, Construction and Working of He-Ne and Ruby Laser, Applications of Laser.	**15**
Origin of Quantum Mechanics and its Applications	Black body radiation, Planck‟s Radiation Law, Wave Particle Duality, de-Broglie hypothesis, Photoelectric effect, Wave Function and its Normalization, Born Interpretation, Schrodinger equation, Particle in a Box, Potential Step (E < Vo),Tunneling effect (Qualitative idea).	**10**
Basics Material Science	Introduction to crystal structure of materials, Miller indices for crystallographic planes and directions. Diffraction of X-Rays, Bragg‟s Law, Determination of crystal structure using X-rays Diffraction and its applications. Defects in solids: point, line and planar defects and their effect on properties of materials. Band theory of solids, conductors, semi-conductors and insulators, metals. Fermi Level. Magnetism: dipole moments, paramagnetism, Curie‟s law, magnetization and hysteresis, Ferromagnetism and Anti-Ferromagnetism. Ferro electricity and Piezoelectricity. Superconductivity inmaterials.	**15**
Electro-Magnetics	Ampere‟s Law and Displacement Current, Maxwell‟s Equations in Integral and Differential Forms, Electromagnetic Wave Propagation in Free Space and Conducting Media, Poynting Theorem.	**8**
	Total No. of Hours	**48**

Text/references books

1. Gaur, Gupta, “Engineering Physics”.
2. Callister W.D., “Materials Science and Engineering: An Introduction”, 6th Edition, John Wiley & Sons Inc., New York2002.
3. J. R. Taylor, C. D. Zafiratos and M. A. Dubson, “Modern Physics for Scientists and Engineers”, 2ndPearson.
4. Arthur Beiser, “Concepts of Modern Physics”, 6th Ed., TMH,(2009).
5. D. J. Griffith:Electrodynamics.
6. Charles Kittel, Introduction to Solid StatePhysics.
7. S. O. Pillai, Solid StatePhysics.

Course outcomes:

Student should be able to:

1. Demonstrate interference, diffraction and polarization of light and explain the working principle of Lasers.
2. Student will understand quantum mechanical aspects of physics.
3. Enable to explain the phenomenon of crystal structure and crystallographic, qualitatively description of X-ray diffraction and its general physical properties, as well as possible applications.
4. Students will understand the phenomenon of defects in solids and their physical properties, band theory of solids and classification of energy bands, electric and magnetic properties of solids and able to explain qualitative idea of superconductivity in materials.
5. This will enable the students to learn physical concepts associated with electromagnetic radiation and devices.

BASIC ELECTRICAL ENGINEERING

Course objective:

1. To impart basic knowledge of electrical quantities and provide working knowledge for the analysis of DC and AC circuits.
2. To understand the construction and working principle of DC and ACmachines.
3. To understand the construction and working principle of variousinstruments.

To understand the construction and working principle of 3- phase supplysystem.

SET/EE/BT/C103 BASIC ELECTRICAL ENGINEERING		
Module Name	**Contents**	**No. of Hrs.**
DC Networks	Concepts of linear, nonlinear, active, passive, unilateral and bilateral elements; Ideal and practical voltage & current sources, conversion from one from the other; Kirchhoff‟s laws, statements; Mesh Analysis; Nodal Analysis; Delta-Star & Star-Delta conversion; Superposition principle; Thevenin‟s theorem, statement, advantages in case of complex networks; explanation & illustration with examples; Norton‟s theorem, Maximum powertransfer theorem, Reciprocity Theorem and its application.	**10**
Single Phase AC Circuits	Generation of single phase AC voltage and determination of average (mean) and RMS (effective) values of voltage and current with special reference to sinusoidal waveforms; Form factor and peak factor for various waves; Representation of sinusoidal time varying quantities as phasors; concepts of reactance, impedance and their representation in complex forms using j operator; Steady state analysis of series R-L-C circuit & its phasor diagram; Conceptofpower&powerfactor;Conceptofadmittance,susceptanceinparallelcircuits; Analysis of series parallel circuits & phasor diagrams; Resonance in series and parallel circuits.	**10**
Three Phase Circuits	Generation of 3-phase balanced sinusoidal voltage; star & delta connections; line & phase quantities (current & voltage); Solution of 3-phase star/delta circuits with balanced supply voltage and balanced load; phasor diagram; 3-phase, 4-wire circuits; Measurement of threephase power by two wattmeter method; phasor diagram with balanced load and determination of load power factor from wattmeter readings.	**6**
Transformers and Rotating Machines	Transformers: Constructional features and principle of operation, concept of ideal transformer under no load & loaded conditions and its equivalent circuit; Practical transformer rating & its equivalent circuit; Autotransformer – principle of operation & relative advantages & disadvantages; Rotating Machine: construction features (stator, rotor & air gap), conditions for production of steady electromagnetic torque; Three phase Induction motor:constructionalfeaturesandoperation;DCMachines:constructionfeatures,EMFand Torque expression, Classification of DC motors and generators; Stepper motor.	**12**
Measuring Instruments	DC PMMC instruments – constructional feature and principle of operation; Moving iron meters construction and principle of operation; Dynamometer type wattmeter; Induction type energy meter construction & principle of operation.	**6**
	Total No. of Hours	**44**

Text/references books

1. A. E. Fitgerald, D. E., Higginbotham and A. Grabel, “Basic Electrical Engineering”, Mc GrawHill.
2. Rizzoni, “Principles and Applications of Electrical Engineering”,TMH.
3. V. Del Toro, “Principles of Electrical Engineering”, PrenticeHall.
4. W. H. Hayt & J. E. Kemmerly, “Engineering Circuit Analysis”, Mc GrawHill.
5. H. Cotton, “Advanced Electrical Technology”, WheelerPublishing.

Course outcomes:

Student should be able to:

1. Understand the basic electric and magnetic circuits.
2. Analyze DC and AC circuits.
3. Interpret the construction and working of different types of electrical machines and instruments.

BASIC ELECTRONICS

Course objective:

1. To familiarize the students with electronics field.
2. To introduce semiconductor fundamentals, electronic devices, and elementary electronic circuits.
3. To familiarize students with digital logics and gates.

SET/EC/BT/C104 BASIC ELECTRONICS		
Module Name	**Contents**	**No. of Hrs.**
Semiconductor Diodes	Semiconductor materials- intrinsic and extrinsic types, Ideal Diode as a switch, Terminal characteristics, and equivalent circuit of PN diode: p-n junction under open circuit condition, p-n junction under forward bias and reverse bias conditions, p-n junction in breakdownregion;Zenerdiodeandbasicvoltageregulatorusing Zenerdiode;Rectifier Circuits, Clipping and Clamping circuits; LED, Photo Diode.	**10**
Bipolar Junction Transistors	Physical structure, physical operation and current-voltage characteristics of NPN transistor; Use of Voltage-dependent Current source as a Voltage amplifier; Transistor as an amplifier: Characteristics of CE amplifier; Active region operation of transistor; D.C. analysis of Common Emitter Amplifier: load line analysis; Transistor as a switch: cut-off and saturation modes.	**10**
Field Effect Transistor	Enhancement-type MOSFET: structure and physical operation, current-voltage characteristics; MOSFET as a Switch, MOSFET as a Voltage-dependent Current sourceand Common Source Amplifier.	**8**
Operation Amplifier	Ideal Op-amp; Properties of the ideal Operational Amplifier; op-amp application circuits (assuming ideal op amp): inverting amplifier, non -inverting amplifier, weighted summer, Integrator and differentiator.	**6**
Digital Logic and Gates	Binary, octal, and hexadecimal number systems; Methods of base conversions; Binary, octal, and hexadecimal arithmetic; Representation of signed numbers; Basic logic operations and logic gates; MOSFET Switch Implementation of Logic Gates, e.g., Inverter, NAND, NOR. Basic postulates and fundamental theorems of Boolean algebra.	**8**
	Total No. of Hours	**42**

Text/references books

1. Agarwal Anant, Lang, Jeffrey H, "Foundations of Analog and Digital Electronic Circuits",Elsevier Science & Technology Books.
2. V. Del Toro, "Principles of Electrical Engineering",PHI.
3. Rizzoni, "Principles and Applications of Electrical Engineering",TMH.
4. Malvino, ElectronicPrinciples.
5. R. L. Boylestad & L. Nashelsky, "Electronics Devices & Circuit Theory",PHI.

Sedra, Smith, "Microelectronic Circuits", Oxford UniversityPress.

Course outcomes:

Student should be able to:

1. Understand the working and current voltage characteristics of semiconductor devices e.g., dio desand transistor.
2. Perform dc analysis of amplifier circuits.
3. Design basic OP AMP circuits.
4. Understand and use basic digital electronic concepts.

FUNDAMENTALS OF INFORMATION TECHNOLOGY

Course objective:

1. Take on significant positions in various ITwork.
2. Collaborate in diverse teamenvironments.
3. Contributions in the field ofIT.
4. Work effectively in the IT field to make a positive contribution to society.

SET/IT/BT/C105 FUNDAMENTALS OF INFORMATION TECHNOLOGY		
Module Name	**Contents**	**No. of Hrs.**
Introduction	Definition of Electronic Computer, Generations, Classification of Computers, Computer Hardware and Basic Computer Organization: CPU- ALU, CU; RAM/ROM, Various I/O devices, Peripherals, Storage Media.	**4**
Computer Languages	Binary, Hexadecimal Number System; Basic Binary Logic Operations; Binary Addition and Subtraction; Generation of Languages, Assembly Language, High level language; Translators, Interpreters, Compilers, Compilers; Flow Charts, Dataflow Diagram.	**6**
OS & Office	Software- System and Application Software; Elementary Concepts in Operating System; Textual Vs GUI, Introduction to DOS, MS Windows, UNIX/Linux.	**4**
Computer Networks	Elements of Communication system; Brief Introduction to Computer Networks-Introduction of LAN and WAN. Network Topologies, Client-server Architecture, IoT, Cloud Computing.	**6**
Internet	Internet & World Wide Web, Hypertext Markup Language, DHTML, Python, WWW, Gopher, FTP, Telnet, Web Browsers, Net Surfing, Search Engines, Email; Introduction to Web Development, Static and Dynamic Pages.	**6**
IT Application and Multi media	Basic Awareness of NICNET and ERNET; E Commerce, E governance; Brief Introduction to Different Formats of Image, Audio,Video.	**6**
Information Concepts & Processing	Definitions of Information, Need of information, quality of information, value of information, concept of information, Entropy category and Level of information in Business Organization,DataConceptsandDataProcessing,DataScience,DataRepresentation, Application of IT to E-commerce, Electronic Governance, Multimedia, Entertainment, Introduction to Information System.	**8**
	Total No. of Hours	**40**

Text/references books

1. Sinha, Sinha, “ComputerFundamentals”.
2. Yadav R. P., “InformationTechnology”.
3. D. S. Yadav, “Foundations of IT”, New Age,Delhi.
4. Rajaraman, “Introduction to Computers”,PHI.
5. Peter Nortans “Introduction to Computers”, TMH.

Course outcomes:

Student should be able to:

1. Develop information technology solutions by evaluating user requirements in the systems development environment.
2. Apply knowledge of IT requirements for technology solutions in cutting edgesapplications.
3. Analyze a problem and identify and define the computing requirements for the appropriatesolutions.
4. Create, select and apply appropriate techniques, resources, and modern engineering and ITtools.

PHYSICS LAB

SET/SH/BT/C107 PHYSICS LAB		
S. No.	**Experiments**	**No. of Hrs.**
1.	To determine refractive index of glass and liquid using spectrometer.	1x2
2.	To determine the wavelength of spectral lines using plane diffraction grating (Use Hg Source).	1x2
3.	To determine the wavelength of sodium light by Newton's Ring method.	1x2
4.	To measure an accessible (Horizontal and vertical) height using sextant.	1x2
5.	Determination of wavelength of He-Ne laser using single slit /N slit diffraction pattern.	1x2
6.	To study the photoelectric effect and determine the value of Planck's constant.	1x2
7.	To determine the heating efficiency of an electric kettle with varying voltage.	1x2
8.	To Determine the wavelength of the semiconductor diode laser.	1x2
9.	Measurement of forward/reverse saturation current in p-n-junction diode at various Temperatures and to find the approximate value of energy gap.	1x2
10.	To study the Hall effect and determine Hall coefficient, carrier density and mobility of a given semiconductor material.	1x2
11.	To draw hysteresis curve of a given sample of ferromagnetic material and from this to determine magnetic susceptibility.	1x2
12.	Measurement of e/m of electron e/m- Thomson's Experiment.	1x2
13.	To verify Ohm's law.	1x2
14.	Conversion of Galvanometer into Voltmeter and Ammeter.	1x2
15.	To determine the unknown resistance by a post office box.	1x2
	Total No. of Hours	**30**
References	1. Practical Physics, C. L. Arora, S. Chand & Co. 2. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt.Ltd. 3. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia PublishingHouse. 4. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted1985, Heinemann EducationalPublishers. 5. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, NewDelhi.	

ENGINEERING GRAPHICS AND WORKSHOP PRACTICE

SET/ME/BT/C108. ENGINEERING GRAPHICS AND WORKSHOP PRACTICE		
Module Name	**Content**	**No. of Hrs.**
Introduction to Engineering Graphics & Projection of Points	Drawing instruments and their use, Different types of lines, Lettering & dimensioning Familiarization with current Indian Standard Code of Practice for Engineering Drawing. Scales, Plain scales, Diagonal scales, Vernier scales. First angle and third angle projections Projection of points in different coordinates, Projections of lines inclined to one of the reference planes.	**08**
Projections of lines and planes	Projections of lines inclined to both the planes, True lengths of the lines and their angles of inclination with the reference planes, Traces of lines. Projection of plane lamina of geometric shapes inclined to one of the reference planes, inclined to both the planes, Traces of planes. Projections on auxiliary planes.	**08**
Projections of polyhedral and solids	Projections of polyhedral and solids of revolution, projection of solids with axis parallel to one of the planes and parallel or perpendicular to the other plane, Projections with the axis inclined to one of the planes.	**08**
Orthographic Projection	Concept of orthographic projection, Rules of Drawing orthographic projection, Conversion of pictorial views into orthographic projection, Drawing of orthographic projection of Machine components.	**08**
Carpentry, Fitting and Black smithy	Minimum two experiments from Carpentry, Fitting and Black smithy. And Development of jobs carried out and soldering, Black Smithy, House Wiring, Foundry (Molding only), Plumbing.	**08**
Welding & Machining	Practice of minimum two experiments of welding joints. Overview of Lathe, Shaper, Milling and Drilling machine. Perform one job on each machine.	**08**
	Total No. of Hours	**48**
Textbooks	1. Bhatt N. D, Elementary Engineering Drawing, Charotar Publishing House, Anand,2002. 2. Elements of Workshop Technology Vol-1 by HazraChaudhary.	
References	1. Narayana K L & Kannaiah P, Engineering Graphics, Tata McGraw Hill, New Delhi,1992. 2. Luzadder W J, Fundamentals of Engineering Drawing, Prentice Hall of India, New Delhi,2001. 3. Thomas E French & Charkes J V, Engineering Drawing & Graphing Technology, McGraw HillBook Co, New York,1993. 4. Venugopal K, Engineering Drawing & Graphics, New Age International Pvt. Ltd., New Delhi,1994. 5. Workshop Technology, Raghubanshi.	

UNDERSTANDING AND CONNECTING WITH ENVIRONMENT

VAC-1 UNDERSTANDING AND CONNECTING WITH ENVIRONMENT		
Module Name	**Content**	**No. of Hrs.**
Understanding of Environment	1. Definition, scope and importance of Environment, Multidisciplinary nature of Environmental Sciences. 2. Understanding of Ecology and Ecosystems, Ecological Succession and 3. Ecosystem Services. 4. Energy flow in an Ecosystem; Food Chain, Food Weband, Ecological Pyramids. 5. Human interaction with its Environment.	**7**
Natural Resources and Biodiversity Conservation	1. Basic concept, types and values of Natural Resources. 2. Resource Consumption, Restoration and Conservation Practices and Sustainable Development. 3. Concept, values and distribution of Biodiversity and its linkages with culture, health and people. 4. Threats to Biodiversity and Biodiversity conservation.	**7**
Global Environmental issues	1. Environmental Pollution and Waste Management. 2. Climate Change, Green House Effect and Global Warming. 3. Radiations, Nuclear and Technological Hazards. 4. Population Growth, Disaster, Pandemic and Human Health Risks.	**8**
Environment and Society	1. Origin and Evolution of Human; Social, Cultural and Religious Structure and values of Environment. 2. Traditional Wisdom, Indigenous/traditional Communities and Livelihood Security 4.3 Industrial Society, Modernization and Adaptations to Natural and Anthropogenic variations. 3. Environmental Movements, Environmental Ethics and Legislations. 4. Connecting human society with conservation and management of water, energy, biodiversity, culture and heritage and waste management.	**8**
	Total No. of Hours	**30**
Text Book/ References	1. WorldCommissiononEnvironmentandDevelopment.1987.*Our Common Future*. Oxford University Press. 2. Ramakrishnan, P.S., Purohit, A.N., Saxena, K.G., Rao, K.S., Maikhuri, R. K. 1996 *Conservation and Management of Biological Resources in Himalaya.* Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi. 3. Erach Bharucha, *Environmental Studies*. 2004, UGC and BVIEER Pune. 4. Khanduri, I., Pandey, M., Maikhuri, R. 2006. *Environment and Ecology*, Trans media Publication Srinagar Garhwal. 5. Pepper,I.L.,Gerba,C.P.&Brusseau,M.L.2011.EnvironmentalandPollutionScience.AcademicPress. 6. Paryavaran Mitra. Explore, Discover, Think, Act. 2011. Centre for Environmental Education. 7. P.D. Sharma, 2012 Ecology and Environment. Rastogi Publication. 8. Sodhi,N.S.,Gibson,L.&Raven,P.H.(eds).2013.*ConservationBiology*:*Voicesfromt heTropics*.JohnWiley&Sons. 9. Singh,J.S.,Singh,S.P.andGupta,S.R.2014.*Ecology,Environmental Science and recourse Conservation*.Anamaya Publishers. 10. Gopal. B., Bhardwaj, N. *Elements of Ecology*. Vikas Publication House New Delhi	

SET/ME/SC/C110	Machining Practice Lab-I (Skill Enhancement Course)	
Course Objective:	1. To make the student learn a Main parts machine and their functions. 2. To learn various operations that can perform on the Machine. 3. To learn how to shape raw materials into useful products.	
Course Outcome:	1. After Completion of this course the student would be able to know about functions of machine parts. 2. Able to shape raw materials according to design of the components.	
Module Name	**Content**	**No. of Hrs**
Module I	Working and principle of Lathe machine, Important parts and Functions. Tools used in making job, Clamping of jobs using various work holding devices, Limitations of work holding devices. Functions of Lathe machine attachments and accessories, Cantering of jobs.	10
Module II	Practice on Lathe machine for making components as per given design related to operations:-Plain turning, Step turning, Taper turning, Knurling, Drilling, Bring, Reaming and Threading	10
Module III	Function and working of Shaper Machine. Work holding device working, Tooling in Shaper, Practice on Shaper machine for making components as per given design related to operations.	10
	Total Hours	**30**

SEMESTER II

S. No.	Category	Course Code	Course Title	L	T	P	Contact Hrs./Week	Credits
1.	Basic Science/ Multidisciplinary	SET/SH/BT/C201	Mathematics II	3	1	-	4	4
2.		SET/SH/BT/C203	Chemistry	3	1	-	4	4
3.	Core Basic Engineering Subjects	SET/ME/BT/C202	Basic Mechanical Engineering	3	1	-	4	4
4.		SET/ME/BT/C204	Engineering Mechanics	3	1	-	4	4
5.		SET/CS/BT/C205	C Programming	3	1	-	4	4
6.	Core/ Basic Engineering Subjects Labs	SET/SH/BT/C208	Chemistry Lab	-	-	1	2	1
7.		SET/CS/BT/C209	C Programming Lab	-	-	1	2	1
8.	Life Skills and Personality Development	VAC-2	*Life Skills and Personality Development	2	-	-	2	2
9.	Skill Course	SET/EC/BT/S206	Basic Electronics Lab	-	-	1	4	2
Total				**17**	**5**	**3**	**30**	**26**

*Common syllabus for all UG courses of the university.
Exit Option with Certificate in B. Tech. (Mechanical Engineering).

MATHEMATICS-II

SET/SH/BT/C201MATHEMATICS-II		
Module Name	**Content**	**No. of Hrs.**
Multiple Integral	Evaluation of definite integral; double and triple integrals; change of order of integration, Change of variables, application to area, volume, centre of gravity, moment of inertia and productofinertia.GammaandBetafunctions,Dirichlet‟sintegralanditsapplication.	**12**
Fourier Series	Periodic functions, Fourier series of functions with period 2n, change of interval, half range sine and cosine series.	**6**
Integral Transform	Laplace transforms, existence theorem, Laplace transform derivatives, inverse Laplace transform, application to solve linear differential equations, unit step function, Dirac delta function, Laplace transforms of periodic functions. Application of Laplace transforms. Definitions of Fourier transform and its simple applications.	**14**
Probability and Statistics	Random variables. Uniform, normal, exponential, Poisson and binomial distributions. Mean, median, mode and standard deviation, Correlation and regression, Conditional probability and Bayes theorem.	**12**
	Total No. of Hrs.	**44**
Textbooks	1. R. K. Jain and S. R. K. Iyengar “Advanced Engineering Mathematics”, NarosaPublications. 2. B. S. Grewal, “Higher Engineering Mathematics”, KhannaPublishers. 3. H. K. Das, “Advanced Engineering Mathematics”, SChand. 4. Erwin Kreyszig, “Advanced EngineeringMathematics”.	

CHEMISTRY

Course objectives:

1. Apply the electrochemical principles in batteries, understand the fundamentals ofcorrosion.
2. Analysis of water for its various parameters and its significance in industrial and domesticApplications.
3. Analyze microscopic chemistry in terms of atomic, molecular orbitals and Intermolecularforces.
4. Analysis of major chemical reactions that are used in the synthesis ofmolecules.
5. Understand the chemistry of various fuels and theircombustion.

SET/SH/BT/C203. CHEMISTRY		
Module Name	**Content**	**No. of Hrs.**
Advanced Theory of Chemical Bonding	Valence bond and molecular orbital theory. Structure of NH_3, H_2O, SO_3, PCl_5, XeO_2 molecules. Types of linkages, Hybridization, Hydrogen bonding, Metallic bonding.	**4**
Equilibrium on Reactivity	Bronsted and Lewis Acids, pH, pka, pkb scale, buffer solution.	**4**
Polymers	Structures of the following polymers, viz, Natural and synthetic rubbers, Polyamide and Polyester fibres, polymethylmethacrylate, poly acrylonitrile and polystyrene. A brief account of conducting polymers (polypyrrole & polytiphene) & their applications.	**3**
Complex Compounds	Introduction, Valence bond and crystal field theory.	**4**
Chemical Kinetics & Catalysis	Order of reactions, Parallel and reversible reactions, Catalysis- homogeneous and heterogeneous catalysis, Characteristics of catalytic reactions, catalytic promoters and poisons, auto catalysis and negative catalysis. Activation energy of catalysis, intermediate compound formation theory and adsorption theory.	**3**
Atmospheric Chemistry& Air Pollution	Environment and ecology, environmental segments, structure and composition of atmosphere, radiation balance of earth and Green House Effect, formation and depletion of Ozone layer, chemical and photochemical reactions of various species in atmosphere, air pollution-sources, reactions and sinks for pollutants, acid rains and smog formation. Pollution control methods.	**5**
Corrosion & Lubricants	Introduction, causes of corrosion, theories of corrosion- direct chemical attack, electrochemical theory of corrosion, factors influencing corrosion, corrosion inhibitors, passivity, types of corrosions, protection from corrosion and protective coatings. Theory, classification and mechanism of lubrication.	**5**
Waterand Waste Water Chemistry	Introduction, hardness of water, characteristics imparted by impurities, analysis of contaminants, treatment of water by Zeolite, L-S process, boiler feed water, waste water treatment.	**6**
Fuels & Combustion	Classification of fuels, non-conventional energy, biogas, biomass and solar energy, calorific value – gross and net, characteristics of good fuel, determination of calorific value, solid fuels, analysis of coal, liquid fuels.	**5**
Stereochemistry oforganic-compounds	Mechanism of chemical reaction, Beckman, Hoffman, Reimer Tiemann, Cunnizzaro, Diels-Alder and Skraup synthesis.	**3**
	Total No. of Hours	**42**
Textbooks	1. Jain, Jain, "EngineeringChemistry". 2. Sharma, Kumar, "EngineeringChemistry".	
References	1. R. T. Morrison and R N Boyd, "Organic Chemistry", 6th Edition, Prentice Hall, NewDelhi. 2. J. D. Lee, "Concise Inorganic Chemistry", Chapman &Hall. 3. W. L. Jolly, "Modern Inorganic Chemistry",McGraw-Hill.	

Course outcomes:

Student should be able to:

1. Describe and understand the operation of electrochemical systems for the production of electricenergy, i.e. batteries.
2. Explain the mode by which potable water is produced through the processes of screening, micro Straining, aeration, coagulation and flocculation, sedimentation, flotation, filtration anddisinfection.
3. Recognize that molecular orbital theory is a method used by chemists to determine the energy of the electron in a molecule as well as itsgeometry.
4. Demonstrate an ability to design, implement, and evaluate the results of experimentation using standard scientific methodologies such as hypothesis formulation and testing.
5. Understand and analyze the combustion mechanisms of variousfuels.

BASIC MECHANICAL ENGINEERING

Course Objectives:

1. To use mechanical principles to solve real-world engineeringissues.
2. To identify appropriate structural system for studying a given problem and isolate it from itsenvironment.
3. Develop a simple mathematical model for an engineering problem and perform a staticanalysis.
4. To carry out kinematics and Kinetics analysis for practices and system ofparticles.

SET/ME/BT/C202 BASIC MECHANICAL ENGINEERING		
Module Name	**Content**	**No. of Hrs.**
Fundamental concept of thermodynamics	Definition of thermodynamics, System, Surrounding and Universe, Phase, Concept of continuum, Macroscopic & microscopic point of view. Thermodynamic equilibrium, Property, State, Path, Process, Cyclic and non-cyclic processes, Reversible and irreversible processes, Quasi static process, Energy and its forms, Enthalpy, Zeroth law, first law, second law and third law of thermodynamics, Steady flow energy equation, Limitations of first law of thermodynamics, Essence of second law, Thermal reservoir, Heat engines. COP of heat pump and refrigerator, Carnot cycle, Carnot theorem, Clausius inequality, Concept of entropy.	**8**
Properties of gases and steam	Boyle's law, Charles's law, Gay-Lussac‟s law, Avogadro‟s law, Combined gas law, Gas constant, Relation between c_p and c_v, Various non-flow processes like constant volume process, constant pressure process, Isothermal process, Adiabatic process, Polytropic process. Steam formation, Enthalpy, Specific volume, Internal energy and dryness fraction of steams, steam calorimeters.	**5**
Thermodynamic Cycle	Rankine cycle, Actual vapour cycle processes, Comparison of Rankine and Carnot cycles, Air standard cycles - Otto, Diesel, dual and Brayton cycles, Vapour compression refrigeration cycles.	**8**
Introduction to Mechanics of Solid	Normal and shear Stress, strain, Hookes‟ law, Poisson‟s ratio, elastic constants and their relationship, stress-strain diagram for ductile and brittle materials, factor of safety. Basic Numerical problems, temperature stresses, shear stress, complementary shear stress, shear strain.	**8**
Compound Stresses and Strains	State of stress at a point, oblique stress, simple tension, pure shear, general two dimensional stress system, principal planes, principal stresses and strains, maximum shear stress.	**8**
Bending Stress and Torsion	Pure bending, moment of inertia, section modulus, bending stresses, combined bending and direct stress, beam of uniform strength, middle third and middle quarter rules for rectangular and circular sections, Circular shafts, torsional shear stress, strain energy in torsion, shafts under varying torque, compound shafts, combined bending andtwisting.	**8**
	Total No. of Hours	**45**
Textbooks	1. R S Khurmi, “EngineeringMechanics”. 2. P K Nag “EngineeringThermodynamics”.	
References	1. Van Wylen G.J. & Sonnlog R.E., Fundamentals of classical thermodynamics, John Wiley & Sons, Inc.NY. 2. Wark Wenneth, Thermodynamics, (2nd edition), Mc Graw Hill book Co.NY. 3. Holman, J.P., Thermodynamics, Mc Graw Hill book Co.NY. 4. Yadav R., Thermodynamics and Heat Engines, Vol I & II (Sl Edition) Central Publishing HouseAllahabad. 5. Yadav R., Steam & GasTurbines. 6. Kshitish Chandra Pal, Heat Power, Orient Longman Limited, 17, Chittranjan Avenue,Calcutta. 7. S. Rao, B.B. Parulekar, „Energy Technology‟, Khanna Pub., NewDelhi. 8. G. H. Ryder, "Strength ofMaterials". 9. F. L. Singer, "Strength ofMaterials". 10. Timoshenko, "Strength ofMaterials". 11. Beer, Johnson,Statics.	

Course Outcomes:

Student should be able to:

1. Apply and demonstrate the concept of mechanics to practical engineeringproblems.
2. Determine the properties of planes andsolids.
3. Apply the basic concept of dynamics to practicalproblems.

ENGINEERING MECHANICS

Course Objectives:

1. To understand distributed force systems, centroid/ center of gravity and method of finding centroidsof composite figures and bodies.
2. To understand the moment of inertia and method of finding moment of inertia of areas andbodies.
3. To understand types of frames and analyze for the forces in the members of the truss by method of joints and method ofsections.
4. To understand dynamics of aparticle.
5. To interpret the simple given dynamic problems and solve them for positions, velocities andaccelerations, etc.
6. To understand the kinetics of the rigid bodies and solve simple problems using work-energymethod.

SET/ME/BT/C204. ENGINEERING MECHANICS		
Module Name	**Content**	**No. of Hrs.**
Force System	Introduction: Force system, dimensions and units in mechanics, laws of mechanics, vector algebra, addition and subtraction of forces, cross and dot products of vectors, moment of a force about a point and axis, couple and couple moment, transfer of a force to a parallel position, resultant of a force system using vector method, Problems involving vector application Equilibrium: Static and dynamic equilibrium, static in determinacy, general equations of equilibrium,Varingnon‟stheorem,Lami‟stheorem,equilibriumofbodiesunderaforcesystem, Problems.	**8**
Trusses And Frames	Truss and Frames: Truss, classification of truss, assumptions in truss analysis, perfect truss, Analysis of perfect plane truss using method of joints and method of sections, Problems.	**8**
Centre Of Gravity And Moment Of Inertia	Centroid, Centre of mass and Centre of gravity, Determination of centroid, centre of mass and centre of gravity by integration method of regular and composite figures and solid objects, Problems, Moment of Inertia: Area moment of inertia, mass moment of inertia, parallel axis and perpendicular axis theorems, radius of gyration, polar moment of inertia, product of inertia, principle axis, problem based on composite figures and solid objects.	**10**
Friction and Virtual Work	Friction-characteristics of dry friction, problems involving friction of ladder, wedges and Connected bodies. Definition of virtual work, principle of virtual work for a system of connected bodies.	**7**
Kinematics And Dynamics	Kinematics: Concept of rigid body, velocity and acceleration, relative velocity, translation and rotation of rigid bodies, equations of motion for translation and rotation, problems. Particle Dynamics: Energy methods and momentum methods, Newton‟s laws, work energy equation for a system of particles, linear and angular momentum equations, projectile motion, problem.	**12**
	Total No. of Hours	**45**
Textbooks	1. R S. Khurmi, “Engineering Mechanics”. 2. P. K. Nag “EngineeringThermodynamics”.	
References	1. Van Wylen G.J. & Sonnlog R.E.: Fundamentals of classical thermodynamics, John Wiley & Sons, Inc.NY. 2. Wark Kenneth: Thermodynamics (2nd edition), Mc Graw Hill book Co.NY. 3. Holman, J.P.: Thermodynamics, MC Graw Hill book Co.NY. 4. Yadav R.: Thermodynamics and Heat Engines, Vol I & II (Sl Edition) Central Publishing HouseAllahabad. 5. Yadav R.: Steam & GasTurbines. 6. Kshitish Chandra Pal: Heat Power, Orient Longman Limited, 17, Chittranjan Avenue,Calcutta. 7. S. Rao, B.B. Parulekar, „Energy Technology‟, Khanna Pub., NewDelhi. 8. G. H. Ryder: "Strength ofMaterials". 9. F. L. Singer: "Strength ofMaterials". 10. Timoshenko: "Strength ofMaterials". 11. Beer, Johnson,Statics.	

Course Outcomes:

Student should be able to:
1. Identify the significance of centroid/ center of gravity and find centroids of composite figures andbodies.
2. Understand the moment of inertia and method of finding moment of inertia of areas andbodies.
3. Identifythetypeofframeandanalyzefortheforcesinthemembersofthetruss(frame)bymethodofjoints and method ofsections.
4. Understand dynamics of aparticle.

C PROGRAMMING

Course Objective:

The course is designed to provide complete knowledge of programming in C language. Students will be able to develop logics, which will help them to create programs and applications in C. Also, by learning the basic programming concepts in C help them to learn any other programming language in future.

SET/CS/BT/C205. C PROGRAMMING		
Module Name	**Content**	**No. of Hrs.**
Introduction	Introduction, The C character set, Constants, Variables, Identifiers, Keywords, Data types, Declarations, The First C Program, Compilation and Execution.	**6**
Operators and Expressions	Arithmetic, Relational, Equality, Logical, Unary, Conditional, Bitwise, Assignment, Comma and Size of operator. Type Conversion and Typecasting.	**6**
Control Statements	If, if-else, while, do-while, for loop, nested loops, switch, break, continue and goto statements.	**5**
Functions & Pointers	Defining and accessing functions, Function prototype, Passing arguments, Recursion, Use of library functions. Introduction to pointers, Declarations, Passing to a function, Operations on pointers, Dynamic memory allocation, Array of pointers.	**11**
Arrays	Single and Multi-dimensional arrays, Row major and Column major form of an array, Character strings and arrays.	**4**
Storage classes	Automatic, Register, Static and External storage class.	**4**
Structures and Unions	Basics of structures, Structures and functions, Arrays of Structures, Pointers to structures, Self-referential structures, Unions.	**4**
File Input/output	Opening a File, Reading from a file, closing the file, Writing to a file.	**4**
	Total No. of Hours	**44**
Textbooks	1. E. Balagurusamy, "Programming in ANSI C".	
References	1. Byron S. Gottfried, "Programming WithC". 2. Yashwant Kanitker, "LET USC". 3. B. W. Kernighan and D. M. Ritchie, "The C ProgrammingLanguage". 4. B. W. Kernighan, "The Practice of Programming", Addison-Wesley,1999. 5. C. L. Tondo and S. E. Gimpel, "The C Answer Book", (2/e), Prentice Hall,1988.	

Course Outcomes:

Student should be able to:

1. Develop programs in C programminglanguage.
2. Analyze the problem and find appropriatesolution.
3. Evaluate the correctness of the developedsolution.

CHEMISTRY LAB

SET/SH/BT/C208. CHEMISTRY LAB	
Content	**No. of Hrs.**
1. To determine the percentage of available chlorine in the supplied sample of bleachingpowder. 2. To determine the ferrous content in the supplied sample of iron ore by titrimetric analysis againststandard K2Cr2O7 solution using K3Fe (CN)6 as external indicator. 3. To determine the chloride content in supplied water sample using Mohr"smethod. 4. To determine the constituents and amount of alkalinity of the supplied watersample. 5. To determine the temporary and permanent hardness of water sample bycomplexometry. 6. To find chemical oxygen demand of a waste water sample using PotassiumDichromate. 7. To determine iron concentration in the sample of water by Spectrophotometricmethod. 8. To determine the molecular weight of a polystyrene sample by using viscometricmethod. 9. To determine pH of a solution by using digital pH meter and titration of such a solution pHmetrically. 10. Analysis of a coal sample by proximate analysismethod.	3x10
Total No. of Hours	**30**

C PROGRAMMING LAB

SET/CS/BT/C209. C PROGRAMMING LAB		
Course Objective	1. To make the student learn a programminglanguage. 2. To learn problem solvingtechniques. 3. To teach the student to write programs in C and to solve theproblems.	
Course Outcomes	course the student would be able to: 1. Read, understand and trace the execution of programs written in Clanguage. 2. Write the C code for a givenalgorithm. 3. Implement Programs with pointers and arrays, perform pointer arithmetic, and use thepre-processor. 4. Write programs that perform operations using derived datatypes.	
Content		**No. of Hrs.**
This lab shall have minimum 25 programs in C. There shall be minimum two programs per module as taught in theory. Programming shall follow logic/algorithm and flowchart wherever applicable. Exercises shall also enhance analytical and debugging abilities.		2x16
Total No. of Hours		**32**

LIFE SKILLS AND PERSONALITY DEVELOPMENT

Course Objectives:

1. The course intends to develop talent, facilitate employability enabling the incumbent to excel and sustain in a highly competitive world of business.
2. The programme aims to bring about personality development with regard to the different behavioral dimensions that have far reaching significance in the direction of organizational effectiveness.
3. To make students know about self-awareness, life skills, soft skills, need for personal development etc.

VAC-2 LIFE SKILLS AND PERSONALITY DEVELOPMENT		
Module Name	**Content**	**No. of Hrs.**
Career and Professional Skills	Career and Professional Skills: Listening Skills, Reading Skills, Writing Skills Effective Resume preparation, Interview Skills, Group Discussion Skills, Exploring Career Opportunities, Psychometric Analysis and Mock Interview Sessions Team Skills: Cognitive and Non-Cognitive Skills, Presentation Skills, Trust and Collaboration, Listening as a Team Skill, Brainstorming, Social and Cultural Etiquettes Digital Skills: Computer skills, Digital Literacy and Social Media, Digital Ethics and Cyber Security.	**06**
Attitude and Motivation	Attitude: Concept, Significance, Factors affecting attitudes, Positive attitude - Advantages, Negative attitude- Disadvantages, Ways to develop positive attitude, Difference between personalities having positive and negative attitude. Motivation: Concept, Significance, Internal and external motives - Importance of self motivation- Factors leading to de-motivation, Maslow's Need Hierarchy Theory of Motivation	**06**
Stress-management and Development of Capabilities	Development of will power, imagination through yogic lifestyle- Development of thinking, emotion control and discipline of mind through Pranayama- Improvement of memory through meditation-Stress: meaning, causes, and effects of stress in life. Management- Stress: psycho-physical mechanism, management of stress through Yoga.	**06**
Other Aspects of personality Development	Body language - Problem-solving - Conflict and Stress Management - Decision-making skills -Leadership and qualities of a successful leader - Character-building -Team-work - Time management -Work ethics – Good manners and etiquette.	**06**
Health and Hygiene	Health and Hygiene- Meaning and significance for Healthy Life- 3. Exercise And Nutrition and Immunity. Obesity- Meaning, Types and its Hazards. – Physical Fitness and Health Related Physical Fitness- Concept, Components and Tests- Adventure Sports.	**06**
	Total No. of Hours	**30**
Text Books/ References	1. Barun K. Mitra, "Personality Development & Soft Skills", Oxford Publishers, Third impression, 2017. 2. Ghosh, Shantikumar. 2004. Universal Values. Kolkata: The Ramakrishna Mission Larry James, "The First Book of Life Skills"; First Edition, Embassy Books, 2016. 3. **L.Chaito : Relaxation & Meditation Techniques,1983.** 4.	

Course Outcomes:

1. The student will be able to understand, analyze develop and exhibit accurate sense of self.
2. Think critically.
3. Demonstrate knowledge of personal beliefs and values and a commitment to continuing personal reflection and reassessment.
4. Learn to balance confidence with humility and overcome problems associated with personality.

SET/ME/SC/C210	Machining Practice Lab-II (Skill Enhancement Course)	
Course Objective:	1. To make the student learn a Main parts machine and their functions. 2. To learn various operations that can perform on the Machine. 3. To learn how to shape raw materials into useful products.	
Course Outcome:	1. After Completion of this course the student would be able to know about functions of machine parts. 2. Able to shape raw materials according to design of the components.	
Module Name	**Content**	**No. of Hrs**
Module I	Working and principle of Drilling machine, Important parts and Functions. Tools used in Drilling and Taping, Clamping of jobs using various work holding devices, Limitations of work holding devices. Functions of Drilling machine attachments and accessories. Jigs and Fixture used in drilling.	10
Module II	Practice on Drilling machine for making components as per given design related to operations:-Drilling, Counter boring, Counter sinking Internal threading	10
Module III	Function and working of Milling machine. Work holding device working, Tooling in milling, Practice on Milling machine for making components as per given design related to milling operations and Gear making.	10
	Total Hours	**30**

SEMESTER III

S. No.	Category	Course Code	Course Title	L	T	P	Contact Hrs./ Week	Credits
10.	Basic Science/ Multidisciplinary	SET/SH/BT/C301	Mathematics III	3	1	-	4	4
11.	Core Subjects	SET/ME/BT/C302	Solid Mechanics	3	1	-	4	4
12.		SET/ME/BT/C303	Fluid Mechanics	3	1	-	4	4
13.		SET/ME/BT/C304	Engineering Thermodynamics	3	1	-	4	4
14.	Interdisciplinary Subject	SET/ME/BT/C305	Engineering Materials and Applications	3	1	-	4	4
15.	Core Subjects Based Labs	SET/ME/BT/C306	Fluid Mechanics Lab	-	-	1	2	1
16.		SET/ME/BT/C307	Engineering Materials and Testing lab	-	-	1	2	1
17.	Extracurricular Courses/ CC	VAC-3	Indian Knowledge System-I*	2	-	-	2	2
18.	Skill Course	SET/ME/BT/C308	Programming for problem solving	-	-	1	4	2
TOTAL				17	5	3	30	26

MATHEMATICS III

Course objective:

1. To introduce the solution methodologies for second order Partial Differential Equations withapplications in engineering.

SET/SH/BT/C301MATHEMATICS- III		
Module Name	**Contents**	**No. of Hrs.**
Ordinary Differential Equations	ODE of 2nd order with constant coefficients both homogeneous and non-homogeneous types with applications to electrical and mechanical systems. Difference equations and their solutions by Z transform. Series solutions of ODE of 2nd orders with variable coefficients with special emphasis to the differential equations of Legendre, Bessel and Chebyser. Legendre's polynomials, Chabyshev polynomials and Bessel's functions and their properties.	**10**
Integral Transforms	Fourier transform and integral Hankel transforms and Hilbert transforms and their properties, some simple applications.	**10**
Partial Differential Equations	Linear PDE with constant coefficients of 2nd order and their classifications. PDE of parabolic, elliptic and hyperbolic type with illustrative examples. Separation of variables method for solving PDE, such as two dimensional heat equations, wave equations and Laplace equations.	**10**
Functions of a Complex Variable	Analytic functions, Cauchy Riemann equations, harmonic functions line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula derivatives of analytic function, Liouvilles theorem, fundamental theorem of algebraic representation of a function by power series, Taylor's & Laurant series, poles & singularity of zeros. Residue theorem, conformal mapping, linear fractional transformation, special linear tranctional transformations.	**10**
	Total No. of Hours	**40**

Text/references books

1. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers
2. H K Das, "Advanced Engineering Mathematics", S Chand
3. Erwin Kreyszig, "Advanced Engineering Mathematics" 9th Edition, John Wiley & Sons, 2006
4. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.

Course outcomes:

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

SOLID MECHANICS

Course objectives:

1.To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads

2.To calculate the elastic deformation occurring in various simple geometries for different types of loading.

SET/ME/BT/C302 SOLID MECHANICS		
Module Name	**Contents**	**No. of Hrs.**
Concept of Stress and Strain	Deformation of bars: Hooke's law, stress, strain, and elongation; Tensile, compressive and shearstresses in 2D solids; Elastic constants and their relations; Volumetric, linear and shear strains;Principal stresses and strain; Principal planes; Mohr's circle.	**12**
Mechanics of Beams	Transverse loading on beams, point and distributed loads; Shear force and bend moment diagrams;Types of beam supports – simplysupported, over-hanging, cantilevers, fixed and guided beams;Static determinacy and indeterminacy; Theory of bending of beams, pure bending stress distributionand neutral plane, second moment of area; Different cross-sections of beams; Shear stressdistribution	**8**
Deflection of Beams	Deflection of a beam using the double integration method;Computation of slopes and deflection inbeams; Myosotis method for computing deflections and slopes.Castigliano's theorems; Maxwellreciprocity theorem.Critical loads using Euler's theory; Different boundary conditions; Eccentric columns.	**8**
Torsion and Twist	Torsion stresses and deformation of circular and hollow shafts; Polar moment of area, stepped shafts;Deflection of shafts fixed at both ends; Stresses and deflection of helical springs.	**8**
Pressure Vessels	Axial and hoop stresses in cylinders subjected to internal pressure; Deformation of thin and thickcylinders; Deformation in spherical shells subjected to internal pressure; Combined thermomechanical stress; Examples and case studies (boilers)	**8**
	Total No. of Hours	**44**

Text/references books

1. Mechanics of Materials by Bear Jhonston.
2. Strength of Materials by Timoshenko and & Youngs.
3. Strength of Materials by Ryder
4. S. C. Crandall, N. C. Dahl, and T. J. Lardner, An Introduction to the Mechanics of Solids, McGraw Hill.
5. Fundamentals of Strength of Materials, Nag, Wiley India
6. E. P. Popov, Engineering Mechanics of Solids, Prentice Hall.

Online resources:

1. https://nptel.ac.in/courses/112/102/112102284/
2. https://nptel.ac.in/courses/105/105/105105108/
3. https://nptel.ac.in/courses/105/106/105106172/

Course outcomes:

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

1. Recognize various types loads applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components
2. Evaluate the strains and deformation that will result due to the elastic stresses developed within the materials for simple types of loading
3. Analyse and design beams, shafts and hollow cylinders.

FLUID MECHANICS

Course objectives:

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

SET/ME/BT/C303 FLUID MECHANICS		
Module Name	**Contents**	**No. of Hrs.**
Introduction & Fluid Statics	Introduction: Continuum, Force, Stress, Strain, Solids vs. fluids, Types of fluids, Fluids Properties, Newton's Law of Viscosity, Stokes' Theorem, Compressibility & vapor pressure. Fundamental Concepts: Fluid Flow definition (Eulerian vs. Langrangian), System vs. Control Volume, Reynold's Transport Theorem. Fluid Statics: Hydrostatic law, Pascal's law, Pressure at a point, Total Pressure, Centre of Pressure, Pressure on a plane (Horizontal, Vertical & Inclined) & Curved Surface, Buoyancy & stability of floating & submerged bodies, Meta-centric height.	**8**
Dynamics of Fluid Flow	Fluid Kinematics: Types of flow (steady vs. unsteady, uniform vs. non-uniform, laminar vs. turbulent, One Two & Three dimensional, compressible vs. incompressible, rotational vs. irrotational), Stream lines, path lines, streak lines, velocity components, convective, local & total acceleration, velocity potential, stream function, Continuity equation in Cartesian co-ordinates. Fluid Dynamics: Introduction to Navier-Stokes's equation, Euler's equation of motion along a stream line, Bernoulli's equation, Application of Bernoulli's equation to Pitot tube, Venturimeter, Orifices, Orifices meter, Triangular & Rectangular Notches.	**8**
Dimensional Analysis & Laminar Flow	Dimensions of physical quantities, Dimensional homogeneity, Buckingham's Pi theorem, Important dimensionless numbers & their significance, Model analysis (Reynold, Froude & Mach). Laminar Flow: Definition, Relation between pressure & shear stresses, Laminar flow through round pipe, fixed parallel plates.	**8**
Boundary Layer Analysis	Development of Boundary layer on a flat plate, Laminar & Turbulent Boundary Layers, Laminar sub layer, Separation of boundary layer & Method of Controlling, Flow around Immersed Bodies, Lift & Drag, Classification of Drag, Flow around circular cylinder & Aerofoil, Development of lift on Aerofoil.	**8**
Flow through Pipes	Total energy line, Hydraulic grade line, Energy losses through pipe, Darchy-Weisbach equation, Minor losses on pipes, pipes in series & parallel, Siphons, Transmission of power, Turbulent flow, Velocity distribution	**8**
	Total hours	**40**

Text/Reference Books

1. S. Gupta, Fluid Mechanics and Hydraulic Machines, Pearson Publishers.
2. F. White, Fluid Mechanics, Tata-McGraw Hill publishers.
3. R. Fox and A. McDonald, Fluid Mechanics, John Wiley Publishers
4. Cengel and Cimbala, Fluid Mechanics, Tata-McGraw Hill Publishers.
5. J. Douglas, J. Gasiorek, J. Swaffield, and L. Jack, Fluid Mechanics, Pearson Publishers.
6. C. Ojha, P. Bernstein and P. Chandramouli, Fluid Mechanics and Machinery, Oxford University Press.

Online resources:

https://onlinecourses.nptel.ac.in/noc22_ce85/preview

Course outcomes:

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

1. Mathematically analyze simple flow situations.
2. Evaluate the performance of various pumps and turbines.

ENGINEERING THERMODYNAMICS

Course objectives:

- To learn about concept of entropy and irreversibility.
- To learn about the concept of thermodynamic relations and third law.
- To learn about power cycles and their efficiencies.
- To learn about the steam generation through boilers.

SET/ME/BT/C304 ENGINEERING THERMODYNAMICS		
Module Name	**Contents**	**No. of Hrs.**
Availability and Irreversibility	Available energy, available energy referred to a cycle, quality of energy, maximum work in a reversible process, reversible work by an open system exchanging heat only with surroundings, useful work, dead state, availability, availability in a chemical reaction, irreversibility and Gouy- Stodala Theorem, availability or energy balance, second law efficiency, comments on energy, Helmholtz and Gibb's function. Problems	6
Thermodynamic Relations, Equilibrium and Third law	Mathematical conditions for exact differential, Maxwell's equation, Tds equations, difference in heat capacities, ratio of heat capacities, energy equation, Clausius-Clapeyron equation, evaluation of thermodynamic properties from an equation of state, general thermodynamic considerations on an equation of state, mixtures of variable composition, conditions of equilibrium of a heterogeneous system, Gibbs phase rule, Joule-Kelvin effect, Joule-Thompson coefficient and Inversion curve.	8
Power cycles	Review of all power cycles, Carnot Cycle, Rankine Cycle, Otto Cycle, Diesel Cycle, Dual Cycle, Brayton Cycle, Stirling Cycle, Ericsson Cycle, Bell Coleman Cycle, Lenoir Cycle	8
Boilers	Purpose of steam generators, Classification of boilers, Fire tube and water tube boilers, Mountings and accessories, description of Lancashire, Locomotive, Babcock Wilcox boilers, draught and design of natural draught chimney, artificial draught, mechanical draught, efficiency of boiler and heat balance. Problems	10
Introduction to Vapour Power Cycles	Introduction: Components of Steam Power System, Carnot Cycle, Rankine Cycle, Modified Rankine Cycle, p-v , h-s and T-s diagram for Rankine and Modified Rankine Cycle, Reheat Cycle, Superheat Cycle, Regenerative Cycle, Reheat Cycle, reheat factor, binary vapor and supercritical cycles, co-generation, Mollier‟s diagram, use of steam table, Problems	8
Total No. of Hours		**40**

Text/ References Books

1. Fundamentals of Thermodynamics by Sonntag, Wiley India
2. Yunus Cengel, Thermodynamics an Engineering Approach, Fourth Edition, Mc Graw Hill
3. Y V C Rao, An Introduction To Thermodynamics, Universities Press.
4. Engineering Thermodynamics by Jones and Dugans, PHI Learning Pvt. Ltd.
5. Fundamentals of Thermodynamics by Sonntag, Wiley India
6. Fundamentals of Classical Thermodynamics by Van Wylen, John Wiley.
7. Gas Turbine Theory & Practice, by Cohen & Rogers, Addison Weslay. Longman Ltd.

Online resources:

https://archive.nptel.ac.in/courses/112/106/112106310/

Course Outcomes:

1. After completing this course, the students will get a good understanding of various practicalpower cycles.
2. They will be able to understand the conversion of heat energy into mechanical energy.
3. They will be able to understand the mechanism usedin boiler draught.

ENGINEERING MATERIALS AND APPLICATIONS

Course objectives:

1. Broad understanding of different types of engineering materials and their applications.
2. Correlation between the internal structure of materials and their mechanical properties.
3. Various methods to quantify the mechanical integrity of materials and their failure criteria.

SET/ID/BT/C305 ENGINEERING MATERIALS AND APPLICATIONS

Module Name	Contents	No. of Hrs.
Engineering Materials and Classification	Introduction of engineering materials and classification;Metals, Plastics, Ceramics and Composites. Relevant properties:Physical, Mechanical, Thermal, Electrical, Chemical. Applications andselection criteria. Ferrous materials: Brief introduction of iron and steel, various types of carbon steels, alloy steels, tool steels and cast irons its properties anduses. Non-Ferrous metals and alloys: Non-ferrous metals such as Cu, Al, Zn, Cr, Ni, Brass, Bronze etc. and its applications.	**6**
Crystallography of Materials	Crystallography and Imperfections: Concept of unit cell space lattice, Bravais lattices, common crystal structures, Atomic packing factor and density, Miller indices, X-ray crystallography techniques, Imperfections, Defects & Dislocations in solids.	**8**
Phase diagram and heat treatment	Phase diagrams and interpretation of microstructure; Iron Iron-carbide phase diagram and cooling (TTT) diagrams. Heat treatment of Steel; Annealing, tempering, normalizing, spheroidising, austempering, martempering, case hardening, carburizing, nitriding, cyaniding,	**8**
Mechanical Properties and Testing	Stress strain diagram, Ductile &Brittle material, Stress vs. Strength, Toughness, Hardness, Fracture, Fatigue and Creep. Tensile, Compression, Torsion, Fatigue and Wear tests; Young's modulus; Relations between true and engineering stress-strain curves; Hardness measurement their relation to strength. Introduction to non-destructive testing (NDT).	**6**
Polymers, Ceramics and Composites	Polymers – Classification and applications; Ceramics – Oxide ceramics, ceramic insulators, bio-ceramics and Glasses; Composites – Reinforcement, matrix, metal matrix composites, ceramic composites, polymer composites, biomaterials.	**6**
Electrical and Magnetic Materials	Magnetic properties: Concept of magnetism - Dia, para, Ferro Hysteresis.Softand hard magnetic materials, Magneticstorages. Electric properties: Energy band concept of conductor, insulator and semi-conductor, Intrinsic & extrinsic semi-conductors. p-n junction and transistors.	**6**
	Total No. of Hours	**40**

Text/ References Books:

1. Van Vlack - Elements of Material Science & Engineering John Wiley & Sons.
2. V. Raghvan - Material Science, Prentice Hall.
3. Callister/Balasubramaniam – Callister‟s Material Science & Engineering Wiley India.
4. Chawla, Composite Materials, Taylor & Francis.

Online resources:

https://nptel.ac.in/courses/113102080

Course outcomes:

At the end of this course students will

1. Know the range of engineering materials, their mechanical properties and applications.
2. Know various methods to measure the mechanical properties of materials.
3. Learn how to improve the properties of ferrous alloys through various heat treatments.

FLUID MECHANICS LAB

SET/ME/BT/C306 FLUID MECHANICS LAB
1. To determine the coefficient of impact for vanes. 2. To determine coefficient of discharge of an orifice meter. 3. To determine the coefficient of discharge of Notch (V and Rectangular types). 4. To determine the friction factor for the pipes. 5. To determine the coefficient of discharge of venture meter. 6. To determine the coefficient of discharge, contraction & velocity of an orifice. 7. To verify the Bernoulli's Theorem. 8. To find critical Reynolds number for a pipe flow. 9. To determine the meta-centric height of a floating body. 10. To determine the minor losses due to sudden enlargement, sudden contraction and bends. 11. To show the velocity and pressure variation with radius in a forced vertex flow. 12. To verify the momentum equation. **Note: Student has to perform 8 experiments**

ENGINEERING MATERIALS AND TESTING L

SET/ME/BT/C307 ENGINEERING MATERIALS AND TESTING LAB
Engineering materials Lab Experiments: 1. Making a plastic mould for small metallic specimen. 2. Specimen preparation for micro structural examination-cutting, grinding, polishing, etching. 3. Grain size determination of a given specimen. 4. Comparative study of microstructures of different given specimens (mild steel, gray cast iron, brass, copper etc. 5. Heat treatment experiments such as annealing, normalizing, quenching, case hardening and comparison hardness before and after. 6. Faradays law of electrolysis experiment. 7. Study of corrosion and its effects. 8. Study of microstructure of welded component and HAZ, Macro and Micro Examination. 9. Suitable experiment on Magnetic/ Electrical/ Electronic materials.
Testing Lab Experiments: 1. To perform Tensile Test on Mild-steel specimen and draw stress strain curve. 2. To perform Izod, Charpy Impact test on standard specimen. 3. To perform Brinell, Rockwell, Vicker Hardness Test on standard specimen. 4. To calculate Torsional Rigidity. 5. To calculate Fatigue Test on Fatigue Testing Machine 6. To calculate Modulus of Elasticity by Non Destructive Testing. 7. Detection of cracks by Ultrasonic Testing Machine. 8. Detection of cracks by Dye Penetration Technique. 9. Creep testing on creep testing machine. 10. To Draw SFD and BMD for a simple supported beam under point and distributed load. **Note: Student has to perform 5-5 experiments from both labs.**

PROGRAMMING FOR PROBLEM SOLVING

Course objectives:

1. To learn the fundamentals of computers.
2. To understand the various steps in program development.
3. To learn the syntax and semantics of C programming language.
4. To learn the usage of structured programming approach in solving problems.
5. To understated and formulate algorithm for programming script
6. To analyze the output based on the given input variables

SET/ME/BT/S308 PROGRAMMING FOR PROBLEM SOLVING		
Module Name	**Contents**	**No. of Hrs.**
Module I	Introduction to Programming**;** Introduction to components of a computer system (disks,memory, processor, where a program is stored and executed, operating system, compilers etc.)Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples. From algorithms to programs; source code, variables (with data types) variables and memorylocations, Syntax and Logical Errors in compilation, object and executable code.	**8**
Module II	Arithmetic expressions and precedence, Recursion, Recursion as a different way of solving problems. Example programs, suchas Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.	**8**
Module III	Conditional Branching and Loops. Writing and evaluation of conditionals andconsequent branching. Iteration and loops, Structures, Defining structures and Array of Structures	**8**
Module IV	Arrays, Arrays (1-D, 2-D), Character arrays and Strings, Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion andSelection), Finding roots of equations, notion of order of complexity through example programs (noformal definition required)	**8**
Module V	Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion andSelection), Finding roots of equations, notion of order of complexity through example programs (noformal definition required), Function, Functions (including using built in libraries), Parameter passing in functions,call by value, Passing arrays to functions: idea of call by reference	**8**
	Total No. of Hours	**40**

Text/Reference Books:

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

Alternative NPTEL/SWAYAM Course:

S.NO.	NPTEL COURSE NAME	INSTRUCTOR	HOST INSTITUTE
1	INTRODUCTION TO PROGRAMMING IN C	PROF. SATYADEV NANDAKUMAR	IIT KANPUR
2	PROBLEM SOLVING THROUGH PROGRAMMING IN C	PROF. ANUPAM BASU	IIT KHARAGPUR

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Simple computational problems using arithmetic expressions.	http://ps iiith.vlabs.ac.in/exp7/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
2	Iterative problems e.g., sum of series.	http://ps iiith.vlabs.ac.in/exp4/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
3	1D Array manipulation.	http://cse02-iiith.vlabs.ac.in/exp4/index.html

4	Matrix problems, String operations.	http://ps iiith.vlabs.ac.in/exp5/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
5	Simple functions.	http://cse02-iiith.vlabs.ac.in/exp2/index.html
6	Programming for solving Numerical methods problems	http://ps iiith.vlabs.ac.in/exp1/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
7	Recursive functions.	http://ps iiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab

Course outcomes:

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

Semester IV

S. No.	Category	Code	Course Title	L	T	P	Contact Hrs./Week	Credits
10.	Core Subjects	SET/ME/BT/C401	Kinematics of Machines	3	1	-	4	4
11.		SET/ME/BT/C402	Manufacturing Technology	3	1	-	4	4
12.		SET/ME/BT/C403	IC Engines	3	1	-	4	4
13.		SET/ME/BT/C404	Applied Thermodynamics	3	1	-	4	4
14.	Interdisciplinary Subject	SET/ME/BT/C405	Measurement, Metrology & Control	3	1	-	4	4
15.	Core Subjects Based Labs	SET/ME/BT/C406	Manufacturing Technology Lab.	-	-	1	2	1
16.		SET/ME/BT/C407	Measurement, Metrology & Control Lab.	-	-	1	2	1
17.	IndianKnowledge System-II(IKS-II)		Indian Knowledge System-II*	2	-	-	2	2
18.	Skill Course	SET/ME/BT/S408	Machine Design, AutoCAD 2D-3D	-	-	1	4	2
TOTAL				17	5	3	30	26

KINEMATICS OF MACHINE

Objectives:

1. To understand the kinematics and rigid- body dynamics of kinematically driven machine components
2. To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link

SET/ME/BT/C401 KINEMATICS OF MACHINE		
Module Name	**Contents**	**No. of Hrs.**
Introduction & Velocity in Mechanisms	Links-types, Kinematics pairs-classification, Constraints-types, Degree of Freedom, Grubler's equation, linkage mechanisms, inversions of four bar linkage, slider crank chain and double slider crank chain. Velocity of point in mechanism, relative velocity method, instantaneous point in mechanism, Kennedy's theorem, instantaneous center method	**8**
Acceleration in Mechanisms & Mechanisms with Lower Pairs	Acceleration diagram, Coriolis component of acceleration, Klein's construction for Slider Crank and Four Bar mechanism, Analytic method for slider crank mechanism. Pantograph, Exact straight line motion mechanisms- Peaucellier's, Hart and Scott Russell mechanisms, Approximate straight line motion mechanisms Grasshopper, Watt and Tchebicheff mechanisms.	**8**
Kinematics Synthesis of Planar Linkages	Movability of four bar linkages, Grashoff's law, graphical methods of synthesis – Two and Three position synthesis of four bar and slider crank mechanisms, Analytical method- Freudenstein's equation for function generation (three position)	**8**
Cams and Follower	Cams and Followers - Classification & terminology, Cam profile by graphical methods for uniform velocity, simple harmonic motion and parabolic motion of followers.	**8**
Gears	Classification & terminology, law of gearing, tooth forms, interference, under cutting, minimum number of teeth on gear and pinion to avoid interference, simple, compound and planetary gear trains	**8**
	Total No. ofHours	**40**
Text Books 1. Theory of machines and mechanisms-Ghosh & Mallik, East-West Press 2.Theory of machines and mechanisms- S. S. Ratan, Tata Mc-Graw Hill		
References: 1.Kinematics, Dynamics and Design of Machinery, 2ed, w/CD, Waldron, Wiley India		

Online Resources:

1. https://nptel.ac.in/courses/112105268

Course Outcomes:

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

1. Design various types of linkage mechanisms for obtaining specific motion and analyze them for optimal functioning

MANUFACTURING TECHNOLOGY

Objectives:

1. 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 manufacturing methods.

SET/ME/BT/C402MANUFACTURING TECHNOLOGY		
Module Name	**Contents**	**No. of Hrs.**
Machining Operations	Lathe: Principle, types, operations, Shaper, Slotter, Planer, Milling: Milling cutters, up & down milling. Dividing head & indexing. Max chip thickness & power required. Drilling and Boring : Drilling, Boring, reaming tools. Geometry of twist drills.	6
Metal Cutting and Machine Tool	Metal Cutting- Mechanics of metal cutting, Geometry of tool and nomenclature, ASA system Orthogonal vs. oblique cutting. Shear angle relationship. Merchant's force circle diagram. Cutting forces, power required. Cutting fluids/lubricants. Tool materials. Tool wear and tool life. Economics of metal cutting.	10
Casting Processes	Basic principle of casting, Types of patterns and allowances. Types and properties of moulding sand. Elements of mould and design considerations, Gating, system, Solidification of casting, Sand casting, defects & remedies and inspection. Die Casting, Centrifugal casting. Investment casting, CO2 casting and Stir casting.	8
Forming Processes	Introduction, plastic flow of metals, flow-stress curve, plastic deformation, yield criteria, work hardening, recrystallization, Hot working vs. cold working, Rolling, , defects in rolled products. Extrusion: Introduction, direct, indirect, impact extrusion, defects and their application in industries. types of forging, forging operations, Design considerations and defects in forging and applications, sheet metal operations like ,Blanking, Piercing, punching, drawing, deep drawing and embossing,	10
Grinding and Metal Joining Process	Grinding & super finishing-Grinding: Grinding wheels, abrasive, cutting action. Grinding wheel specification, Grinding wheel wear – attritions wear, fracture wears. Dressing and Truing. Surface and Cylindrical grinding. Centerless grinding. Super finishing: Honing, lapping, and polishing. Welding principle, electrodes, processes. Gas welding process and equipment. Arc welding: TIG & MIG, Resistance Welding- Spot and seam welding, Welding defects.	10
Total No. of Hrs		**42**
Text Books 1. Modern Machining Processes by P.C. Pandey & H.S. Shan. 2. Manufacturing Technology Metal Cutting & Machine Tools by PN Rao, TMH.		
Reference Books 1. Manufacturing science by Degarmo, Wiley India 2. Fundamentals of Modern Manufacturing, Groover, Wiley India.		

Online Resource:

1 https://www.mooc-list.com/tags/manufacturing

Course Outcomes:

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

1. Understand the different conventional manufacturing methods employed for making different products.

I.C. ENGINES

Objectives:

1.To motivate and challenge students to understand the concept of two-stroke and 4- stroke engine.

2. To understand the new technologies used in I.C. Engine like Supercharger, EFI, Magneto and battery ignition.

SET/ME/BT/C403 I.C. ENGINES		
Module Name	**Contents**	**No. of Hrs.**
Introduction to I.C Engines and Fuels	Introduction to I.C Engines: Engine classification, Air standard cycles, Otto, Diesel, Dual Stirling and Ericsson cycles, Two and four stroke engines, SI and CI engines, Rotary engines, stratified charge engine, Fuel air cycles and their analysis, Actual cycles and their analysis, Valve timing diagram. Concept of variable compression ratio engines (VCR). Fuels: Fuels for SI and CI engine, important qualities of SI engine fuels, Rating of SI engine fuels, Important qualities of CI engine fuels, Dopes, Additives, Gaseous fuels, LPG, CNG, Biogas, Producer gas, Alternative fuels for IC engines	8
SI Engines	Carburetion, Mixture requirements, Carburetor types Theory of carburetor, MPFI, Combustion in SI engine, Flame speed, Ignition delay, abnormal combustion and it's control, combustion chamber design for SI engines. Ignition system requirements, Magneto and battery ignition systems, ignition timing and spark plug, Electronic ignition, battery and its types, Charging and discharging of batteries.	8
CI Engines	Fuel injection in CI engines, Requirements, Types of injection systems, CRDI, Fuel pumps, Fuel injectors, Injection timings. Combustion in CI engines, Ignition delay, Knock and it's control, Combustion chamber design of CI engines. Scavenging in 2 Stroke engines, pollution and it's control	8
Lubrication & Supercharging	Engine Cooling: Different cooling systems, Cooling Towers, Radiators and cooling fans. Lubrication: Engine friction, Lubrication principal, Type of lubrication, Lubrication oils, Crankcase ventilation. Supercharging: Effect of altitude on power output, Types of supercharging. Testing and Performance: Performance parameters, Basic measurements, Blow by measurement, Testing of SI and CI engines	8
Compressors	Classification, Reciprocating compressors, Single and multi stage, Intercooling, Volumetric efficiency. Rotary compressors, Classification, Centrifugal compressor, Elementary theory, Vector Diagram efficiencies, Elementary analysis of axial compressors.	8
	Total No. of Hrs	**40**
Text Books 1. I.C. Engines by Ganeshan, TMH 2. I C Engines by Ferguson, Wiley India 3. A Course in International Combustion Engines, by Mathur & Sharma, Dhanpat Rai & Sons.		
References Books 1. I.C Engine Analysis & Practice by E.F Obert. 2. I.C Engine, by R. Yadav, Central Publishing House, Allahabad.		

Online Resource:

1.https://www.youtube.com/watch?v=CO2StedJtAc&list=PLwdnzlV3ogoXHbVNKWL1BYOo_8PpyNtnc

Course Outcomes:

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

1. Understand the basic concepts of S.I and C.I. Engine.
2. Understand about fuels and future alternative fuels.

APPLIED THERMODYNAMICS

Objectives:

1. To learn about gas dynamics of air flow and steam through nozzles
2. To learn the about reciprocating compressors with and without intercooling
3. To analyze the performance of steam turbines

SET/ME/BT/C404. APPLIED THERMODYNAMICS		
Module Name	**Contents**	**No. of Hrs.**
Steam Engines & Steam Nozzles	Steam Engine: Working of steam engine, single acting and double acting steam engine, , ideal and actual indicator diagram, mean effective pressure, diagram factor, mechanical & thermal efficiency of steam engine.Steam Nozzles: Function of steam nozzles, shape of nozzles for subsonic and supersonic flow of steam, Steady state energy equation, continuity equation, nozzle efficiency, critical pressure ratio for max. Discharge, Problems.	**8**
Steam Turbines	Steam Turbine: Classification of steam turbine, impulse turbine, working principle, compounding of impulse turbine, velocity diagram, power output and efficiency of a single stage impulse turbine, reaction turbine, working principle, degree of reaction, velocity diagram, power output and efficiency, governing of steam turbines, problem.	**8**
Steam Condensers & Fuel and Fuel Combustion	Steam Condensers: Classification of condensers, sources of air leakage in condensers, effect of air leakage in condenser, vacuum efficiency, condenser efficiency, air pumps, cooling water calculation, and problem. Fuel and Combustion: Classification of fuels – solid, liquid and gaseous fuels, calorific values of fuels, stochiometric air fuel ratio, excess air requirement, analysis of exhaust gases, problem.	**10**
Compressors & Gas Power Cycles	Introduction to Centrifugal, Axial Flow Compressors, Reciprocating Compressors; Combustion Chambers; Simple gas turbine cycle – single and twin shaft arrangements, intercooling, reheating, regeneration, closed cycles, optimal performance of various cycles, combined gas and steam cycles;; Problems	**8**
Jet Propulsion	Jet Propulsion: turbojet, turboprop, turbofan, ramjet, thrust and propulsive efficiency; Rocket Propulsion; Direct Energy Conversion: thermionic and thermoelectric converters, photovoltaic generators, MHD generators, fuel cells.	**6**
Total no. of Hours		**40**
Text Books & References : 1. Thermodynamics and Heat Engines Vol II – R. Yadav, Central Publishing House 2. Thermal Engineering - P.L.Balaney Khanna Publisher. 3. Heat Engineering – V.P.Vasandani and D.S.Kumar, Metropolitan Book Co. Pvt. Ltd.		

Online Resource:

https://www.youtube.com/watch?v=fNPPwmfE-SY&list=PL6Qggk0O9yRItYPKm51jEnZoM-mSOM4XA

Course Outcomes:

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

MEASUREMENTS, METROLOGY AND CONTROL

Objectives:

1. To understand the proper use and maintenance of important instruments, such as Vernier callipers, autocollimators, slip gauges, and pyrometers
2. To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.

SET/ME/BT/C405. MEASUREMENTS, METROLOGY AND CONTROL		
Module Name	**Contents**	**No. of Hrs.**
Measurement Purpose Parameters and Principle	Parameters – geometry (straightness, flatness, roundness, etc.), displacement, force, speed, torque, flow, level, pressure, temperature, acceleration, etc.; Definitions: Accuracy, precision, range, resolution, uncertainly and error sources; Regression analysis.Structure and examples of measurement systems; Calibration principles; Linear and angular measurements; Comparators; Gauge design; Interferometry.	8
Limits, Fit and Tolerances	Definitions; Tolerance zone and grades, Hole and shaft system, Geometric tolerances, Tylor's principle of gauging, Design of tolerances for various applications; Tolerance analysis in manufacturing and assembly; Role of metrology in Design of Manufacturing.	8
Mechanical Measurements and Equipment	*Dimensional metrology* – Vernier, micrometers, LVDT; *Form metrology* – form tester, surface profiler, CMM, 3D scanning; *Surface metrology* – optical microscopes, Laser scanning microscopes, electron microscopy (SEM/TEM), x-ray microscopy, Raman spectroscopy; Tool wear, workpiece quality and process metrology. Measurement of temperature, thermal conductivity and diffusivity; Flow obstruction methods; Magnetic flow meters.	8
Electrical Measurements and Instruments	Signal generators and analysis; Wave analyzer; Spectrum analyzer; *Frequency counters* – measurement errors, extending the frequency range; *Transducers* – types, strain gages, displacement transducers; *Digital data acquisition system* - interfacing transducers to electronics control and measuring system; Instrumentation amplifier; Isolation amplifier; Computer-controlled test system	8
Design of Experiments and Statistical Analysis	DOE techniques; Taguchi orthogonal arrays; Data acquisition, signal processing and conditioning; Error of a system of ideal elements; Error probability density function of a system of non-ideal elements; Error reduction techniques; Quality control and assurance in industry.	8
	Total No. of Hrs	**40**
Reference Books: 1. B.C. Kuo , "Automatic Control System" Wiley India. 2. Doeblein E.O., "Measurement Systems, Application Design", McGraw Hill.		
Text Book: 1. Beckwith Thomas G., Mechanical Measurements, Narosa Publishing House. 2. Nagrath & Gopal, "Control System Engineering", 4th Edition, New age International.		

Online Resource:

1. Mechanical Measurements and Metrology by Prof. S P Venkateshan (IIT Madras), NPTEL Course (Link: https://nptel.ac.in/courses/112/106/112106138/).
2. Principles of Mechanical Measurement by Prof. Dipankar N Basu (IIT Guwahati), NPTEL Course (Link: https://nptel.ac.in/courses/112/103/112103261/).

Course Outcomes:

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

1. Basic knowledge about measurement systems and their components
2. Various instruments used for measurement of mechanical and electrical parameters

MANUFACTURING TECHNOLOGY LAB

SET/ME/BT/C406. MANUFACTURING TECHNOLOGY LAB
List of Experiments: 1. Bolt (thread) making on Lathe machine. 2. Tool grinding (to provide tool angles) on tool-grinder machine. 3. Gear cutting on Milling machine. 4. Finishing of a surface on surface-grinding machine. 5. Drilling holes on drilling machine and study of twist-drill. 6. Study of different types of tools and its angles & materials. 7. Gas welding experiment. 8. Arc welding experiment. 9. Resistance welding experiment. 10. Soldering & Brazing experiment. 11. Design of pattern for a desired casting (containing hole). 12. Pattern making. 13. Making a mould (with core) and casting. 14. Sand testing (at least one such as grain fineness number determination). 15. Forging: hand forging processes. 16. Forging: power hammer study & operation. 17. Tube bending with the use of sand and on tube bending m/c. 18. Press work experiment such as blanking/piercing, washer, making etc. 19. Wire drawing/extrusion on soft material. 20. Rolling-experiment. **Note: At least fifteen experiments should be performed from the above list.**

MEASUREMENT, METROLOGY & CONTROL LAB

SET/ME/BT/C 407 MEASUREMENT, METROLOGY & CONTROL LAB
List of Experiments: 1. Study & working of simple measuring instruments- Vernier calipers, Micrometer, Tachometer. 2. Measurement of effective diameter of a screw thread using 3 wire methods. 3. Measurement of angle using Sine bar & slip gauges. 4. Study of limit gauges. 5. Study & angular measurement using level protector. 6. Adjustment of spark plug gap using feeler gauges. 7. Study of dial indicator & its constructional details. 8. Use of dial indicator to check a shape run use. 9. Study and understanding of limits, fits & tolerances. 10. Study of Pressure & Temperature measuring equipment. 11. Strain gauge measurement. 12. Speed measurement using stroboscope. 13. Flow measurement experiment. 14. Vibration/work measuring experiment. 15. Experiment on Dynamometers. **Note: At least eight experiments (Four of Measurement and remaining four for the Metrology & control) should be performed from the above list.**

Machine Drawing and AUTOCAD 2D-3D

SET/ME/BT/S408. *Machine Drawing and AUTOCAD 2D-3D
List of Experiments:
1. Design & drawing of Cotter joint 2 Design & drawing of Knuckle joint 3 Design of machine components subjected to combined steady and variable loads 4 Design of eccentrically loaded riveted joint 5 Design of boiler riveted joint 6 Design of shaft for combined constant twisting and bending loads 7 Design of shaft subjected to fluctuating loads 8 Design and drawing of flanged type rigid coupling 9 Design and drawing of flexible coupling 10 Design and drawing of helical spring 11 Design and drawing of screw jack Isometric Drawings by CAD :Drawings of following on computer:Cone, Cylinder, Isometric view of objects 3D Modelling: 3D modelling, Transformations, scaling, rotation, translation Various Programmes on ANSYS.

SEMESTER V

S. No.	Category	S. No.	Course Title	L	T	P	Contact Hrs./Week	Credits
1.	Core Subjects	SET/ME/BT/C501	Machine Design-I	3	1	-	4	4
2.		SET/ME/BT/C502	Dynamics of Machines	3	1	-	4	4
3.		SET/ME/BT/C503	Refrigeration & Air Conditioning	3	1	-	4	4
4.			@Program Elective-I	3	1	-	4	4
5.	Open Elective / Inter-disciplinary Subject		#Open Elective-I	3	1	-	4	4
6.	Core Subjects Based Labs	SET/ME/BT/C504	Machine & Mechanism Lab.	-	-	1	2	1
7.		SET/ME/BT/C505	Refrigeration & Air Conditioning Lab.		-	1	2	1
8.	Extracurricular/ Courses/ Compulsory course	SET/EC/BT/M505	*Culture, traditions and moral values/ Yoga Practices	-	-	1	4	2
9.	Skill Course	SET/ME/BT/S506	Mini Project-I	-	-	2	4	2
TOTAL				15	5	4	32	26

@Course offered by the department from the Program Elective- I list as given below.
#Courses offered by any other department of School of Engineering and Technology.
*University will prepare a course with focus on Indian/ Regional culture studies. In case no syllabus is prepared by the university then yoga Practices course will be offered.

	S. No.	Code	Course Title
Program Elective- I	5.	SET/ME/BT/E507	Mechatronics
	6.	SET/ME/BT/E508	Engineering Tribology
	7.	SET/ME/BT/E509	CNC Machines and Programming
	8.	SET/ME/BT/E510	Nanotechnology

	S. No.	Code	Course Title
Open Elective- I	5.	SET/ME/BT/OE 511	Python
	6.	SET/ME/BT/OE 512	Industrial Engineering & Management
	7.	SET/ME/BT/OE 513	Numerical Methods in Engineering
	8.	SET/ME/BT/OE 514	Human resource management

MACHINE DESIGN - I

Course objectives:

- To understand safety-critical design of machine components using failure criteria based on mechanics of materials.
- To understand the origins, nature and applicability of empirical design principles, relevant codes, standards and design guidelines for different machine elements.
- To appreciate the relationships between component level design and overall machine system design and performance.

SET/ME/BT/C501 MACHINE DESIGN - I		
Module Name	**Contents**	**No. of Hrs.**
Introduction	Introduction: Definition, Methods, standards in design & selection of preferred size. Selection of materials for static & fatigue loading, Materials for components subjected to creep, BIS system of designation of steels, steels, plastics & rubbers. AISI (American Iron & Steel Institution), ASTM rubber testing methods.	**8**
Design against static and fluctuating load	Design against static load: Modes of failure, Factor of safety, stress-strain relationship, principal stresses, theories of Failure. Design against fluctuating load: stress concentration, stress concentration factors, Fluctuating/alternating stresses, fatigue failure, endurance limit, design for finite & infinite life, Soderberg & Goodman criteria	**10**
Design of Joints, Shaft, Keys & Coupling	Design of Joints: Welded joint, screwed joints, eccentric loading of above joints, joint design for fatigue loading. Shaft, keys & coupling: Design against static and fatigue loads, strength & rigidity design, Selection of square & flat keys & splines, rigid & flexible couplings.	**10**
Design of Mechanical Springs and Power Screws	Mechanical springs: Design of Helical and leaf springs, against static & fatigue loading. Design analysis of Power Screws: Form of threads, square threads, trapezoidal threads, stresses in screw, design of screw jack.	**8**
Introduction to Product Development & Design Process	Introduction to Product Development & Design Process: Definition of Design, Design Process, Need Analysis, and Need based developments, Design by Evolution; Technology based developments, Examples case Studies, and brain-storming.	**8**
	Total no. of Hours	**44**

Text/ References Books and:

1. Design of Machine Elements: V.B. Bhandari, TMH.
2. Machine design : Sharma & Aggarwal, Katsons publications.
3. Mechanical Design, Theory and Methodology, Waldron, BSP, Hyderabad.
4. Machine Design : Maleev & Hartman.
5. Machine Design, Robert L Norton, Pearson .
6. Machine Design –U C Jindal, Pearson

Online resources:

https://archive.nptel.ac.in/courses/112/105/112105124/

Course outcomes:
At the end of this course students will demonstrate the ability to

- Principles of machine elements and how they can be combined to function as a system.
- Failure analysis of machine elements.
- An overview of codes, standards and design guidelines for different elements.
- Ability to analyze mechanical systems

DYNAMICS OF MACHINE

Course 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 linkage mechanisms and cam systems to generate specified output motion.
- To understand the kinematics of gear trains

SET/ME/BT/C502 DYNAMICS OF MACHINE		
Module Name	**Contents**	**No. of Hrs.**
Force Analysis, Turning Moment & Fly Wheel	Static force analysis of linkages, Equivalent offset inertia force, Dynamic analysis of slider crank & Bar mechanism. Piston and Crank effort, Inertia, Torque, Turning moment diagrams, Fluctuation of energy, Flywheel.	**8**
Balancing of Machines	Static and dynamic balancing, balancing of rotating and reciprocating masses, Primary and secondary forces and couples.	**8**

Brakes and Dynamometers	Friction: Pivot and collar friction, Friction circle, Single plate, Multi-plate and Cone clutches, Michelle & Kingsbury thrust bearing and rolling contact bearing, Belts and pulleys, Flat and V belts, Design and selection. Brakes and Dynamometers (Mechanical Type): External and internal shoe brakes, Band and Block brakes, Hydraulic brakes, Absorption and Transmission dynamometers.	**8**
Governors and Gyroscopic Motion	Governors: Dead weight and spring loaded governors, Sensitivity, Stability, Hunting, Isochronisms, Effort and Power, Friction and Insensitivity, Introduction to inertia governors. Gyroscopic Motion: Principles, Gyroscopic acceleration, gyroscopic couple and Reaction. Effect of Gyroscopic couple upon the stability of aeroplanes, ships, two & four wheelers.	**8**
Vibrations of Machine Elements	Single degree-of-freedom systems; Natural frequency and critical damping; Forced vibration; Resonance; Balancing of reciprocating and rotating masses; Torsional vibration and critical speeds of shafts.	**8**
	Total no. of Hours	**40**

Text/ References books:

1. Theory of Machine: Thomas Bevan (Pearson).
2. Theory of Machine: S.S.Ratan (TMH).
3. Kinematics, Dynamics & Design of Machinery-Waldron (Pearson).

Online resources:

https://archive.nptel.ac.in/courses/112/104/112104114/

Course outcomes:

At the end of this course students will demonstrate the ability to design various types of linkage mechanisms for obtaining specific motion and analyze them for optimal functioning.

REFRIGERATION & AIR CONDITIONING

Course objectives:

- To familiarize with the terminology associated with refrigeration systems and air conditioning.
- To understand basic refrigeration processes.
- To understand the basics of psychrometry and practice of applied psychrometrics.
- To acquire the skills required to model, analyse and design different refrigeration as well as air conditioning processes and components

SET/ME/BT/C503 REFRIGERATION & AIR CONDITIONING		
Module Name	**Contents**	**No of Hrs**
Refrigeration	Introduction to refrigeration system, Methods of refrigeration, Carnot cycle, Reversed Carnot cycle, Carnot refrigerator and heat pump Unit of refrigeration, Air Refrigeration cycle: Open and closed air refrigeration cycles, Bell Coleman or Reversed Brayton air refrigeration cycle, Aircraft refrigeration system, Classification of aircraft refrigeration system. Simple system, Boot strap refrigeration, Regenerative, Reduced ambient, Dry air rated temperature (DART) Steam jet refrigeration	**8**
Vapour Compression System	Modification in reversed Carnot cycle, Single stage system, Analysis of vapour compression cycle, use of T s and p h charts, Effect of change in suction and discharge pressures on C O P, Effect of sub cooling & superheating of suction vapour on performance of the cycle, Actual vapour compression cycle, Different configuration of multistage system, Cascade system Refrigerants: Classification, Nomenclature, Desirable properties of refrigerants, Common refrigerants, Secondary refrigerants and CFC free refrigerants.	**8**
Vapour Absorption System	Working Principal of vapour absorption refrigeration system, Comparison between absorption & compression systems, Ammonia – Water vapour absorption system, Lithium Bromide water vapour absorption system, Comparison	**8**
Air Conditioning	Introduction to air conditioning, Psychrometric properties and their definitions, Psychrometric chart, Different Psychrometric processes, Sensible heat factor (SHF), By pass factor , Apparatus dew point (ADP), Thermal analysis of human body, Design considerations, Effective temperature and comfort chart, Cooling and heating load calculations, Infiltration & ventilation, Internal heat gain, Grand Sensible heat factor (GSHF)	**8**
Refrigeration Equipment	Elementary knowledge of refrigeration & air conditioning equipments e g compressors, condensers, evaporators & expansion devices, Air washers, Cooling, towers & humidifying efficiency, Food preservation, cold	**8**

& Applications	storage, Freezers, Ice plant, Water coolers, Elementary knowledge of transmission and distribution of air through ducts and fans, Basic difference between comfort and industrial air conditioning .	
	Total No. of Hrs	**40**

Text/ References Books:

1. Refrigeration and Air conditioning by C P Arora TMH.
2 Refrigeration and Air conditioning by Arora & Domkundwar, Dhanpat Rai.
3 Refrigeration and Air conditioning by stoecker & Jones.
4. Refrigeration and Air conditioning by Roy J Dossat Pearson.
5. Heating Ventilating and Air conditioning by Mcquiston.

Online resources:

https://archive.nptel.ac.in/courses/112/105/112105129/

Course Outcomes:

At the end of this course students will demonstrate the ability to understand the working principles of refrigeration and air-conditioning systems.

MECHATRONICS

Course objectives:

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

SET/ME/BT/E507 MECHATRONICS		
Module Name	**Contents**	**No of Hrs**
Introduction	Electro-mechanical systems; Typical applications; Examples – automobiles, home appliances, medical instruments, etc. Transduction principles; Sensitivity, accuracy, range, resolution, noise sources; Sensors for common engineering measurements – proximity, force, velocity, temperature, etc.; Signal processing and conditioning; Selection of sensors.	**8**
Actuators	Pneumatic and hydraulic actuators; Electric motors including DC, AC, BLDC, servo and stepper motors; Solenoids and relays; Active materials – piezoelectric and shape memory alloys.	**8**

Machine Controls	Microprocessors and their architecture; Memory and peripheral interfacing; Programming; Microcontrollers; Programmable Logic Controllers; PLC principle and operation; Analog and digital input/output modules; Memory module; Timers, internal relays, counters and data handling; Industrial automation systems; Basic PLC programming; Industry kits (Arduino, Raspberry Pi, etc.).	**8**
Control Theory and Systems	Basic control concepts; Feedback; Open and closed loop control; Concept of block diagrams; P, PI and PID controllers; Tuning the gain of controllers; System models, transfer functions, system response, frequency response; Root Locus method and Bode plots.	**8**
Computational Tools	Demonstration and projects using simulation software (e.g., Matlab, Scilab, ROBODK) for control systems and robotics.	**8**
	Total No. of Hrs	**40**
Tex/References Books 1 W. Bolton, "Mechatronics," Addison Wesley Longman, 2010. 2. G.K. McMillan, "Process/Industrial Instruments and Controls Handbook," McGraw-Hill, 1999		

Online resources:

https://archive.nptel.ac.in/courses/112/107/112107298/

Course outcomes:
At the end of this course students will demonstrate the ability to

- Ability to recognize and analyze electro-mechanical systems in daily lives.
- Understand the role of sensors, actuators, and controls in mechatronic systems.
- Familiarity with control theory and controller design.
- Understand the measurement of various quantities using instruments, their accuracy & range, and the techniques for controlling devices automatically

ENGINEERING TRIBOLOGY

Course objectives:

- To expose the student to different types of bearings and bearing materials.
- To understand friction characteristics and power losses in journal bearings.
- To learn theory and concept about different types of lubrication.

SET/ME/BT/E508 ENGINEERING TRIBOLOGY		
Module Name	**Contents**	**No of Hrs**
Introduction to tribology	Historical background, practical importance, and subsequent use in the field. Lubricants: Types and specific field of applications. Properties of lubricants, viscosity, its measurement, effect of temperature and pressure on viscosity, lubrication types, standard grades of lubricants, and selection of lubricants	**8**
Friction and Wear	Origin, friction theories, measurement methods, friction of metals and non-metals. Classification and mechanisms of wear, delamination theory, debris analysis, testing methods and standards. Related case studies.	**8**
Hydrodynamic journal bearings	Friction forces and power loss in a lightly loaded journal bearing, Petroff's equation, mechanism of pressure development in an oil film, and Reynold's equation in 2D. Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Sommerfeld's number and it'ssignificance; partial bearings, end leakages in journal bearing, numerical examples on full journal bearings only.	**8**
Hydrostatic lubrication and bearing materials	Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical example, Commonly used bearings materials, and properties of typical bearing materials. Advantages and disadvantages of bearing materials.	**8**
Introduction to Surface engineering	Concept and scope of surface engineering. Surface modification – transformation hardening, surface melting, thermo chemical processes. Surface Coating – plating, fusion processes, vapor phase processes. Selection of coating for wear and corrosion resistance.	**8**
	Total No. of Hrs	**40**

Tex/References Books

1.Introduction to Tribology, B. Bhushan, John Wiley & Sons, Inc., New York, 2002
2. Engineering Tribology, Prasanta Sahoo, PHI Learning Private Ltd, New Delhi, 2011.
3.Engineering Tribology, J. A. Williams, Oxford Univ. Press, 2005.
4. Introduction to Tribology in bearings, B. C. Majumdar, Wheeler Publishing.

Online resources:

https://archive.nptel.ac.in/courses/112/102/112102015/

Course outcomes:

- Understand the basic concepts and importance of tribology.

- Evaluate the nature of engineering surfaces, their topography and surface characterization techniques.
- Analyze the basic theories of friction and frictional behavior of various materials.
- Select a suitable lubricant for a specific application.
- Compare different wear mechanisms.
- Suggest suitable material combination for tribological design.

CNC Machines and Programming

Course objectives:

- To expose the student to different of NC and CNC structure and important parts.
- To understand selection criteria of NC and CNC machines in manufacturing system.
- To learn theory and writing the part programming of CNC machines.

SET/ME/BT/E509 CNC Machines and Programming		
Module Name	**Contents**	No of Hrs
Module 1	Introduction: Definition of NC, Applications of NC ,Historical Developments in Automation, Classification of NC Systems, Comparison of NC and Conventional Machines, Advantages of NC	**8**
Module -II	Constructional Details of CNC Machines, Design Considerations, Mechanical Elements, Structure, Guide ways and Slides, Guideway Elements, Transmission Systems, Spindle Unit, Coolant system, Lubrication System, Tool and work Changing Mechanisms, Electrical Elements, Drives, Sensors, Control Loops, Computing Elements/ Firmware, Interpolators	**8**
Module -III	Fundamentals of part Programming: Introduction, NC word, Writing a Part Program, Manual Part Programming Using Do Loops and Canned Cycles, Computer-Assisted Part Programming, Automatic Part Program Generation.	
Module -IV	Tooling for CNC Machines: Introduction Cutting Tools Qualified Tools Indexable Inserts, Tool Holders, Automatic Tool changer.	**8**
Module -V	Maintains of CNC Machine Tools: Different Types of Machine Tools Maintenance, Systems and sub-systems of CNC Machines, Best Maintenance Practices, Maintenance Tools and Accessories Required During CNC Machine Tools, Maintenance Work, Daily Maintenance Check list For CNC Lathes , Causes for the failure of Electronics systems in the CNC Machine Tools, Deviation from Normal Performance in CNC Machines.	**8**

Module - VI	Need for Automation in CNC Machines, Potential areas of automation, Adaptive Control, Example of automation in product and manufacturing, Disadvantages of Highly automated systems, low cost Automation.	**8**
		40

Text Books & Reference Books

1. Krar S. and Gill A., CNC: Technology and Programming, McGraw Hill
2. Koren Y., Computer Control of Manufacturing Systems, Tata McGraw Hill
3. Pressman R.S. and Williams J.E., Numerical Control and Computer-Aided Manufacturing, John Wiley & Sons
4. Chang C.H. and Melkanoff M.A., ,NC Machine Programming and Software Design, Prentice-Hall
5. **CNC Machines, M. Adithan, B.S. Pabla, New Age International Publishers**

Course outcomes:

- Understand the basic concepts and importance of NC and CNC machines
- Select a suitable of NC and CNC machines in manufacturing sysytem.
- Understand structure of part CNC programming.
- Able to write CNC part program.

NANOTECHNOLOGY

Course objective:

- Understand the fundamentals of nanotechnology.
- Give a general introduction to different classes of nanomaterials.
- Improve their knowledge on various synthesis methods of nanomaterials.
- Understand characterization techniques involved in nanotechnology

SET/ME/BT/E510 NANOTECHNOLOGY		
Module Name	**Contents**	**No of Hrs**

Basics and Scale of Nanotechnology	Introduction and scientific revolutions, Time and length scale in structures, Definition of a nanosystem, Dimensionality and size dependent phenomena, Surface to volume ratio, Fraction of surface atoms and surface energy, Surface stress and surface defects, Properties at nanoscale – optical, mechanical, electronic, and magnetic	**8**
Different Classes of Nanomaterials	Classification based on dimensionality, Quantum dots, wells and wires, Carbon-based nano materials – fullerences and buckyballs, Carbon nanotubes and grapheme, Metal based nano materials – Nanogold and Nanosilver, Metal oxide based nano materials, Nanocomposites and nanopolymers, Biological nanomaterials	**8**
Synthesis of Nanomaterials	Chemical methods: Metal nanocrystals by reduction, Solvothermal synthesis and photochemical synthesis, Sonochemical routes and chemical vapor deposition (CVD), Metal oxide chemical vapor deposition (MOCVD) Physical methods: Ball milling, Electrodeposition techniques, Spray pyrolysis and flame pyrolysis, DC/RF magnetron sputtering, Molecular beam epitaxy (MBE)	**8**
Fabrication and Characterization of Nanostructures	Nanofabrication: Photolithography and its limitation and electron beam lithography (EBL), Nanoimprinting and soft lithography patterning, Characterization: Field emission scanning electron microscopy (FESEM) and environmental scanning electron microscopy (ESEM), High resolution transmission electron microscope (HRTEM), Scanning tunneling microscope (STM), Surface enhanced raman spectroscopy (SERS), X-ray photoelectron spectroscopy (XPS), Auger electron spectroscopy (AES), Rutherford backscattering spectroscopy (RBS)	**8**
Applications in Nanotechonology	Solar energy conversion and catalysis, Molecular electronics, nanoelectronics and printed electronics, Polymers with a special architecture, liquid crystalline system, Linear and nonlinear optical and electro-optical properties, Applications - nanomaterials for data storage, Photonics and plasmonics, Chemical and biosensors, Nanomedicine and nanobiotechnology, Nanotoxicology challenges	**8**
	Total No. of Hrs	**40**

Text/References Books

1. T. Pradeep, "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education Pvt. Ltd., 2012
2. Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press, 2008
3. C.Dupas, P.Houdy, M.Lahmani, "Nanoscience: Nanotechnologies and Nanophysics", Springer-Verlag Berlin Heidelberg, 2007
4. A. S. Edelstein and R. C. Cammarata, "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Pub., 2001

Online resources:

https://nptel.ac.in/courses/118102003

Course outcomes:

- Deals understanding at an advanced level of Physics and Chemistry of Nanotechnological applications and mainly focus on the design and development of efficient innovative nanostructured materials prepared by various methodologies and physicochemical characterization for technological applications that can facilitate widespread commercialization and it also acquired an understanding of selected areas of nanoscience and technology for various applications at the frontiers of knowledge.

PYTHON

Course objective:

- When students complete Intro to Programming with Python, they will be able to: Build basic programs using fundamental programming constructs like variables, conditional logic, looping, and functions. Work with user input to create fun and interactive programs.

SET/ME/BT/OE511 PYTHON		
Module Name	**Contents**	**No of Hrs**
Introduction and Basics	**Introduction**: The Programming Cycle for Python, Python IDE, Interacting with Python Programs, Elements of Python, Type Conversion. **Basics**: Expressions, Assignment Statement, Arithmetic Operators, Operator Precedence, Boolean Expression.	**8**
Conditionals and Loops	**Conditionals**: Conditional statement in Python (if-else statement, its working and execution), Nested-if statement and Elif statement in Python,Expression Evaluation & Float Representation. **Loops**: Purpose and working of loops, While loop including its working, For Loop, Nested Loops, Break and Continue.	**8**
Function and	**Function**: Parts of A Function, Execution of A Function, Keyword and Default Arguments, Scope Rules.	**8**

Strings	**Strings**: Length of the string and perform Concatenation and Repeat operations in it, Indexing and Slicing of Strings. **Python Data Structure:** Tuples, Unpacking Sequences, Lists, Mutable Sequences, List Comprehension, Sets, Dictionaries. **Higher Order Functions:** Treat functions as first-class Objects, Lambda Expressions.	
Sieve of Eratosthenes & File I/0	**Sieve of Eratosthenes:** generate prime numbers with the help of an algorithm given by the Greek Mathematician named Eratosthenes, whose algorithm is known as Sieve of Eratosthenes. **File I/O:** File input and output operations in Python Programming. **Exceptions and Assertions Modules:** Introduction, Importing Modules. Abstract Data Types, Abstract data types and ADT interface in Python Programming. **Classes**: Class definition and other operations in the classes, Special Methods (such as init, str, comparison methods and Arithmetic methods etc.), Class Example, Inheritance, Inheritance and OOP.	**8**
Iterators & Recursion	**Iterators & Recursion:** Recursive Fibonacci, Tower Of Hanoi. **Search**: Simple Search and Estimating Search Time, Binary Search and Estimating Binary Search Time. **Sorting & Merging:** Selection Sort, Merge List, Merge Sort, Higher Order Sort.	**8**
	Total No. of Hrs	**40**

Text/References Books

1. R Nageswara Rao, "Core Python Programming", Dreamtech press, 2017 Edition. 2. Dusty Philips, "Python 3 Object Oriented Programming", PACKT Publishing, 2nd Edition, 2015.
2. Michael H.Goldwasser, David Letscher, "Object Oriented Programming in Python", Prentice Hall, 1st Edition, 2007.

Online resources:

1. https://realpython.com/python3-object-oriented-programming/
2. https://python.swaroopch.com/oop.html
3. https://python-textbok.readthedocs.io/en/1.0/Object_Oriented_Programming.html
4. https://www.programiz.com/python-programming/

Course outcomes:

- Setup python to develop simple applications.

- Make use of the python programming language to construct basic programs.
- Knowhow to use collections such as list, tuple, range, dictionary and sets.
- Make use of functions, classes and objects from those classes.
- Understand the concepts of inheritance and polymorphism for code reusability and extensibility.
- Write robust code using exception handling.
- Create and animate a variety of shapes and develop an application with graphical user interface (GUI).
- Extend the knowledge of python programming to build successful career in software development.

SET/SE/BT/OE512. INDUSTRIAL ENGINEERING & MANAGEMENT		
Module Name	**Contents**	**No. of Hrs.**
Definition of Industrial Engineering	Organization: Factory system, principles of organization, types of organization and their selection. Plant Layout: Site selection, types of layout, factors affecting layout, plant building, flexibility and expandability, materials handling devices.	**5**
Manufacturing Cost Analysis & Materials Management	Manufacturing Cost Analysis: Fixed & variable costs, Direct, indirect & overhead costs, & Job costing, Recovery of overheads, Standard costing, Cost control, Cost variance Analysis -Labor, material, overhead in volume, rate & efficiency, Break even Analysis, Marginal costing & contribution, Numerical. Materials Management : Definition and purpose of inventory, Inventory cost, Inventory systems- Single and multi period, EOQ, EBQ, Fixed order quantity models, Fixed time period models, Inventory control and Supply chain management (SCM)- ABC Inventory planning, Numerical.	**5**
Quality Management	Quality Management: Total quality management, Quality specifications and quality costs, ISO 9000 and ISO 14000, Six sigma- methodology and tools, Statistical quality control (SQC), Variables & Attributes- X, R, P & C - charts, Acceptance sampling, OC - curve,	**6**
Production Planning & Control (PPC)	Production Planning & Control (PPC) : Definition, objectives and importance of PPC, Functions and components of PPC, Demand management- Simple & Weighted moving average methods of forecasting, ,Aggregate planning techniques- Basic concepts, Master production schedule (MPS), Introduction to JIT, KANBAN, BIN Cards, CPM and PERT, Numerical.	**8**
Management Information Systems (MIS)	Management Information Systems (MIS): What is MIS? Importance of MIS, Organizational & information system structure, Role of MIS in decision making, Data flow diagram, Introduction to systems analysis & design, Organizing information systems. Product Design and Development: Various Approaches, Product life cycle.	**6**

Total No. of Hours	**30**
Reference Books 1. Operations Management- Jacobs, Chase & Aquilano, Mc Graw Hill	
Text Books: 1. Operations Management - Schroeder, McGraw Hill ISE 2. Industrial & Systems Engineering - Turner, MIZE, CHASE, Prentice Hall 3. Production & Operations Management - Chary, TMH, New Delhi. 4. Industrial Engineering & Operations Management – S.K.Sharma & Savita Sharma, S.K.Kataria & Sons	

NUMERICAL METHODS IN ENGINEERING

Course objectives:

- To enhance the problem solving skills of engineering students using an extremely powerful problem solving tool namely numerical methods.
- The tool is capable of handling large system of equations, non-linearities and complicated geometries that are not uncommon in engineering practice and that are often impossible to solve analytically.

SET/ME/BT/OE513 NUMERICAL METHODS IN ENGINEERING		
Module Name	**Contents**	**No of Hrs**
Data, its Arrangements and Measures	Introduction: Data, Data Array; Frequency Distribution Construction and Graphic representation. Mean, median, mode and standard deviation.	**8**
Probability and sampling Distributions	Introduction: Definition probability and Probability Distribution; Conditional probability; Random variables, Poisson, Normal and Binomial distributions. Introduction: Fundamentals of Sampling, Large samples, small samples; Normal sampling distributions; Sampling distribution of the means, t-Distribution, F-Distribution, Chi-square Distribution	**8**
Solution of Algebraic and Transcendental Equations	Bisection method, iteration method, Method of false position, Newton -Raphson method, solution of systems of non linear equations.Gauss Elimination method (fall and banded symmetric and unsymmetric systems), Gauss Jordon method. Eigen value problems (Power	**8**

	method only).	
Interpolation Method	Finite difference, forward, backward and central difference, Difference of polynomial, Newton's formulae for interpolation, central difference interpolation formulae, Interpolation with unevenly spaced points, Newton's general interpolation formula, interpolation by iteration	**8**
Numerical Differentiation and Integration	Numerical differentiation, maximum and minimum values of a tabulated function; Numerical Integrationtrapezoidal rule, Simpson1/3 rule, Simpsons 3/8 rule, Newton-cots integration formulae; Euler-Meclaurin formula, Gaussian integration(One dimensional only).	**8**
	Total No. of Hrs	**40**

Tex/References Books

1. S. S. Sastry, Introductory methods of numerical analysis by: Prentice Hall of India
2. V. RajaRaman, Computer Oriented Numerical Methods-
3. S.D. Conte, Cari De Boor, Elementary Numerical Analysis, Mc Graw Hill.
4. B. Cornahn, Applied Numerical Methods, John Wiley.
5. Richard I. Levin, S. David., Rubin Statistics for Management, Pearson.

Online resources:

https://archive.nptel.ac.in/courses/127/106/127106019/

Course outcomes:

- Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
- Apply numerical methods to obtain approximate solutions to mathematical problems.
- Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
- Analyze and evaluate the accuracy of common numerical methods.

HUMAN RESOURCE MANAGEMENT

Course objectives:

- To enable the students to understand the HR Management and system at various levels in general and in certain specific industries or organizations.
- To help the students focus on and analyse the issues and strategies required to select and develop manpower resources.
- To develop relevant skills necessary for application in HR related issues.

- To Enable the students to integrate the understanding of various HR concepts along with the domain concept in order to take correct business decisions

SET/ME/BT/OE514 HUMAN RESOURCE MANAGEMENT		
Module Name	**Contents**	**No of Hrs**
Module 1	Human Resource Planning: Need and Importance of Human Resource Planning- Process of Human Resource Planning-Factors affecting Human Resource Planning Process- Forecasting Techniques-Demand and Supply Forecasting in Planning- Job Analysis Process and Methods-Job Design-Job Description- Job Specification- Job Evaluation.	**8**
Module 2	Recruitment: Definition, Importance and Process of Recruitment-Current Trends in Recruitment, Recruitment Source-Internal and External Sources of Selection-Selection Process Methods of Selection-Types of Tests-Types of Interview-Induction Types of Induction and Importance of Induction-Training and Development-Needs of Training- Type of Training and Types of Training Methods-Process of Training- TNA (Training Need analysis) Need and Benefits	**8**
Module 3	Motivation: Nature and Types of Motivation -Employee Motivation Need-Process of Motivation -Theories of Motivation-Goal Setting and Career Planning Need and Importance- Role of Human Resource in Textile Industry- Human Resource Skill Requirements in Textile Industry-Human Resource Planning in Textile Industry	**8**
Module 4	HR & MIS: Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries Strategic HRM: Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals Labor Laws & Industrial Relations: Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act 10	**8**
Module 5	Organizational Structure &Design: Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. Power and Politics: Sources and uses of power; Politics at workplace,	**8**

	Tactics and strategies.	
	Total No. of Hrs	**40**

Text/References Books

1. K Aswathappa- Human Resource and Personnel Management -Publisher Mc Graw Hill Education 8th Edition.
2. P. Subba Rao -Human Resource Management – Himalayan Publication – Revised Edition.
3. Neo, Hollenbeck, Gerhart& Wright – Fundamentals of Human Resource ManagementPublisher Mc Graw Hill Education 3rd Edition.

Online resources:

https://archive.nptel.ac.in/courses/110/105/110105069/

Course outcomes:

- To develop the understanding of the concept of human resource management and to understand its relevance in organizations.
- To develop necessary skill set for application of various HR issues.
- To analyse the strategic issues and strategies required to select and develop manpower resources.
- To integrate the knowledge of HR concepts to take correct business decisions.

MACHINE & MECHANISM LAB

SET/ME/BT/C504 MACHINE & MECHANISM LAB

List of Experiments:

1. Study of simple linkers/models/mechanisms.
2. Experiment on Mechanism.
3. Design of 4-bar mechanism and its inversion.
4. Synthesis of Slider Crank Mechanism.
5. Study of straight line mechanism.
6. Experiment on Velocity acceleration.
7. Study of Ackerman-Devis Steering Mechanism.
8. Experiment on Gears (tooth profile, interference etc.).
9. Experiment on Gear trains.
10. Experiment on cams.
11. Experiment on Governors.
12. Experiment on critical speed of shaft (whirling of shaft).
13. Experiment on Gyroscope.
14. Experiment on Vibration (spring).
15. Balancing of Rotating and Reciprocating Masses.

Note: At least ten experiments should be performed from the above list. Five experiment from the first eight and five from the remaining list.

REFRIGERATION & AIR CONDITIONING LAB

SET/ME/BT/C505 REFRIGERATION & AIR CONDITIONING LAB

List of Experiments:

1. Experiment on refrigeration test ring and calculation of various performance parameters.
2. To study different types of expansion devices used in refrigeration system.
3. To study different types of evaporators used in refrigeration systems.
4. To study basic components of air-conditioning system.
5. Experiment on air-conditioning test rig & calculation of various performance parameters.
6. To study air washers.
7. Study of window air conditioner.
8. Study & determination of volumetric efficiency of compressor.
9. Experiment on Ice-plant.
10. Experiment on two stage Reciprocating compressor for determination of volumetric efficiency, PV diagram and effect of inter cooling.
11. Study of Hermetically sealed compressor.
12. Experiment on Desert coolers.

Note: At least eight experiments should be performed from the above list.

SET/ME/BT/S506 Mini Project-I

The student will identify the local problem/innovative ideas and prepare a review report/paper with analyse of the tentative solution.

VI Semester

(Click on subject for detail syllabus.)

S. No.	Category	Code	Course Title	L	T	P	Contact Hrs./Week	Credits
10.	Core Subjects	SET/ME/BT/C601	Machine Design-II	3	1	-	4	4
11.		SET/ME/BT/C602	Fluid Machinery	3	1	-	4	4
12.		SET/ME/BT/C603	Heat & Mass Transfer	3	1	-	4	4
13.			@Program Elective-2	3	1	-	4	4
14.	Open Elective/ Inter-disciplinary Subject		#Open Elective-2	3	1		4	4
15.	Core Subjects Based Labs	SET/ME/BT/C604	Heat & Mass Transfer Lab.	-	-	1	2	1
16.		SET/ME/BT/C605	Fluid Machinery Lab			1	2	1
17.	Communication skills/CC	SET/EC/BT/M606	* Communication Skills Course/ Technical Seminar	-	-	1	4	2
18.	Skill Course	SET/ME/BT/S607	Mini Project-II	-	-	1	4	2
TOTAL					15	5	4	32

@Course offered by the department from the Program Elective- II list as given below.
#Courses offered by any other department of School of Engineering and Technology.
*University will prepare communication course in Modern/Indian languages from which student will select one language course. The course will be more on applied side with giving students a chance to develop their soft skills. In case no syllabus is prepared by the university then Technical Seminar course will be offered.

	S. No.	Code	Course Title
Program Elective- II	5.	SET/ME/BT/E608	Operation Research Techniques
	6.	SET/ME/BT/E609	Advance Machine Tools and operations
	7.	SET/ME/BT/E610	Maintenance Engineering
	8.	SET/ME/BT/E611	Smart Materials

	S. No.	Code	Course Title
Open Elective-2	5.	SET/ME/BT/OE 612	Machine Learning
	6.	SET/ME/BT/OE 613	Entrepreneurs Essential
	7.	SET/ME/BT/OE 614	Work Study and Ergonomics
	8.	SET/ME/BT/OE 615	Flexible Manufacturing System

MACHINE DESIGN-II

Objectives:

1. To understand safety-critical design of machine components using failure criteria based on mechanics of materials
2. To understand the origins, nature and applicability of empirical design principles, relevant codes, standards and design guidelines for different machine elements

SET/ME/BT/C601 MACHINE DESIGN-II		
Module Name	**Contents**	No of Hrs
Gears	Spur Gears: Tooth forms, System of gear teeth, contact ratio, Standard proportions of gear systems, Interference in involutes gears, Backlash, Selection of gear materials, Gear manufacturing methods, Design considerations, Beam strength of gear tooth, Dynamic tooth load, Wear strength of gear tooth, Failure of gear tooth, Design of spur gears, AGMA and Indian standards. Helical Gears: Terminology, Proportions for helical gears, force analysis, Beam strength and wear strength of helical gears, herringbone gears, crossed helical gears, Design of helical gears Worm Gears: Types of worms, Terminology, Gear tooth proportions, Efficiency of worm gears, Heat dissipation in worm gearing, force analysis, Strength and wear tooth load for worm gears, Design of worm gearing	**10**
Rolling Contact Bearing	Types of ball bearing, Thrust ball bearing, Types of roller bearing, Selection of radial ball bearing, bearing life, Selection of roller bearings, Dynamic equivalent load for roller contact bearing under constant and variable loading, Reliability of Bearing, Selection of rolling contact bearing, Lubrication of ball and roller bearing, Mounting of bearing	**10**
Sliding Contact Bearing	Types, Selection of bearing, Plain journal bearing, Hydrodynamic lubrication, Properties and materials, Lubricants and lubrication, Hydrodynamic journal bearing, Heat generation, Design of journal bearing, Thrust bearing pivot and collar bearing, Hydrodynamic thrust bearing	**6**
Design of IC Engine Parts	Selection of type of IC engine, General design considerations, Design of Cylinder and cylinder head; Design of piston, piston ring and gudgeon pin; Design of connecting rod; Design of centre crankshaft	**8**
Statistical Considerations in Design	Frequency Distribution, Characteristic of frequency curves, Probability distribution, Normal curve, Design and Natural Tolerances, reliability, Probabilistic approach to Design	**6**
	Total no ofHrs	**40**
References 1. Mechanical Engineering Design – Joseph E Shigely, McGraw Hill Publications. 2. Design of Machine Elements V B Bhandari, Tata McGraw Hill Co. 3. Machine design M F Spott, Prentice Hall India		
Text books:		

1 Machine Design Maleev and Hartman, CBS .
2. Machine design Black & Adams, McGraw Hill

Online Resources:

1 https://archive.nptel.ac.in/courses/112/105/112105124/

Course Outcomes:

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

1. Principles of machine elements and how they can be combined to function as a system
2. Ability to analyse mechanical systems

FLUID MACHINERY

Objectives:

1. To obtain the velocity and pressure variations in various types of simple flows
2. To analyse the flow in water pumps and turbines.

SET/ME/BT/C602 FLUID MACHINERY		
Module Name	**Contents**	**No of Hrs**
Impact of jet	Application of momentum and momentum equation to flow through hydraulic machinery, Euler's fundamental equation.Impact of jet: Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat & curved), effect of inclination of jet with the surface Hydraulic Turbines: Classification of turbines, Impulse turbines, constructional details, velocity triangles, power and efficiency calculations, governing of Pelton wheel	**8**
Reaction Turbines	Fransis and Kaplan turbines, constructional details, velocity triangles, power and efficiency calculations, degree of reaction, draft tube, cavitation in turbines, principles of similarity, unit and specific quantities, specific speed, performance characteristics, selection of water turbines, bulb Turbines	**8**
Centrifugal Pumps	Classifications of centrifugal pumps, vector diagram, work done by impeller, efficiencies of centrifugal pumps, specific speed, model testing, cavitation and separation, performance characteristics Net positive suction head	**8**
Positive Displacement Pumps	Reciprocating pump theory, slip and coefficient of discharges, indicator diagram, effect and acceleration, work saved by fitting air vessels, comparison of centrifugal and reciprocating pumps, positive rotary pumps, Gear and Vane pumps, performance characteristics	**8**
Other Machines	Other Machines: Hydraulic accumulator, Intensifier, Hydraulic press, Lift and Cranes, theory of hydraulic coupling and torque converters, performance characteristics. Water Lifting Devices: Hydraulic ram, Jet pumps, Airlift pumps, water distribution systems	**8**
	Total no ofHrs	**40**
Text Books 1. Fluid Mechanics and Hydraulic Machines by S C Gupta, Pearson 2 Fundamentals of Fluid Mechanics by Munson, Pearson 3 Hydraulic Machines by JagdishLal, Metropolitan book co pvt ltd		
References Books 1 Hydraulic Machines: Theory & Design, V P Vasandhani, Khanna Pub 2 Hydraulic Machines by R K Rajput, S Chand & co Ltd 3 Hydraulic Machines by D S Kumar		

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc22_ce85/preview

Course Outcomes:

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

1. Mathematically analyze simple flow situations
2. Evaluate the performance of various pumps and turbines.

HEAT & MASS TRANSFER

Objectives:
1. 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, 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.

SET/ME/BT/C603 HEAT & MASS TRANSFER		
Module Name	**Contents**	**No. of Hrs.**
Introduction to Heat Transfer and Conduction	Concepts of heat flows: conduction, convection and radiation, effect of temperature on thermal conductivity of materials, introduction to combined heat transfer. Conduction: One-dimensional general heat conduction equation in the Cartesian, cylindrical and spherical coordinates Initial and boundary conditions. Steady State One-dimensional Heat conduction: Composite Systems in rectangular, cylindrical and spherical coordinates with and without energy generation, thermal resistance concept, Analogy between heat and electricity flow, thermal contact resistance, Overall heat transfer coefficient, critical thickness of insulation.	**8**
Fins and Transient Conduction	Fins: Types of fins, Fins of uniform cross-sectional area, errors of measurement of temperature in thermometer wells. Transient conduction: Transient heat conduction Lumped capacitance method, unsteady state heat conduction in one dimension only, Heisler charts.	**6**
Natural and Forced Convection	Forced Convection: Basic concepts, hydrodynamic boundary layer, thermal boundary layer, flow over a flat plate, flow across a single cylinder and a sphere, flow inside ducts, empirical heat transfer relations, relation between fluid friction and heat transfer, liquid metal heat transfer. Natural Convection: Physical mechanism of natural convection, buoyant force, and empirical heat transfer relations for natural convection over vertical planes and cylinders, horizontal plates and cylinders and sphere.	**8**
Radiation	Thermal Radiation: Basic radiation concepts, radiation properties of surfaces, black body radiation laws, shape factor, black-body radiation exchange, Radiation exchange between non-blackbodies in an	**8**

	enclosure, Infinite parallel planes, radiation shields	
Heat Exchanger and Introduction to Mass Transfer	Heat Exchanger: Types of heat exchangers, fouling factors, overall heat transfer coefficient, logarithmic mean temperature difference (LMTD) method, effectiveness-NTU method, compact heat exchangers. Condensation and Boiling: Introduction to condensation phenomena, heat transfer relations for laminar film condensation on vertical surfaces and on a horizontal tube, boiling modes: pool boiling curve, forced convective boiling. Mass Transfer: Introduction: Fick's law of diffusion, steady state equimolar counter diffusion, steady state diffusion though a stagnant gas film.	**10**
	Total No. ofHours	**40**

Text Books and References:

1. Elements of Heat transfer by Cengel, TMH.
2. Heat and mass transfer, M.Thirumaleswar, Pearson.
3. Fundamentals of Heat & Mass Transfer by Incropera Wiley India.
4. Heat & Mass Transfer by Khurmi, Schand,New Delhi

Online Resources:

1 https://onlinecourses.nptel.ac.in/noc22_ch65/preview

Course Outcomes:

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

1. Formulate and analyze a heat transfer problem involving any of the three modes of heat transfer.
2. Obtain exact solutions for the temperature variation using analytical methods where possible or employ approximate methods or empirical correlations to evaluate the rate of heat transfer

OPERATION RESEARCH TECHNIQUES

Objectives:

1. To provide knowledge on machines and related tools for manufacturing various components.
2. To understand the relationship between process and system in manufacturing domain.
3. To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.

SET/ME/BT/E608 OPERATION RESEARCH TECHNIQUES		
Module Name	**Contents**	**No. of Hrs.**
Linear Programming	Basics of Operations Research, Introduction & Scope, Problem formulation, Graphical Method, Simplex methods, primal & dual problem sensitivity analysis.	9
Transportation & Assignment problems.	.Introduction,Initial Basic Feasible solution, N-W corner cell method, least cost method, VAM method, Test for optimality, stepping stone method, MODI method, Degeneracy method, unbalance transportaon problem, maximization transportain problem Classification of assignment problems, minimization type problems, Hungarian method	9
Decision theory and Game Theory	Formulation of games, two person-Zero sum game, games with and without saddle point, Graphical solution (2x n, m x 2 game), dominance property.Duality, PRIMAL-DUAL relations-its solution, shadow price, economic interpretation, dual-simplex, post-optimality & sensitivity analysis, problems	7
Queuing Theory and PERT-CPM Techniques	Queuing system and their characteristics.The M/M/1 Queuing system, Steady state performance analyzing of M/M/ 1 and M/M/C queuing model. Network construction, determining critical path, floats, scheduling by network, project duration, variance under probabilistic models, prediction of date of completion, crashing of simple networks	6
Simulation and Decision Theory	Introduction, design of simulation, models & experiments, model validation, process generation, time flow mechanism, Monte Carlo methods- its applications in industries, problems. SIMON model types of decision making environment- certainty, risk, uncertainty, decision making with utilities, problems.	9
	Total no. of Hrs	**40**

References Book

1. Operations Research, Taha H. A, Pearson.
2. Introduction to operation research: Theory and Applications, Springer BSP, Hyderabad .
3. Operations Research,. S D Sharma , KedarnathRamnath

TextBooks

1. Operations Research: Principles and practice: Ravindran, Phillips & Solberg, Wiley.
2. Operation Research, AM Natarajan, P.Balasubramani , ATamilaravari , Pearson

Online Resources:

1 https://onlinecourses.nptel.ac.in/noc20_mg06/preview

Course Outcomes:

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

1. To provide knowledge on production management techniques that develop and establish relationship between market demand and production capability.
2. To understand the operation management: Resource planning and their utility
3. To understand the scientific approach and tools and techniques that assure market competitiveness by ensuring the quality, cost and time

Advance Machine Tools and Operations

Objectives:

1.To develop a solution oriented approach by in depth knowledge of Machine Tool Design.
2. To address the underlying concepts, methods and application of Machine Tool Design.

SET/ME/BT/E609 Advance Machine Tools and Operations		
Module Name	**Contents**	**No. of Hrs.**
Introduction	General requirements to machine tools, Machine tool design recommendations, Classification ofmotions to shape surface, Machine tool drives for rectilinear motion, Periodic motion, reversing motion etc.Kinematics or gearing diagram of Lathe, drilling Machine, Milling Machine etc. Main. drive andfeed drive, principles specification of Machine tool.	9
Design of Kinematics Scheme	Methods to determine transmission ratios for drives,. Development of Kinematics scheme, minimum of transmission groups, Determination of number of teeth on gears. General requirement Design of zAQTgear trains, speed boxes types, speed changing devices, Feed boxes characteristics of feed mechanism, types of Rapid traverse mechanisms, variable devices.	9
Spindle Design and Spindle Bearings	Main requirement, Materials and details of spindle design, Spindle bearings, bearings, types of bearings and their selections, Bearing Materials BED, Columns, Tables and Ways: Materials, typical constructions and design.	7
Machine Tools Control Systems	Requirement of control system selection and construction of control systems Mechanical control system, predilection control, remote control safety devices.	6
Machine Tool Dynamics:	Dynamic performance, dynamic and elastic system of Machine, tools. Dynamics of cutting forces, tool chatter.	9

Total no. of Hrs	**40**
References Book 1. Design Principles of Metal-Cutting Machine Tools by F. Koenigsberger 2. Machine Tool Design by N. K. Mehta. McGraw Hill Publishing 3. Machine Tool Design by Acherkan, Mir publishing	
TextBooks 1 Machine Tool Design by S.K, Basu, Oxford and IBH Publishing 2. Machine tool design by Sen and Bhattacharya, CBS Publications	

Course Outcomes:

1. The student can identify different areas of Machine Tool Design
2. Can find the applications of all the areas in day to day life.

Maintenance Engineering

Objectives:

1.To develop a basic approach towards maintenance in industries.

2. Understanding to apply engineering concepts to the optimization of equipment, procedures, and departmental budgets to achieve better maintainability, reliability, and availability of equipment.

SET/ME/BT/E610 Maintenance Engineering		
Module Name	**Contents**	**No. of Hrs.**
Fundamental Of Maintenance management	Concept of maintenance, objective and characteristics of maintenance function, maintenance strategy and organisation, organization of the maintenance system, operating practices in maintenance, Maintenance record keeping.	9
Maintenance management systems	Maintenance system, Maintenance planning and scheduling, Maintenance system and operation, documentation and regular compliance, Project and trending management, contract management.	9
Operation aspect of Maintenance management	Spare part and inventory management, material handling system, industrial safety management, asset replacement decision, shutdown maintenance, Maintenance audit, financial of Maintenance management.	7
Reliability and condition monitoring	Concept and definition, configuration of failure data, various terms used in failure data analysis in mathematical forms, component and system failures, uses of reliability concepts in design and Maintenance of different system, lubrication practice, failure analysis and reliability engineering, thermal insulation and refractory.	6

Reliability improvement	Reliability in design, reliability in engineering, systems, systems with spares, reliability simulation, redundant and stand by systems, confidence levels, component improvement element, unit and standby redundancy optimization and reliability-cost trade off.	9
	Total no. of Hrs	**40**

References Book

1. Managing Maintenance Resources- A. Kelly, Butterworth-Heinemann.
2. Handbook of Maintenance Management- Levitt Joel, Industrial Press.

TextBooks

1. Maintenance Planning and Control- A. Kelly, East West Press.
2. Mechanical Fault Diagnosis- R.A. Collacott, Chapman and Hall.

Course Outcomes:

1. The students will understand the need of maintenance in industries.
2. Can find the applications of all the areas in day to day life.

Smart Materials

Objectives:

1. To study various types of smart materials used in engineering application
2. To study processing of smart materials
3. To study basics of sensors and its engineering application
4. To study basics of actuators and its engineering application

SET/ME/BT/E611 Smart Materials		
Module Name	**Contents**	**No. of Hrs.**
Overview of smart materials	Introduction to Smart Materials, Principles of Piezoelectricty, PerovskytePiezoceramic Materials, Single Crystals vs Polycrystalline Systems, Piezoelectric Polymers, Principles of Magnetostriction, Rare earth Magnetostrictive materials, Giant Magnetostriction and Magneto-resistance Effect, Introduction to Electro-active Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer Matrix Composite (IPMC), Shape Memory Effect, Shape Memory Alloys, Shape Memory Polymers, Electro-rheological Fluids, Magneto Rhelological Fluids	9

High-band width, low strain smart sensors	Piezeoelctric Strain Sensors, In-plane and Out-of Plane Sensing, Shear Sensing, Accelerometers, Effect of Electrode Pattern, Active Fibre Sensing, Magnetostrictive Sensing, Villari Effect, Matteuci Effect and Nagoka-Honda Effect, Magnetic Delay Line Sensing, Application of Smart Sensors for Structural Health Monitoring (SHM), System Identification using Smart Sensors	9
Smart actuators	Modelling Piezoelectric Actuators, Amplified Piezo Actuation – Internal and External Amplifications, Magnetostrictive Actuation, Joule Effect, Wiedemann Effect, Magnetovolume Effect, Magnetostrictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control	7
Smart composites	Review of Composite Materials, Micro and Macro-mechanics, Modelling Laminated Composites based on Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, Governing Equation of Motion, Finite Element Modelling of Smart Composite Beams	6
Advances in smart structures & materials	Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials, Autophagous Materials, SelfHealing Polymers, Intelligent System Design, Emergent System Design	9
	Total no. of Hrs	**40**

References Book

1. Smart Structures: Analysis and Design, A. V. Srinivasan, Cambridge University Press, Cambridge, New York, 2001.
2. Smart Structures, P. Gauenzi, Wiley, 2009
3. Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers, G. Gautschi, Springer, Berlin, New York, 2002

TextBooks

1. Smart Material Systems and MEMS: Design and Development Methodologies, V. K. Varadan, K. J. Vinoy, S. Gopalakrishnan, John Wiley and Sons, England, 2006.
2. Smart Structures and Materials, Brain Culshaw, Artech House, London, 1996. 3. Smart Materials and Structures, Mukesh V. Gandhi, Brian S. Thompson, , Springer, May1992

Course Outcomes:

By the end of course students will able to

1. Understand various smart material and its importance in engineering application
2. Know various processing technics of smart materials
3. Get knowledge of use of smart material as sensors and actuators

Machine Learning

Objectives:

1.To understand the basic theory underlying machine learning.
2.To be able to formulate machine learning problems corresponding to different applications.
3. To understand a range of machine learning algorithms along with their strengths and weaknesses.

SET/ME/BT/OE 612 Machine Learning		
Module Name	**Contents**	**No. of Hrs.**
Introduction	Learning Problems – Perspectives and Issues – Concept Learning – Version Spaces and Candidate Eliminations – Inductive bias – Decision Tree learning – Representation – Algorithm – Heuristic Space Search.	9
Neural Networks and Genetic Algorithms	Neural Network Representation – Problems – Perceptrons – Multilayer Networks and Back Propagation Algorithms – Advanced Topics – Genetic Algorithms – Hypothesis Space Search – Genetic Programming – Models of Evalution and Learning.	9
Bayesian and Computational Learning Bayes Theorem	Concept Learning, Maximum Likelihood, Minimum Description Length Principle, Bayes Optimal Classifier – Gibbs Algorithm – Naïve Bayes Classifier – BayesianBelief Network – EM Algorithm – Probability Learning – Sample Complexity – Finite and Infinite Hypothesis Spaces – Mistake Bound Model.	7
Instant Based Learning	K- Nearest Neighbour Learning – Locally weighted Regression – Radial Bases Functions – Case Based Learning.	6
Advanced Learning	Sets of Rules – Sequential Covering Algorithm – Learning Rule Set – First Order Rules – Sets of First Order Rules – Induction on Inverted Deduction – Inverting Resolution – Analytical Learning – Perfect Domain Theories – Explanation Base Learning – FOCL Algorithm – Reinforcement Learning – Task – Q-Learning – Temporal Difference Learning. "Current Streams of Thought	9
	Total no. of Hrs	**40**

References Book

1. Ryszard, S., Michalski, J. G. Carbonell and Tom M. Mitchell, Machine Learning: An Artificial Intelligence Approach, Volume 1, Elsevier. 2014 ,
2. Stephen Marsland, Taylor & Francis 2009. Machine Learning: An Algorithmic Perspective.

TextBooks

1. Marco Gori , Machine Learning: A Constraint-Based Approach, Morgan Kaufmann. 2017

2. EthemAlpaydin, Machine Learning: The New AI, MIT Press-2016

Course Outcomes:

1. Appreciate the importance of visualization in the data analytics solution
2. Apply structured thinking to unstructured problems

ENTREPRENEUR Essential

Objectives:
To develop and strengthen the entrepreneurial quality, to motivate them for achievement and to enable participants to be independent, capable, promising businessmen.

SET/ME/BT/OE613 ENTREPRENEUR Essential		
Module Name	**Contents**	**No. of Hrs.**
Concept of Entrepreneurship	Entrepreneurship and small scale industry, need for promotion of entrepreneurship, entrepreneurship development programmes (EDP), personality characteristics of entrepreneur	9
Identification of Investment Opportunities	Governmental regulatory framework, industrial policy, industrial development and regulation act, regulation of foreign collaboration and investment, foreign exchange regulation act, incentives for export oriented units, incentives for units in industrially backward areas, incentives for small scale industry, government assistance to SSI, how to start and SSI, list of items reserved for SSI, Scouting for project ideas, preliminary screening, project identification for an existing company.	9
Market and Demand Analysis	Information required for market and demand analysis, market survey, demand forecasting, uncertainties demand forecasting.	7
Cost of Project and Means of Financing	Cost of project, means of financing, planning the capital structure of a new company, term loan financial institutions, cost of production.	6
Financial Management	Concept and definition of financial management types of capital, of finance, reserve and surplus, concepts and liabilities, profit and loss statement balance sheet, depreciation, methods of calculating depreciation break even analysis.	9
	Total no. of Hrs	**40**
References Book 1. E.D.I. Ahmedabad, Publication regarding Entrepreneurship. 2. Prasanna Chandra, Project Preparation, Appraisal Budgeting and Implementation, McGraw Hill. . 3. C.S.Gupta and N.P.Srinivasan, Entrepreneurial Development, S. Chand and co.		
TextBooks 1. S. S. Khanka, Entrepreneurship Development Practice and Planning, S. Chand and co.		

Course Outcomes:
By the end of course students will able to
1. Understand the concept of entrepreneurship.
2. Students will understand to develop their own industries.

Work Study and Ergonomics

Objectives:

1. Improvement of manufacturing processes and procedures.
2. Improvement of working conditions.
3. Improvement of plant layout and work place layout

SET/ME/BT/OE614 Work Study and Ergonomics		
Module Name	**Contents**	**No. of Hrs.**
Unit I	Work Study - Areas of Application of Work Study in Industry; Method Study and Work Measurements and their Inter-Relationship, Reaction of Management and Labor to Work Study, Role of Work Study in Improving Plant Productivity and Safety.	9
Unit II	Method Study - Objectives and Procedure for Methods Analysis, Select, Record, Examine, Develop,Define, Install and Maintain; Recording Techniques, Micro Motion and Macro-Motion Study, Principles of Motion Economy, Normal Work Areas and Work Place Design.	9
Unit III	Work Measurement - Objectives, Work Measurement Techniques - Time Study, Work Sampling, PreDetermined Motion Time Standards (PMTS), Etc., Determination of Time Standards, Observed Time, Basic Time, Normal Time, Rating Factors, Allowances, Standard Time.	7
Unit IV	Introduction to Ergonomics - Historical Development of Human Factors Engineering, Importance of Ergonomics Workplace Improvement and Preventing Workplace Injuries.	6
Unit V	Human-Machine Interface - The Man-Machine System, Machine as a System Component, Reaction Time, Muscular Performance, Static Work. Types of Displays - Quantitative, Qualitative,Representative and Alpha-Numeric, Efficiency of Each Type, Pedal Design, Design of Tools and Controls, Stress in Human Body and its Consequences, Human Anthropometry - Measurement, Instrumentation, Adjustments in Measurement, Anthropometric Data for Indian Workers, Uses of Anthropometric Data, Computer-Aided Man-Machine System Design.	9
	Total no. of Hrs	**40**

References Book

1. Shan, H. S. - Work Study and Ergonomics , DhanpatRai& Sons, New Delhi.
2. Dalela, S. and Saurabh -Work study and Ergonomics, Standard Publishers Distributors, New Delhi.
3. Bridger, R. S.- Introduction to Ergonomics ,Mcgraw Hill, New York.

TextBooks

1.Hicks - Industrial Engineering & Management, Tata McGraw Hill, New Delhi.
2. ILO - Introduction to Work Study, International Labor Office, Geneva.

Course Outcomes:

By the end of course students will able to

1. Understand various symbols and its importance in engineering application
2. Understand to improve productivity of men, machines and materials.

FLEXIBLE MANUFACTURING SYSTEMS

Objectives:

To learn various concepts of GT,CAPP, MHS which helps in industrial automation

SET/ME/ BT/OE615 FLEXIBLE MANUFACTURING SYSTEMS		
Module Name	**Contents**	**No of Hrs**
Module1	Understanding of FMS: Evolution of Manufacturing Systems, Definition, objective and Need, Components, Merits, Demerits and Applications of FMS	**6**
Module2	Processing stations: Machining Centers, CMM etc. Different Layouts and their Salient features. Material Handling System: An introduction, Conveyor, AGV, ASRS, Robots, etc. and their salient features.	**10**
Module3	Management technology: Tool Management, Configuration planning and routing, Production Planning and Control, Scheduling and control	**10**
Module4	Computer networks and control: Hardware, Software and database of FMS, Advantages of modular Software design and development, Requirement of FMS Software, Types of FMS software modules.	**10**
Module5	Case studies: Typical FMS problems from researches papers	**4**
	Total no of hrs	**40**

Text and References Books

1. Paul Ranky., "The design and operation of FMS", IFS publication, 1983.
2. Mikell P Groover, "Automation Production systems, Computer Integrated Manufacturing", Prentice Hall, 1987.
3. David J.Parrish, "Flexible Manufacturing" Butterworth-Heinemann, 1990
4. Computer Aided Manufacture by Chien Chang and Richard A Wysk, Prentice HALL

Course Outcomes:

At the end of the course

The students will gain an experience in the implementation of flexible systems for industrial automation

SET/ME/BT/C604 HEAT & MASS TRANSFER LAB
List of practicals: 1. Conduction - Composite wall experiment. 2. Conduction - Composite cylinder experiment. 3. Convection - Pool boiling experiment. 4. Convection - Experiment on heat transfer from tube-natural convection. 5. Convection - Heat Pipe experiment. 6. Convection - Heat transfer through fin-natural convection. 7. Convection - Heat transfer through tube/fin-forced convection. 8. Determination of Stephan Boltzmann Constant. 9. Determination of emissivity. 10. Heat exchanger - Parallel flow experiment. 11. Heat exchanger - Counter flow experiment. 12. Experiment on critical insulation thickness. 13. Conduction - Determination of thermal conductivity of fluids. 14. Conduction - Thermal Contact Resistance Effect. **Note: At least eight experiments should be performed from the above list.**

SET/ME/BT/C605 FLUID MACHINERY LAB
List of practicals: 1. Impact of Jet experiment. 2. Turbine experiment on Pelton wheel. 3. Turbine experiment on Francis turbine. 4. Turbine experiment on Kaplan turbine. 5. Experiment on reciprocating pump. 6. Experiment. on centrifugal pump. 7. Experiment on Hydraulic Jack/Press 8. Experiment on Hydraulic Brake 9. Experiment on Hydraulic Ram 10. Study through first visit of any pumping station/plant 11. Study through second visit of any pumping station/plant. 12. Any other suitable experiment/test rig such as comparison & performance of different types of pumps and turbines. **Note: At least eight experiments should be performed from the above list.**

SET/ME/BT/S607 Mini Project-II

The student will prepare working model/Analysis/ Sample Analysis of identified problem in mini project -I

SEMESTER VII

S. No.	Category	Code	Course Title	L	T	P	Contact Hrs./Week	Credits
1.	Core Subjects	SET/ME/BT/C701	Automobile Engineering	3	1	-	4	4
2.			@Program Elective-3	3	1	-	4	4
3.			@Program Elective-4	3	1	-	4	4
4.	Core Subjects Based Labs	SET/ME/BT/C702	Automobile Lab	-	-	1	2	1
5.		SET/ME/BT/C703	Industrial Training Seminar	-	-	1	2	1
6.	Life Skills and personality development	SET/SH/BT/L701	*Essential Management Practices	2	-	-	2	2
7.	Skill Course	SET/ME/BT/S704	Major Project Preparation	-	-	1	8	4
TOTAL				11	3	3	26	20

@Course offered by the department from the Program Elective- II list as given below.
#Courses offered by any other department of School of Engineering and Technology.
*University will prepare communication course in Modern/Indian languages from which student will select one language course. The course will be more on applied side with giving students a chance to develop their soft skills. In case no syllabus is prepared by the university then Technical Seminar course will be offered.

Programme Electives (PEL): Total **2** to be taken, at least one from each group – *Technology* and *Industry Sector*, based on Project topic and individual interest. Illustrative courses are listed here.

S.N.	PEL (Technology)	Code	PEL (Industry Sector)	Code
1	Finite Element Method	SET/ME/BT/E705	CAD/CAM and Robotics	SET/ME/BT/OE709
2	Renewable Energy Engineering	SET/ME/BT/E706	Product Design and Development	SET/ME/BT/OE710
3	Additive Manufacturing	SET/ME/BT/E707	Unconventional Manufacturing Processes	SET/ME/BT/OE711
4	Computational Fluid Dynamics	SET/ME/BT/E708	Turbo Machines	SET/ME/BT/OE712

AUTOMOBILE ENGINEERING

Objective:

1. To understand the construction and working principle of various parts of an automobile.

SET/ME/BT/C701		
Module Name	**Contents**	No of Hrs
Introduction & FuelSupply System	Introduction: Classification of automobile, Parts of an automobile, Description of an automobile, performance of automobile, engine cycle energy balance, terms connected with I C Engines, Detonation, performance number, attractive efforts. Fuel Supply System:S I Engine: Carburetion & carburetors, Induction system, factor influencing carburetion, Mixture requirement, Distribution, Complete carburetor, theory of simple carburetor C I Engine: Functional requirements of an injection system, Fuel pump and fuel injector (Atomizer), Types of nozzles and fuel spray patterns, troubleshooting of a fuel system & carburetor, Turbo Charger (Function and benefits)	**7**
Engine Friction, Lubrication and Cooling System	Determination of engine friction, Lubrication, lubrication system, Crankcase ventilation, Necessity of engine cooling, Areas of heat flow in engines, gas temperature variation, heat transfer, temperature distribution & temp Profiles, cooling air and water requirements, cooling systems, troubleshooting of cooling system, gear box (Problems)	**7**
Chassis & Suspension	Chasis: Introduction Classification of chassis, Frame Suspension: Introduction, requirements of suspension system, springs, damper Wheels: Introduction, Requirement, types of wheels Tyres: Introduction, requirements, types of tyre, tyre construction cross ply, radial ply, belted bias, tyre materials tyre shape, tread patterns, tyre markings, tyre inflation pressure, causes of wear, factors affecting tyre life, wheel balancing, wheel alignments	**7**
Steering&Braking System	Steering & Gears: Purpose, function, requirements, general arrangements of steering systems, steering gears, steering ratio, reversibility, steering geometry, under steering, over steering, steering arms, Drag link, power steering, adjusting of steering geometry, steering troubleshooting Requirements Clutches Toque converters Over drive and free wheel, Universal joint Differential Gear Mechanism of Rear Axle Automatic transmission, Steering and Front Axle Castor Angle. Front Axle: Introduction, construction, types of front axles, stub axles Braking System: Necessity, functions, requirements, classification of brakes, Mechanical brakes, hydraulics brakes, power brakes, brake effectiveness, brake shoe holding down arrangements, brake tester, brake service, troubleshooting chart of hydraulic brakes system, air brakes & Brake shoes & drums	**10**
Ignition System	Automotive Electric System: Introduction, main parts of vehicles. Starting System: Introduction, battery, starting motor Ignition System: Introduction, purpose, requirements, coil ignition system, firing order, ignition timing, spark plugs, troubleshooting Charging System: Introduction Dynamo, alternators Lighting: introduction, main circuits, lighting system Maintenance system: Preventive maintenance, break down maintenance, and over hauling system	**9**
	Total noof Hrs	**40**

Text Books & Reference Books

1. Automotive Engineering Hietner
2. Automobile Engineering Kripal Singh
3. Automobile Engineering Narang
4. Automobile Engg K M Gupta

Online Resources:

1. https://archive.nptel.ac.in/courses/107/106/107106088/

Course Outcomes:

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

1. Upon completion of this course, students will understand the function of each automobile component and also have a clear idea about the overall vehicle performance.

FINITE ELEMENT METHOD

Objectives:

1. To learn basic principles of finite element analysis procedure .
2. To learn the theory and characteristics of finite elements that represent engineering structures.
3. To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses**.**

SET/ME/BT/E705 FINITE ELEMENT METHOD		
Module Name	**Contents**	**No. of Hrs.**
Introduction	Introduction to finite difference method and finite elements method, Advantages and limitations, Mathematical formulation of FEM, Different approaches in Finite Element Method – Direct Stiffness approach, simple examples, Variational approach, Elements of variational calculus - Euler Lagrange equation, Rayliegh Ritz method, Weighted Residual methods, Point Collocation method, Galarkin method - Steps involved in FEM.	8
Types of Elements Used	Interpolation Polynomials - Linear elements Shape function - Analysis of simply supported beam - Element and Global matrices - Two-dimensional elements, triangular and rectangular elements - Local and Natural Co-ordinate system.	8
Finite Element Formulation of Field Problems	1-D and 2-D heat transfer, fluid flow (incompressible and non viscous fluid) in ducts, Simple electrical and magnetic field problems. Simple Numerical examples.	8
Finite Element Formulation of Solid Mechanics Problems	1-D problem of shaft; Truss element analysis of pinned truss, Plane stress/strain problems, Axi symmetric problems, thin plate problems; Vibration of shafts & beams.	8
Numerical Methods in FEM	Evaluation of shape functions - One dimensional & triangular elements, Quadrilateral elements, Isoperimetric elements - Numerical Integration, Gauss Legendre quadrature - Solution of finite element equations – Gauss Elimination Method, Cholesky decomposition.	8
	Total no. of Hrs	**40**
References:- 1.The Finite Element Method O.C. Zienkiewicz and R.L. Taylor McGraw Hill 2. An Introduction to Finite Element Method J. N. Reddy McGraw Hill 3. Finite Element Procedure in Engineering Analysis K.J. Bathe McGraw Hill		
Text books:- 1. Finite Element Analysis C.S. Krishnamoorthy Tata McGraw Hill 2. Numerical Methods E Balagurusamy Tata McGraw Hill		

Course Outcome:

Upon successful completion of this course you should be able to:

1. Understand the concepts behind formulation methods in FEM.
2. Identify the application and characteristics of FEA elements such as bars, beams, plane and iso-parametric elements.

Renewable Energy Engineering

Objectives:

1. To acquire knowledge of technical competency combined with research to generate innovative solutions in Energy engineering.
2. To be acquainted with a variety of options in energy sources.
3. To prepare the students to exhibit a high level of professionalism, integrity, environmental and social responsibility, and life-long independent learning ability with environment in mind.

SET/ME/BT/E706 **Renewable Energy Engineering**		
Module Name	**Contents**	**No. of Hrs.**
Unit 1	Basic concepts of energy; Introduction to Renewable Energy Technologies; Energy and Environment – global warming, acid rains, depletion of ozone layer; Global and Indian Scenario of renewable energy sources; Energy storage - necessity and energy storage methods. **Solar Energy**: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data.	8
Unit 2	**Solar Thermal Systems**: Introduction; Basics of thermodynamics and heat transfer; Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Solar refrigeration and air conditioning; Thermal energy storage systems. **Solar Photovoltaic Systems**: Introduction; Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction; Photovoltaic thermal systems.	8
Unit 3	**Wind Energy**: Introduction; Origin and nature of winds; Wind turbine siting; Basics of fluid mechanics; Wind turbine aerodynamics; wind turbine types and their construction; Wind energy conversion systems. .	8
Unit 4	**Fuel cells**: Overview; Classification of fuel cells; Operating principles; Fuel cell thermodynamics. **Biomass Energy**: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification..	8
Unit 5	**Other forms of Energy**: Introduction: Nuclear, ocean and geothermal energy applications; Origin and their types; Working principles.	8
	Total no. of Hrs	**40**

Text/ References:-

1. O.P. Gupta, "Energy Technology", Khanna Book Publishing, New Delhi.
2. V.V.N. Kishore, "Renewable Energy Engineering and Technology: Principles and Practice," Routledge, 1st Edition, 2019.
3. N. Jenkins and J. Ekanayake, "Renewable Energy Engineering," Cambridge University Press, 1st Edition, 2017.
4. G. Boyle, "Renewable Energy," OUP Oxford, 2nd Edition, 2009.

Course Outcome:

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

1. Acquire, apply and share in depth knowledge in the area of Energy Engineering and Management.
2. An ability to apply engineering and scientific principles for the effective management of energy systems.

Additive Manufacturing

Objective:

To provide an overview of Additive Manufacturing processes, systems and applications.

SET/ME/BT/E707 Additive Manufacturing		
Module Name	**Contents**	**No. of Hrs.**
Introduction	Evolution of AM/3D printing; Comparison with subtractive and forming processes; Advantages of AM; Classification of AM processes; Key steps in AM.	8
Liquid State-based AM Processes	Stereo lithography – Process and working principle; Photopolymers; Photo polymerization, layering technology, Laser and Laser scanning; Micro-stereolithography; Equipment and specifications; Applications, advantages, disadvantages, examples; Solid ground curing: Process, Working principle; Equipment and specifications; Applications, advantages, disadvantages, examples.	8
Solid State-based AM Processes	Fused Deposition Modeling – Process, working principle and materials; Equipment and specifications; Laminated object manufacturing – Process and working principle; Equipment and specifications; Applications, advantages, disadvantages, examples; Other solid-state processes – Ultrasonic consolidation, Gluing, Thermal bonding; Demonstration of equipment.	8
Powder Based AM Processes	Powder Bed Fusion Processes – Working principle and materials; Powder fusion mechanism and powder handling; Various LBF processes (principle, materials, applications and examples) – Selective laser Sintering, Electron Beam Melting, Laser Engineered Net Shaping, Binder Jetting and Direct Metal Deposition; Comparison between LBF processes; Materials-process-structure-property relationships; relative advantages and limitations.	8
Applications of AM	Product development lifecycle applications – Rapid prototyping, concept models, visualization aids, replacement parts, tooling, jigs and fixtures, moulds and casting; Application sectors – aerospace, automobile, medical, jewelry, sports, electronics, food, architecture, construction and others.	8
	Total no. of Hrs	**40**

References:-

1.The Finite Element Method O.C. Zienkiewicz and R.L. Taylor McGraw Hill

2. An Introduction to Finite Element Method J. N. Reddy McGraw Hill

3. Finite Element Procedure in Engineering Analysis K.J. Bathe McGraw Hill

Text books:-

1. Finite Element Analysis C.S. Krishnamoorthy Tata McGraw Hill

2. Numerical Methods E Balagurusamy Tata McGraw Hill

Course Outcome:

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

1. Understand the overall principle and various processes for additive manufacturing.
2. Select a particular additive manufacturing process based on the end application.
3. Plan the steps in fabricating a given part using additive manufacturing.

Computational Fluid Dynamics

Objective:

1. Students will conduct numerical experiments and carry out data analysis.
2. They will acquire basic skills on programming of numerical methods used to solve the Governing equations.

SET/ME/BT/E708 Computational Fluid Dynamics		
Module Name	**Contents**	**No of Hrs**
Introduction to CFD and Governing Equations	Need of CFD as tool, role in R&D, continuum, material or substantial derivative or total derivative, gradient, divergence and curl operators, Linearity, Principle of Superposition. Derivation of Navier-Stokes equations in control volume (integral form) and partial differential form, Euler equations (governing inviscid equations). Mathematical classification of PDE (Hyperbolic, Parabolic, Elliptic). Method of characteristics, Introduction to Riemann Problem and Solution Techniques.	**10**
One-dimensional Euler's equation	Conservative, Non-conservative form and primitive variable forms of Governing equations. Flux Jacobian Is there a systematic way to diagonalise Eigenvalues and Eigenvectors of Flux Jacobian. Decoupling of Governing equations, introduction of characteristic variables. Relation between the two non-conservative forms. Conditions for genuinely nonlinear characteristics of the flux Jacobian. Introduction to Turbulence Modeling: Derivation of RANS equations and k-epsilon model.	**10**
Representation of Functions on Computer	Need for representation of functions, Box Function, Hat Function, Representation of sinx using hat functions: Aliasing, high frequency, low frequency. Representation error as a global error. Derivatives of hat functions, Haar functions, Machine Epsilon. Using Taylor series for representation of Derivatives.	**10**
Finite difference method	Applied to Linear Convection equation, Laplace Equations, Convection Diffusion equations, Burgers equations, modified equations • Explicit methods and Implicit methods – as applied to applied to linear convection equation, Laplace equations, convectiondiffusion equation◦ FTCS, FTFS,FTBS,CTCS ◦ Jacobi Method, Gauss-Siedel, Successive Over Relaxation Method, TDMA.• VonNaumann stability (linear stability) analysis. Upwind Method in Finite Difference method.	**7**
Finite volume method	Finite volume method. Finding the flux at interface.Lax-Friedrichs Method, Lax-Wendroff Method, Two-Step Lax-Wendroff Method and Mac Cormack Method, Flux Splitting Method Steger and Warming, vanLeer, Roe's Method and finding Roe's Averages.	**8**
	Total no ofHrs	**45**

Text Books

1. T.j.chung,Computational Fluid Dynamics, , Cambridge University Press
2. Ghoshdastidar, Computational fluid dynamics and heat transfer, Cengage learning, 2017.
3. Charles Hirsch,Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics – Vol 1 &Vol 2, Butterworth- Heinemann, 2007

References Books

1.Pletcher, r. H., Tannehill, j. C., Anderson, d., Computational fluid mechanics and heat transfer, 3rd ed., Crc press, 2011, ISBN 9781591690375.

Course Outcome:

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

- Understand mathematical characteristics of partial differential equations.
- Explain how to classify and computationally solve Euler and Navier-Stokes equations.

CAD/CAM AND ROBOTICS

Objective:

1. To Impart knowledge to students in recent advances in the Computer Aided Manufacturing to educate them to prosper in Manufacturing engineering and research related professions

SET/ME/BT/OE 709 CAD/CAM AND ROBOTICS		
Module Name	**Contents**	**No of Hrs**
CAD Tools & Geometric Modeling	CAD Tools: Definition of CAD Tools, Types of system, CAD/CAM system evaluation criteria, input and output devices Graphics standard, functional areas of CAD, Modeling and viewing, Review of C, C++, statements such as if else for while & switch, functions, pointernotations, structure & class, concept of OOPS .Geometric Modeling: Output primitives Bresenham's line drawing and Midpoint circle algorithms Types of mathematical representation of curves, wire frame models wire frame entities parametric representation of synthetic curves hermite cubic splines Bezier curves B splines rational	**10**
Surface Modeling	Surface Modeling: Mathematical representation surfaces, Surface model, Surface entities surface representation, Parametric representation of surfaces, plane surface, rule surface, surface of revolution, Tabulated Cylinder Parametric Representation of Synthetic Surface:HermiteBicubic surface, Bezier surface, B Spline surface, COONs surface, Blending surface , Sculptured surface, Surface manipulation – Displaying, Segmentation, Trimming, Intersection, Transformations (both 2D and 3D). Geometric Modeling 3D: Solid modeling, Solid Representation, Boundary Representation (B rep), Constructive Solid Geometry (CSG)	**10**
Collaborative Engineering	CAD/CAM Exchange: Evaluation of data – exchange format, IGES data representations and structure, STEP Architecture, implementation, ACIS & DXF. Collaborative Engineering: Collaborative Design, Principles, Approaches, Tools, Design Systems Introduction to CAD/CAE, Element of CAD, Concepts of integrated CAD/CAM, CAD Engineering applications, its importance & necessity Finite Element Methods: Introduction and Application of FEM, Stiffness Matrix/ Displacement Matrix, One/Two Dimensional bar & beam element (as spring system) analysis	**10**
NC Part Programming	NC Part Programming Manual (word address format) programming Examples Drilling and Milling.	**7**
System Devices &Interpolators	System Devices Introduction to DC motors, stepping motors, feed back devices such as encoder, counting devices, digital to analog converter and vice versa Interpolators Principle, Digital Differential Analysers Linear interpolator, circulator Interpolator and its software interpolator Control of NC Systems Open and closed loops Automatic control of closed loops with encoder & tachometers Speed variation of DC motor Adaptive control	**8**
	Total no ofHrs	**45**
Text Books **1.** CAD/CAM Theory and Practice – Ibrahim Zeid, TMH. 2. Computer Oriented Numerical Methods, Rajaraman, PHI		
References Books 1. CAD/CAM – Groover&Zimmers, Pearson		

Course Outcome:

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

1.An ability to write and present a substantial technical report/document.

2. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PRODUCT DESIGN AND DEVELOPMENT

Objective:

The aim of the course is to facilitate students develop of a key ability in the search of value creation of a business.

SET/ME/BT/OE710. PRODUCT DESIGN AND DEVELOPMENT		
Module Name	**Content**	**No. of Hrs.**
Product Design	Introduction, Product Planning, Identifying Customer Needs, Project Selection, Concept Generation, Concept Testing, Concept Selection, Product Specification, Product Architecture, Industrial Design, Robust Design, Product Development Economics, Design for Manufacturing, Supply Chain Design, Intellectual Property, Design for Environment.	20
Product Development	Product Development Schedule, Customer base for customer needs survey, Project Proposal, Mission statement and customer needs, Concepts sketch and target specification, Preliminary concept selection, Drawings, plans and revised schedule, financial model and patent review Submission and Evaluation of Alpha prototype and test report, Beta prototype and customer evaluation, demonstration of working model.	20
Total No. of Hours		**40**
References	1. Karl T. Ulrich and Steven D. Eppinger, "Product Design and Development", 3rd Edition, Tata McGraw- Hill, 2003, ISBN 0-07-058513-X. 2. Kevin Otto and Kristin Wood, "Product Design", Pearson Education, 2003, ISBN: 8129702711.	

Course Outcome:

As the outcome of completing this course, the student should get the ability to:

1. Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
2. Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

Objective

1. Compare non-traditional machining, classification, material applications in material removal process.
2. Summarize the principle and processes of abrasive jet machining.
3. Understand the principles, processes and applications of thermal metal removal processes.

	SET/ME/BT/OE711UNCONVENTIONAL MANUFACTURING PROCESSES	
Module	**Contents**	**No of Hrs**
Introduction	Limitations of conventional manufacturing processes need of unconventional manufacturing processes & its classification and its future possibilities	8
Unconventional Machining Process	Principle and working and applications of unconventional machining process such as Electro Discharge machining, Electro chemical machining, ultrasonic machining, Abrasive jet machining etc Principle and working and application of unconventional machining processes such as Laser beam machining, Electron beam machining, Ultrasonic machining etc (these can also be used for welding)	8
Unconventional welding processes	Explosive welding, Cladding etc under water welding, Metalizing, Plasma are welding/cutting etc	8
Unconventional Forming processes	Principle, working and applications of High energy forming processes such as Explosive Forming, Electromagnetic forming, Electro Discharge forming, water hammer forming, explosive compaction etc	8
Electronic device Manufacturing	Brief description of Diffusion and Photo Lithography process for electronic device manufacturing	8
	Total noof Hrs	**40**
	Text and Reference Books: 1. Modern Machining Processes – P C Pandey 2. Unconventional Machining – V K Jain	

Course Outcome:

1. Understand of fundamentals of the non-traditional machining methods and industrial applications.
2. Compare Conventional and Non-Conventional machining and analyze the different elements of Ultrasonic Machining and its applications.
3. Identify and utilize fundamentals of metal cutting as applied to machining

TURBO MACHINES

Objective

To provide fundamental knowledge of turbo machines and their application. Also make them able to describe the working principles and applications of gas turbines and their components.

SET/ME/BT/OE712 TURBO MACHINES		
Module Name	**Contents**	**No of Hrs**
Basic Concepts of Turbo machines	Definition, classification and stages of turbo machines, estimation of specific work for incompressible and compressible flow machines. Internal and external losses, various efficiencies, representation of specific work on T-s and h-s diagrams, velocity triangles - centrifugal and axial flow machine impellers, Euler's energy equation across the impeller as applicable to all machines, slip and its estimation, degree of reaction, blade angles and their effects, calculations considering slip.	**9**
Centrifugal Flow Machines	Fans - different impeller sizes, shapes, blade angles, speed and construction. Blade shape, blade number, simple design calculations, performance in series and parallel. Compressor - slip, inducers, designs without inducer but with inlet guide vanes (IGV). Simple problems with inducer and IGV's - blade angles, temperature rise and static pressure rise across the impeller. Vaned and vaneless diffuser and volute casing. Pump - system head, priming of pumps, net positive suction head, minimum starting speed and cavitations.	**9**
Axial Flow Fans And Compressors	Low pressure head rise fans - blade profile, lift and drag coefficients, their variation with incidence, expressions for energy transfer and pressure rise in terms of CL and CD, simple design calculations. Compressors - brief introduction to two-dimensional cascade and its application to design, flow deflection and stagnation pressure loss across blade rows, expression for pressure rise coefficient in terms of flow angles and loss coefficient. Design of impeller blades for free vortex and forced vortex. Simple design and performance calculations. Stall and surge phenomenon.	**9**
Hydraulic Turbines	Pelton turbine- impulse wheel, single jet and multiple jet units, velocity triangles at inlet and exit of buckets, performance calculations considering losses in the nozzle and buckets. Francis turbine - reaction, impeller shapes for different shape numbers/ heads, calculations on impeller dimensions, blade angles and performance using velocity triangles, draft tubes. Kaplan / Propeller Turbine - reaction, impeller (adjustable and fixed) blades and guide blades, calculation of performance using velocity triangles / blade angles at different radii for free vortex flow, its suitability for low heads.	**9**
Axial Flow Turbines	Degree of reaction - expression in terms of flow angles, importance of 50 percent reaction stage, effect on the velocity triangles, blade shape and efficiency. Comparison of impulse blades of constant thickness with blades thicker at the centre.Representation on h-s diagram, comparison of impulse and 50 percent reaction stages, stage efficiencies, velocity triangles, blade angle calculations. Steam turbines - condensing and non-condensing, partial admission at inlet, presence of moisture at the low pressure end of condensing turbines, problems associated with moisture - blade erosion and methods to reduce the bad effects.	**9**
	Total noof Hrs	**45**
Text and Reference Books: 1. Yahya.S.M, "Turbines, Fans and Compressors", 3rd edition, Tata McGraw Hill Publications. 2. Gopalakrishnan.G, PrithviRaj.D, "Treatise on Turbomachines", 1st edition, Chennai, SciTech Publications.		

Course Outcome:

As the outcome of completing this course, the student should get the ability to:

1. The students will understand about different turbines.
2. the students will get knowledge about vane diagram of turbines.

AUTOMOBILE LAB

SET/ME/BT/C702 AUTOMOBILE LAB
List of Experiment 1.Performance Analysis of Four stroke S I Engine. Determination of indicated and Brake thermal efficiency, specific fuel consumption at different loads and Energy Balance 2.Determination of Indicated Horse Power of I C Engine by Morse Test 3.Performance Analysis of Four stroke C I Engine. Determination of indicated and brake thermal efficiency, specific fuel consumption at different loads and Energy Balance 4.To measure CO & Hydrocarbons in the exhaust of 2- stroke / 4-stroke petrol engine. 5.To find intensity of smoke from a single cylinder / multi-cylinder diesel engine. 6. To draw the scavenging characteristic curves of single cylinder petrol engine. 7.Study& experiment on Valve mechanism 8.Study& experiment on Gear Box 9.Study& experiment on Differential Gear Mechanism of Rear Axle 10.Study& experiment on Steering Mechanism 11.Study& experiment on Automobile Braking System 12.Study& experiment on Chassis and Suspension System **Note: At least ten experiments should be performed from the above list**

INDUSTRIAL TRAINING SEMINAR

SET/ME/BT/C703. INDUSTRIAL TRAINING SEMINAR	
Module Name	Content
	Student shall prepare a detailed report on her/his industrial training and deliver a seminar of 30 minutes.
Total No. of Hours	

SEMESTER VIII

S. No.	Category	Code	Course Title	L	T	P	Contact Hrs./Week	Credits
6.	Core Subjects	SET/ME/BT/C801	Power Plant Engineering	3	1	-	4	4
7.			@Program Elective-5	3	1	-	4	4
8.			@Program Elective-6	3	1	-	4	4
9.	Life Skills and personality development	SET/SH/BT/L801	*Disaster Management	-	-	1	4	2
10.	Skill Course	SET/ME/BT/S802	Major Project	-	-	1	12	6
Total				9	3	2	28	20

@Course offered by the department from the Program Elective- II list as given below.
#Courses offered by any other department of School of Engineering and Technology.
*University will prepare communication course in Modern/Indian languages from which student will select one language course. The course will

be more on applied side with giving students a chance to develop their soft skills.

Programme Electives (PEL): Total **2** to be taken, at least one from each group – *Technology* and *Industry Sector*, based on Project topic and individual interest. Illustrative courses are listed here.

S.N.	PEL (Technology)	Credit	PEL (Industry Sector)	Credit
1	Advance Welding Technology	SET/ME/BT/E802	Composite Material	SET/ME/BT/OE806
2	Gas Dynamics and Jet Propulsion System	SET/ME/BT/E803	Computer Integrated Manufacturing Systems	SET/ME/BT/OE807
3	Solar Thermal Power Engineering	SET/ME/BT/E804	Optimization Techniques in Engineering	SET/ME/BT/OE808
4	Experimental Stress Analysis	SET/ME/BT/E805	Biomedical Engineering	SET/ME/BT/OE809

POWER PLANT ENGINEERING

Course objectives:

To provide an overview of power plants and the associated energy conversion issues.

SET/ME/BT/C801 POWER PLANT ENGINEERING		
Module Name	**Contents**	**No of Hrs**
Introduction	Power and energy, sources of energy, review of thermodynamic cycles related to power plants, fuels and combustion, calculations Variable Load problem Industrial production and power generation compared, ideal and realised load curves, terms and factors Effect of variable load on power plant operation, methods of meeting the variable load problem Power plant economics and selection Effect of plant type on costs, rates, fixed elements, energy elements, customer elements and investor's profit, depreciation and replacement, theory of rates Economics of plant selection, other considerations in plant selection	**8**
Steam power plant	Power plant boilers including critical and super critical boilers Fluidized bed boilers, boilers mountings and accessories General layout of steam power plant Different systems such as fuel handling system, pulverizes and coal burners, combustion system, draft, ash handling system, feed water treatment and condenser and cooling system, turbine auxiliary systems such as governing, feed heating, reheating , flange heating and gland leakage Operation and maintenance of steam power plant, heat balance and efficiency	**9**
Diesel power plant	General layout, performance of diesel engine, fuel system, lubrication system, air intake and admission system, supercharging system, exhaust system, diesel plant operation and efficiency, heat balance Gas turbine power plant Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants	**9**
Hydro electric station	Principles of working, applications, site selection, classification and arrangements, hydroelectric plants, run off size of plant and choice of units, operation and maintenance, hydro systems, interconnected systems, micro and mini hydro power plant	**8**
Nuclear power plant	Principles of nuclear energy, basic components of nuclear reactions, nuclear power station Nuclear fuels in fission and fusion reactors, Types of nuclear reactors, Fissile and fertile materials, Neutron chain reaction in fission reactors, Neutron flux, Concept of criticality for bare homogeneous reactors, Coolants, moderators, Control and structural materials Heat generations and steady state temperature distribution in fuel elements, Heat removal	**9**
	Total no of Hrs	**43**

Text books:

1. Nuclear Reactor Engineering By S Glastone and A Sesonske .
2. Basic Nuclear Engineering, by K S Ram .
33. Introduction to Nuclear Engineering, by J R lamarsh.
4. "Power Plant Engineering" F T Morse, Affiliated East West Press Pvt Ltd, New Delhi/Madras

References Books

1 Power Plant Engineering, Mahesh Verma, Metropolitan Book Company Pvt Ltd.
2. Power Plant Technology, El Vakil, McGraw Hill.
3. Power Plant Engineering by P K Nag, Tata McGraw Hill.
4. Steam & Gas Turbines & Power Plant Engineering by R Yadav, Central Pub.

Course outcomes:
At the end of this course students will demonstrate the ability to
1. Upon completion of the course, the students can understand the principles of operation for different power plants and their economics**.**

SET/ME/BT/E802 ADVANCE WELDING TECHNOLOGY

Course objectives:
The objective of this course is
1. To learn various concepts related to welding, its application
2. To have practical purview of various welding process, welding standards, advanced welding process.

SET/ME/BT/E802 ADVANCE WELDING TECHNOLOGY		
Module Name	**Contents**	**No of Hrs**
Module 1	Solid state welding: classification of solid state welding processes, Adhesive bonding, advantages and applications.	**8**
Module 2	Friction welding: Friction welding process variables, welding of similar and dissimilar materials, Defective analysis of friction welded components, Friction welding of materials with inter layer. Friction stir welding: Processes parameters, tool geometry, welding of Aluminium alloys, Friction stir welding of Aluminum alloys and Magnesium alloys.	**8**
Module 3	Electron Beam welding (EBW): Electron Beam welding process parameters, atmospheric affect Defective analysis of Electron beam welds and Electron Beam welding dissimilar materials.	**10**
Module 4	Laser Beam welding (LBW): Laser Beam welding process parameters, atmospheric affect and Laser Beam welding of steels.	**6**
Module 5	Selection power source : Constant voltage and constant current power sources. Weldability of cast iron and steel : weldability studies of cast iron and steel,	**8**
	Total no of Hrs	**40**

Text and Reference Books:
1. Nadkarni S.V., Modern Welding Technology, Oxford IBH Publishers, 1996.
2. Parmar R. S., Welding Engineering and Technology, Khanna Publishers, 2005.
3. D. L. Olson, T. A. Siewert, Metal Hand Book, Vol 06, Welding, Brazing and Soldering, ASM International Hand book Metals Park, Ohio USA, 2008.

Course outcomes:
At the end of the course
The students will gain an experience in the implementation of welding techniques concepts which are applied in the field of production.

SET/ME/BT/E803 Gas Dynamics and Jet Propulsion system

Course objectives:

1. Define basic concept and importance of gas dynamics.
2. Interpret the flow pattern in flow and non flow systems.
3. Identify the thrust equation and its usage in jet aircraft and rocket propulsion in an efficient way.

SET/ME/BT/E803 Gas Dynamics and Jet Propulsion system		
Module Name	**Contents**	**No of Hrs**
Module 1	Gas Turbines - Introduction, Classification, Applications. Gas Turbine and Its Components, Gas Turbine Power Plants. Optimum Pressure Ratio for Maximum Specific and Thermal Efficiency in Actual Gas Turbine Cycle. Effect of Operating Variables on Thermal Efficiency, Air Rate and Work Ratio.	**8**
Module 2	Combustion Chamber- Types of Combustion Chamber, Factors Affecting Combustion Chamber Design, Combustion Processes, Combustion Chamber Performance, Fuel Injection Systems. Axial Flow Turbines & Combustion Chamber- Classification, Elementary Theory, Vortex Theory, Limiting Factors in Turbine Design, Overall Turbine Performance, Design Performance of Gas Turbine Plant, Matching of Turbine Components.	**8**
Module 3	Centrifugal Compressors- Prewhirling, Adiabatic Efficiency, Performance Characteristics, Pressure Coefficient and Slip Factor, Losses, Surging, Compressor Design Calculations, Mach Number.	**10**
Module 4	Axial Flow Compressors- Principles of Operation, Simple Design Method, Blade Design, Calculation of Stage, Overall Performance, Compressor Characteristics, Mach Number, Reynolds Number.	**6**
Module 5	Jet Propulsion- Turbo Jet, Turbo Prop, Ram Jet, Rocket Engines Thrust Power, Propulsive Efficiency and Thermal Efficiency, Jet Propulsion Performance, Specifying Thrust and Specific Fuel Consumption in each case For Turbo Jet and Turbo Propulsion Units.	**8**
	Total no of Hrs	**40**

Text and Reference Books:

1. Gas Turbine Theory, Sarvanamatto, Cohen H, Rogers, Longmans Green.
2. Turbines, Compressors and Fans, S M Yahya, Tata McGraw Hill book Co., New Delhi.
3. Steam and Gas Turbines, R Yadav.

Course outcomes:

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

1. Explain basic concepts of gas dynamics and describe the basic fundamental equations of one dimensional flow of compressible fluid and isentropic flow of an ideal gas.
2. Analyze the steady one-dimensional is entropic flow, frictional flow and isothermal flow and express the concepts of steady one dimensional flow with heat transfer.
3. Discuss the effect of heat transfer on flow parameters.
4. Describe the jet propulsion engines
5. Describe the basic concepts of rocket propulsion

SET/ME/BT/E804 Solar Thermal Power Engineering

Course objectives:

The objective of the course is to

1. Develop a detailed understanding of design and evaluation solar thermal power plants.
2. Provide economic analysis and implementation of solar thermal power projects.

SET/ME/BT/E804 Solar Thermal Power Engineering		
Module Name	**Contents**	**No of Hrs**
ENERGY RESOURCES AND SOLAR SPECTRUM	World energy resources - Indian energy scenario - Environmental aspects of energy utilization. Renewable energy resources and their importance - Global solar resources. Solar spectrum – Electromagnetic spectrum, basic laws of radiation. Physics of the Sun - Energy balance of the earth, energy flux, solar constant for earth, green house effect.	**8**
SOLAR RADIATION AND MEASUREMENT	Solar radiation on the earth surface - Extraterrestrial radiation characteristics, Terrestrial radiation, solar insolation, spectral energy distribution of solar radiation. Depletion of solar radiation - Absorption, scattering. Beam radiation, diffuse and Global radiation. Measurement of solar radiation – Pyranometer, Pyrheliometer, Sunshine recorder. Solar time - Local apparent time (LAT), equation of time (E).	**8**
SOLAR RADIATION GEOMETRY AND CALCULATIONS	Solar radiation geometry - Earth-Sun angles – Solar angles. Calculation of angle of incidence – Surface facing due south, horizontal, inclined surface and vertical surface. Solar day length – Sun path diagram – Shadow determination. Estimation of Sunshine hours at different places in India. Calculation of total solar radiation on horizontal and tilted surfaces. Prediction of solar radiation availability.	**10**
SOLAR THERMAL ENERGY CONVERSION	Thermodynamic cycles – Carnot – Organic, reheat, regeneration and supercritical Rankine cycles – Brayton cycle – Stirling cycle – Binary cycles – Combined cycles. Solar thermal power plants - Parabolic trough system, distributed collector, hybrid solar-gas power plants, solar pond based electric-power plant, central tower receiver power plant.	**6**
SOLAR ELECTRICAL ENERGY CONVERSION	Solar photovoltaic energy conversion - Principles - Physics and operation of solar cells. Classification of solar PV systems, Solar cell energy conversion efficiency, I-V characteristics, effect of variation of solar insolation and temperature, losses. Solar PV power plants.	**8**
	Total no of Hrs	**40**

Text and Reference Books:

1. Foster .R, Ghassemi M., Cota A., "Solar Energy", CRC Press, 2010.
2. Duffie .J.A, Beckman W.A. "Solar Engineering of Thermal Processes", 3rd ed., Wiley, 2006.
3. De Vos .A, "Thermodynamics of Solar Energy Conversion", Wiley-VCH, 2008.
4. Garg .H.P, Prakash .J, "Solar Energy Fundamentals and Applications", Tata McGraw-Hill, 2005.
5. Kalogirou .S, "Solar Energy Engineering", Processes and Systems, Elsevier, 2009.
6. Petela .R, "Engineering Thermodynamics of Thermal Radiation for Solar Power", McGraw-Hill Co., 2010.
7. Yogi Goswami .D, Frank Kreith, Jan F. Kreider, "Principles of Solar Engineering", Second Edition, Taylor & Francis, 2003.
8. Andrews .J, Jelley .N, "Energy Science", Oxford University Press, 2010.

Course outcomes:

After completing this course, a student will be able to:

1. Develop a comprehensive understanding on different collector technologies and their comparative performance characteristics.
2. Design a solar thermal power plant through appropriate selection of collector, receiver, power cycles, heat transfer fluid and tracking mechanism.
3. Carry out the economic analysis of a solar thermal power plant and develop understanding on implementation process of a solar thermal power project.

SET/ME/BT/E805
Experimental Stress Analysis

Course objectives:

To bring awareness on experimental method of finding the response of the structure to different types of load.

1. Recognize the various techniques available to measure the stress and Strains using different sources.
2. Realize the working of recording instruments and data logging methods.
3. Distinguish the principles of photo elasticity in two dimensional stress analyses.

SET/ME/BT/E805 Experimental Stress Analysis		
Module Name	**Contents**	**No of Hrs**
STRAIN MEASUREMENT METHODS AND ANALYSIS OF STRAIN GAGE DATA	Various types of strain gauges, Electrical Resistance strain gauges, Gage Sensitivity and Gage Factor Semiconductor strain gauges, Temperature compensation, strain gauge circuits. Three Element Rectangular Rosette, Delta Rosette, strain gauge rosette.	**8**
RECORDING INSTRUMENTS	Introduction, static recording and data logging, dynamic recording at very low Frequencies, dynamic recording at intermediate frequencies, dynamic recording at high Frequencies, dynamic recording at very high frequencies.	**8**
BRITTLE COATINGS and BIREFRINGENT COATINGS	**Brittle Coatings:** Introduction, coating stresses, failure theories, brittle coating crack patterns, crack detection, ceramic based brittle coatings, resin based brittle coatings, test procedures for brittle coatings analysis, calibration procedures, analysis of brittle coating data. **Birefringent Coatings**: Introduction, Coating stresses and strains, coating sensitivity, coating materials, application of coatings, effects of coating thickness, Fringe-order determinations in coatings, stress separation method Undercoating.	**10**
MOIRE METHODS	Introduction, mechanism of formation of Moire fringes, the geometrical approach to Moire-Fringe analysis, displacement field approach to Moire-Fringe analysis, out of plane displacement measurements, out of plane slope measurements, sharpening and multiplication of Moire-Fringes, experimental procedure and techniques.	**6**
PHOTO ELASTICITY	Introduction Polariscope – Plane and circularly polarized light, Bright and dark field setups, Isochromatic Fringe Patterns, Isoclinic Fringe Patterns, CompensationTechniques, Calibration Methods, Separation Methods, Shear Difference Method, Materials for Two Dimensional Photo elasticity	**8**
	Total no of Hrs	**40**

Text and Reference Books:

1. Experimental stress analysis, (Third Edition) by James Dally and Riley, Mc Graw-Hill International, New Delhi.1978.
2. Experimental stress analysis, (6th edition) by Dr. Sadhu Singh, KhannaPublishers, New Delhi, 1996.
3. A treatise on Mathematical theory of Elasticity, by Augustus Edward Hough Love, University Press, fourth edition, 1906.
4. Experimental stress analysis principles and methods, by G.S. Holister, Cambridge university press, 1967.
5. Theory of Elasticity, (Third Edition), S.Timoshenke and JN. Goodier McGraw-Hill, New York ,1970.

Course outcomes:

Upon completion of this course the student will be able to:
1. Understand the overall concepts of stress/strain analysis by experimental means.
2. Familiar with the theory and practice of common experimental stress analysis Methods including moire methods, photo elasticity.
3. Acquire the knowledge on Brittle and bi-refrigent coatings and working of strain gauges.

SET/ME/BT/OE806
Composite Material

Course objectives:
1. To study the behaviour of composite materials.
2. To investigate the failure modes of composite materials.
3. To understand the fracture mechanics of composite materials.

SET/ME/BT/OE806 COMPOSITE MATERIAL		
Module Name	**Contents**	**No of Hrs**
Introduction	Introduction, Current and potential advantages of fibre reinforced composites, Applications of composite materials, Military, civil, space, automotive and commercial applications	**8**
Fibers, matrices and fillers	Glass, Graphite, Aramid, Poletyhylene Fibers, Ceramic Fibres, Composite Fibres, SiC Whisker, SiC Particle, polymer matrix materials	**7**
Manufacturing of composites	Production Techniques of MMC, Polymer Matrix composites (PMCs), Production of(PMCs), Ceramic matrix Composites (CMCs), production techniques, Carbon-carbon Composites(CCCs), Production Chemical Vapor Deposition, Pyrolysis Using thermosets, Pyrolysis Using Thermoplastics	**10**
Mechanics of Composite Materials	Continuous Fibers, Iso stress condition, Iso strain condition, Stress Vs Strain Critical Volume fraction of fiber, Minimum volume fraction of fibre discontinuous fibers, Creep of composites Fatigue of Composites, Fracture Toughness Testing and inspection.	**6**
Recent developments	Self healing composites, Molecular Composites, Micro Composites, Nano Composites, Left Handed Composite Materials, Stiffer Than stiff Composites, Quick step process for PMCs, Biocomposites , Complex Composites.	**9**
	Total no of Hrs	**35**

Text and Reference Books:
1. Ronald F. Gibson, Principles of composite material mechanics, CRC Press, 2011.
2. Robert M Jones, Mechanics of Composite Materials, Taylor & Francis, 2000.
3. Lawrence E. Nielsen, Nielson, Paul Nielsen, Mechanical Properties of Polymers and Composites, Second Edition, CRC press, 2000

Course outcomes:
At the end of the course student will be able
1. Apprehend the stress strain relationship of orthotropic and anisotropic materials.
2. Analyze laminated composites.
3. Assess the failure criterion and fracture mechanics of composites

SET/ME/BT/OE807
Computer Integrated Manufacturing Systems

Course objectives:
1. Students will be introduced to CAD/CAM/CAE concepts.
2. Student will learn steps in upgrading from FMS to CIM.

3. Students will learn about importance of data generation and management in CIMS.

SET/ME/BT/OE807 Computer Integrated Manufacturing Systems		
Module Name	**Contents**	**No of Hrs**
Module 1	Introduction - Production Systems Facilities, Automation in Production Systems, Manual Labor in Production Systems, Automation Principles and Strategies; Manufacturing Operations, Production Concepts and Mathematical Models, Cost of Manufacturing Operations.	**8**
Module 2	Group Technology and Cellular Manufacturing, Parts Classification and Coding, Production Flow Analysis, Cellular Manufacturing. Industrial Robotics: Robot Anatomy and Related Attributes, Robot Control Systems, Robot Applications.	**7**
Module 3	Definition and Broad Characteristics of Flexible Manufacturing Cells, Systems, Flexible Transfer Lines, Place of Flexible Manufacturing Systems in CIM, Economics and Technological Justification for FMS, Design and Planning, Role of Associated Technologies such as GT, JIT and Simulation, Operation and Evaluation, Scheduling Problems, FMS Hardware, Control Aspects of FMS, Flexible Machining Cells.	**10**
Module 4	Introduction to Material Handling, Material Transport Systems, Storage SystemsConventional / Automated Storage Systems, Automatic Identification Methods.	**6**
Module 5	Shop Floor Control – Functions, Order Release, Order Scheduling, Order Progress, Factory Data Collection Systems, Corrective Actions	**9**
	Total no of Hrs	**35**

Text and Reference Books:

1. Groover, M. P.-Automation Production Systems and Computer Integrated Manufacturing, Pearson Education Asia, Delhi.
2. Zeid, I. - CAD/CAM - Theory and Practice, Tata McGraw Hill, New Delhi.
3. Ranky, P. G. -Computer Integrated Manufacture, Prentice-Hall International, UK.
4. Rao, P. N. – CAD/CAM, Tata McGraw Hill, New Delhi.
5. Craig, J. J. - Introduction to Robotics: Mechanics and Control, Addison-Wesley, New York.

Course outcomes:

1. Students will be able to apply knowledge about Computer Aided Quality control and Process Planning Control.
2. Students will be able to Design Flexible manufacturing cell after carrying out Group technology study and finally creating FMS.
3. Students will be able to apply knowledge about various methods of communication in CIMS.
4. They will able apply data management and its importance for decision making in CIMS environment.

SET/ME/BT/OE808
OPTIMIZATION TECHNIQUES IN ENGINEERING

Course objectives:

The students will try to learn:

1. Operation research models using optimization techniques based upon the fundamentals of engineering mathematics (minimization and Maximization of objective function).
2. The problem formulation by using linear, dynamic programming, game theory and queuing models.
3. The stochastic models for discrete and continuous variables to control inventory and simulation of manufacturing models for the production decision making.
4. Formulation of mathematical models for quantitative analysis of managerial problems in industry.

Course outcomes:
1. Recall the theoretical foundations of various issues related to linear programming modeling to formulate real-world problems as a L P model.
2. Explain the theoretical workings of the graphical, simplex and analytical methods for making effective

SET/ME/BT/OE808 OPTIMIZATION TECHNIQUES IN ENGINEERING		
Module Name	**Contents**	**No of Hrs**
Linear Programming	Introduction and formulation of models, Convexity, Simplex method, Big-M method, Two-phase method, Degeneracy, non-existent and unbounded solutions, revised simplex method,	**8**
Linear Part Programming	Duality in LPP, dual simplex method, sensitivity analysis, transportation and assignment problems, traveling salesman problem.	**7**
Nonlinear Programming:	Introduction and formulation of models, Classical optimization methods, equality and inequality constraints, Lagrange multipliers and Kuhn-Tucker conditions, quadratic forms, quadratic programming problem, Wolfe's method.	**10**
Dynamic Programming	Principle of optimality, recursive relations, solution of LPP	**6**
Integer Linear Programming	Gomory's cutting plane method, Branch and bound algorithm, Knapsack problem, linear 0-1 problem	**9**
	Total no of Hrs	**35**

Text and Reference Books:

1. Kanti Swarup, Man Mohan and P.K.Gupta, Introduction to Operations Research, S.Chand & Co., 2006
2. J.C.Pant, Introduction to Operatins Research, Jain Brothers, New Delhi, 2008.
3. N.S.Kambo : Mathematical Programming Techniques, East-West Pub., Delhi, 1991.

decision on variables so as to optimize the objective function.
3. Identify appropriate optimization method to solve complex problems involved in various industries.
4. Demonstrate the optimized material distribution schedule using transportation model to minimize total distribution cost.

SET/ME/BT/OE809
Biomedical Engineering

Course objectives:
1. To introduce the field of biomedical engineering and role of biomedical engineers in society.
2. To impart knowledge on principles of various diagnostic, therapeutic equipment.
3. Achieve familiarity with some basic ethical framework and medical standards to be followed in hospitals.

SET/ME/BT/OE809 Biomedical Engineering		
Module Name	**Contents**	**No of Hrs**

Introduction	Historical Perspective-Evolution of modern healthcare system-Role of Biomedical engineers in various domain -Professional status of biomedical engineering-General constraints in design of medical instrumentation systems	**8**
Fundamentals of Medical Instrumentation	Anatomy and Physiology – Sources of biomedical signals- basic medical instrumentation system-General block of medical instrumentation system – Performance requirements –General constraints in design of medical instruments.	**7**
Diagnostic Imaging	X-rays, Nuclear Medical Imaging-Positron Emission Tomography-Magnetic Resonance Imaging Scanners-Diagnostic Ultrasound- Thermal imaging systems	**10**
Introduction to Biomedical Equipment	ECG – EEG - Cardiac Pacemakers - Cardiac Defibrillators – Haemodialysis Machines-Artificial KidneyDialyzers- Ventilators-Humidifiers, Nebulizers and Aspirators- Anaesthesia Machine.	**6**
Medical Safety Standards and Ethical Practices in Health Care	Medical standards and regulations – Institutional Review Boards – Good Laboratory Practices -Good Manufacturing Practices -Human factors. Morality and Ethics-A Definition of terms,Human Experimentation-Ethical issues in feasibility studies, Ethical issues in emergency use, Ethical issues in treatment use-Codes of ethics for bio engineers.	**9**
	Total no of Hrs	**35**

Text and Reference Books:

1. Enderle, John D, Bronzino, Joseph D, Blanchard, Susan M- Introduction to Biomedical Engineering-ElsevierInc2ndedition,2005.
2. R. S. Khandpur, Handbook of Biomedical Instrumentation, McGraw-Hill Publishing Company Limited, 2ndedition,2003.
3. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurement, Prentice Hall of India, New Delhi,2nd edition, 2002
4. Joseph. J Carr, John M Brown, Introduction to Biomedical Equipment Technology, John Wiley& Sons, New York,4th edition, 2008

Course outcomes:

The Student will be able to

1. Interpret the role of biomedical engineering in society.
2. Demonstrate the principles of various diagnostic devices.
3. Identify the various techniques used in diagnosis though imaging.
4. Describe the working principles of various therapeutic and assist devices.
5. Understand device specific safety goals and standards.
6. Illustrate the concepts of ethical theories and moral principles for the health professions.