Curriculum and syllabi of B.Tech Programme

In

Mechanical Engineering

(Academic Session 2019-20 & onwards)

ALIAH UNIVERSITY

Kolkata-700160

A. Programme Outcome:

1. Apply basic knowledge of mathematics, science and engineering principles to solve technical problems.
2. Design and analyze a system component, or process to meet desired needs in Mechanical Engineering.
3. Design a system and conduct experiments to find suitable solution in the field of mechanical engineering
4. Identify, visualize, formulate and solve engineering problems in the field of mechanical Engineering.
5. Use the techniques, skills, and modern engineering tools necessary for engineering practice with appropriate considerations for societal and environmental constraints.
6. Apply their fundamental field skills towards the understanding of the impact of engineering solutions on the society in a global and social context.
7. Function on multi disciplinary teams as a team member/leader and create user friendly environment.
8. Communicate effectively in oral, written, visual and graphic modes within interpersonal, team, and group environments.
9. Apply the techniques, skills and modern engineering tools necessary for engineering projects.
10. Recognize the need for professional advancement by engaging in lifelong learning.
11. Demonstrate the ability to succeed in national and international competitive events in the relevant fields.

B. Programme Specific Outcome

1. Analyze, design and develop machining systems to solve the engineering problems by integrating thermal, design and manufacturing domains of mechanical engineering.

2. Adopt a multidisciplinary approach to solve real-world industrial problems

3. To produce Mechanical Engineers capable of solving research oriented and realistic industrial problems

General, Course structure & Theme

Course code and definition:

Course code	Definitions
L	Lecture
T	Tutorial
P	Practical
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional core courses
PEC	Professional Elective courses
OEC	Open Elective courses

Definition of Credit:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credits
2 Hours Practical (Lab)/week	1 credit

Range of credits:

A range of credits from 150 to 160 is required for a student to be eligible to get Under Graduate degree in Engineering. A student will be eligible to get Under Graduate degree with Honours or additional Minor Engineering, if he/she completes an additional 20 credits. These could be acquired through MOOCs.

Structure of Undergraduate Engineering program:

Category Index	Category name	Ideal credit set by AICTE	Actual credit proposed
HSMC	Humanities and social science including management	12	9
BSC	Basic Science course	25	23
ESC	Engineering Science course	24	25.5
PCC	Professional core courses	48	57
PEC	Professional elective courses	18	15
OEC	Open elective course	18	18
PROJ	Project work, seminar and internship in industry or elsewhere	15	13

MC	Mandatory courses	Non credit	No credit
Total		160	160.5

I. **Semester-wise structure of curriculum**

[L= Lecture, T = Tutorials, P = Practical & C = Credits]

Semester I (First year]
Branch/Course Mechanical Engineering

Sl no	Category Index	Paper Code	Name of the Paper	Periods per week				Credit
				L	T	P	Total	
1	ESC	MENUGES01	Engineering Mechanics	3	1	0	4	4
2	ESC	ECEUGES01	Basic Electronics Engineering	3	0	0	3	3
3	BSC	MATUGBS01	Engineering Mathematics I	3	1	0	4	4
4	BSC	PHYUGBS01	Engineering Physics	3	0	0	3	3
5	ESC	CENUGES01	Engineering Drawing	1	0	3	4	2.5
6	ESC	ECEUGES02	Basic Electronics Engineering Lab	0	0	3	3	1.5
7	BSC	PHYUGBS02	Engineering Physics lab	0	0	3	3	1.5
8	MC	UCCUGAU01	Arabic language & Islamic Studies	4	0	0	4	0
Total credits								**19.5**
Total Period per week								**28**

** Students will undergo an induction program of 3 weeks duration during the First Semester

Semester II (First year] Branch/Course
Mechanical Engineering

Sl no	Category Index	Paper Code	Name of the Paper	Periods per week				Credit
				L	T	P	Total	
1	ESC	CSEUGES01	Programming for Problem Solving	3	0	0	3	3
2	ESC	EENUGES01	Basic Electrical Engineering	3	0	0	3	3
3	BSC	MATUGBS02	Engineering Mathematics II	4	0	0	4	4
4	BSC	CHMUGBS01	Engineering Chemistry	3	0	0	3	3
5	HSMC	ENGUGHU01	Communicative English	3	0	0	3	3
6	ESC	CSEUGES02	Programming for Problem Solving Lab	0	0	4	4	2
	ESC	EENUGES01	Basic Electrical Engineering Lab	0	0	3	3	1.5
8	ESC	MENUGES02	Workshop practice	0	1	3	3	2
9	BSC	CHMUGBS02	Engineering Chemistry lab	0	0	3	3	1.5
10	HSMC	ENGUGHU0	Language lab	0	0	2	2	1
Total Credits								**24**
Total Period per week								**31**

Semester III (Second year] Branch/Course
Mechanical Engineering

Sl. No.	Category	Code	Course Title	Hours per week			Total contact hours	Credits
				Lecture	Tutorial	Practical		
1	BSC	MATUGBS03	Mathematics III (PDE, Probability & Statistics)	3	1	0	4	4
2	ESC	**MENUGES03**	Materials Engineering	3	0	0	3	3
3	PCC	MENUGPC01	Strength of Materials	3	1	0	4	4
4	PCC	MENUGPC02	Fluid Mechanics	3	1	0	4	4
5	PCC	MENUGPC03	Thermodynamics	3	1	0	4	4
6	Mandatory courses	UCCUGAU03	Indian Constitution	2	0	0	2	0
7	OEC			3	0	0	3	3
8	PCC	MENUGPC04	Mechanical Engineering Lab-I (Material Testing))	0	0	3	3	1.5
							Total Credit	**23.5**
							Total Period per week	**27**

Semester IV (Second year] Branch/Course
Mechanical Engineering

Sl. No.	Category	Code	Course Title	Hours per week			Total contact hours	Credits
				Lecture	Tutorial	Practical		
1	PCC	MENUGPC05	Applied Thermodynamics	3	0	0	3	3
2	PCC	MENUGPC06	Manufacturing Process-I	3	0	0	3	3
3	BSC	BIOUGBS01	Biology for engineers	2	0	0	2	2
4	PCC	MENUGPC07	Mechanism and Machines	3	1	0	4	4
5	PCC	MENUGPC08	Fluid Machinery	3	0	0	3	3
6	MC	UCCUGMC02	Environmental Science	2	0	0	2	0
7	OEC	OEC		3	0	0	3	3
8	PCC	MENUGPC09	Mechanical Engineering Lab-II (Fluid Mechanics & Machinery)	0	0	3	3	1.5
							Total credits	**19.5**
							Total Period per week	**25**

Semester V (Third year] Branch/Course
Mechanical Engineering

Sl. No.	Category	Code	Course Title	Hours per week			Total contact hours	Credits
				Lecture	Tutorial	Practical		
1	PCC	MENUGPC10	Heat Transfer	3	1	0	4	4
2	PCC	MENUGPC11	Machine Design-I	3	0	0	3	3
3	PCC	MENUGPC12	Manufacturing Processes-II	3	0	0	3	3
4	PCC	MENUGPC13	Measurement & Instrumentation	3	0	0	3	3
5	OEC			3	0	0	3	3
6	Project (Summer internship)	MENUGPR01	Project-I	0	0	2	2	1
7	PCC	MENUGPC14	Mechanical Engineering Lab-III (Thermal, IC Engine & Heat Transfer)	0	0	3	3	1.5
9	PCC	MENUGPC15	Mechanical Engineering Lab-IV (Design, CAD & DOM)	0	0	4	4	2
							Total credits	**20.5**
							Total Period per week	**25**

Semester VI (Third year] Branch/Course
Mechanical Engineering

Sl. No.	Category	Code	Course Title	Hours per week			Total contact hours	Credits
				Lecture	Tutorial	Practical		
1	PCC	MENUGPC16	Advance Manufacturing Technology	3	0	0	3	3
2	PCC	MENUGPC17	Machine Design-II	3	0	0	3	3
3	PEC	MENUGPE01 / MENUGPE02	Advance Engineering Materials/ IC Engines	3	0	0	3	3
4	OEC	OEC		3	0	0	3	3
5	PEC	MENUGPE05 / MENUGPE06	Mechatronics Engineering/ Control systems	3	0	0	3	3
6	Project (Or Summer internship)	MENUGPR02	Project-II	0	0	6	6	3
7	PCC	MENUGPC18	Mechanical Engineering Lab-V (Machine Shop, Foundry & Welding Practice)	0	0	4	4	2
							Total credits	**20**
							Total period per week	**25**

Semester VII (Fourth year]
Branch/Course: Mechanical Engineering

Sl. No.	Category	Code	Course Title	Hours per week			Total contact hours	Credits
				Lecture	Tutorial	Practical		
1	PCC	MENUGPC19	Automation in Manufacturing	3	0	0	3	3
2	PEC	MENUGPE10 / MENUGPE11	Robotics/ Industrial automation and control	3	0	0	3	3
3	PEC	MENUGPE14 / MENUGPE15	Refrigeration and Air Conditioning/ Power Plant Engineering	3	0	0	3	3
4	HSMC	MBAUGHU01	Industrial Economics Management	3	0	0	3	3
5	OEC	OEC		3	0	0	3	3
6	Project	MENUGPR03	Project-III	0	0	6	6	3
7	PCC	**MENUGPC20**	Mechanical Engineering Lab-VI (Measurements, Robotics &Advanced manufacturing)	0	0	3	3	1.5
							Total credits	**19.5**
							Total Period per week	**24**

Semester VIII (Fourth year]
Branch/Course Mechanical Engineering

Sl. No.	Category	Code	Course Title	Hours per week			Total contact hours	Credits
				Lecture	Tutorial	Practical		
1	PEC	MENUGPE18 / MENUGPE19/ MENUGPE20 **ME 402**	Non-Conventional Energy Utilization / FEM/ Mechanics of Composite Materials	3	0	0		3
2	HSMC	MBAUGHU02 **HU 402**	Professional Values & Ethics	2	0	0	2	2
3	OEC	OEC- 301 **OCS 402**		3	0	0	3	3
4	Project	MENUGPR04 **ME 492**	Project-IV	0	0	12		6
							Total credits	**14**

List of Open Elective Courses

Sl no	Code	Course	Semester
1	**CENUGOE01**	Building Materials	3rd
2	**CSEUGOE01**	Data Structures & Algorithms Analysis	
3	**ECEUGOE01**	Electronic Devices & Circuits	
4	**MENUGOE01**	Materials Engineering	
5	**CENUGOE02**	Engineering Geology	4th
6	**CSEUGOE02**	Computer Organization	
7	**ECEUGOE02**	Principal of Communication System	
8	**ECEUGOE03**	Digital Electronics	
9	**MENUGOE02**	Thermodynamics	
10	**CENUGOE03**	Transportation Engineering	5th
11	**CSEUGOE03**	Object Oriented Programming	
12	**ECEUGOE04**	Microprocessor & its Application	
13	**MENUGOE03**	Strength of Material	
14	**CENUGOE04**	Environmental Engineering	6th
15	**CSEUGOE04**	Data Communication & Computer Networks	
16	**ECEUGOE05**	Microelectronics	
17	**MENUGOE04**	Mechatronics	
18	**CENUGOE05**	Hydraulics Engineering	7th
19	**CSEUGOE05**	Digital Image Processing	
20	**ECEUGOE06**	Radar System	
21	**MENUGOE05**	Non-conventional Energy Utilization	
22	**CENUGOE06**	Construction Management	8th
23	**CSEUGOE06**	Data Science	
24	**ECEUGOE07**	Laser Technology	
25	**ECEUGOE08**	Neural Network	
26	**MENUGOE06**	Finite Element Method	
27	**MBAUGOE01**	Entrepreneurship Development	5th semester onwards

Detail syllabus of open elective courses will be provided by the department offering the course.

Semester wise Credit Segregation

Semester	ESC	BSC	HSMC	PCC	OEC	MC	PJ	PEC	Total credit
1st	11	8.5							19.5
2nd	11.5	8.5	4						24
3rd	3	4		13.5	3				23.5
4th		2		14.5	3				19.5
5th				16.5	3		1		20.5
6th				8	3		3	6	20
7th			3	4.5	3		3	6	19.5
8th			2		3		6	3	14
Total credit	25.5	23	9	57	18		13	15	160.5

Detailed syllabus

Semester I (First year)

ESC	**MENUGES 01**	**Engineering Mechanics**	**3L-1T-0P**	**4 Credits**

Course Outcomes: Upon completion of this course, students will able to grasp the following concepts –

- Use scalar and vector analytical techniques for analyzing forces in statically determinate structures.
- Apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems.
- Understand basic kinematics concepts – displacement, velocity and acceleration (and their angular counterparts);
- Understand basic dynamics concepts – force, momentum, work and energy;
- Understand and be able to apply Newton's laws of motion;
- Understand and be able to apply other basic dynamics concepts – the Work-Energy principle, Impulse – Momentum principle and the coefficient of restitution;
- Learn to solve dynamics problems choosing an appropriate solution strategy;
- Attain an introduction to basic machine parts such as pulleys and mass-spring systems

Module	Content	Lecture
Module 1	Importance of Mechanics in engineering. Introduction to Statics; Concept of Particle and Rigid Body; Types of forces: collinear, concurrent, parallel, concentrated, distributed; Vector and scalar quantities; Force as a vector; Transmissibility of a force.	**3**
	Introduction to Vector Algebra; Parallelogram law; Lami's theorem; Co-ordinate representation of vector; Cross product and Dot product and their applications.	**3**
	Two dimensional force system; Resolution of forces; Moment; Varignon's theorem; Couple; Resolution of a coplanar force by its equivalent force-couple system; Resultant of forces	**4**
Module 2	Concept and Equilibrium of forces; Free body concept and diagram; Equations of equilibrium, plane frames and trusses.	**4**
	Concept of Friction; Coulomb friction; Angle of Repose; Coefficient of friction	**4**

Module 3	Distributed Force: Centroid and Centre of Gravity; Centroids, circular sector, quadrilateral, composite areas consisting of different figures.	**4**
	Moments of inertia: Parallel axis theorem; Perpendicular axis theorem; Mass moment of inertia of symmetrical bodies e.g. cylinder, sphere, cone etc.	**4**
	Concept of virtual work and energy; Concept of simple stresses and strains; Torsion; Concept of fluid statics	**4**
Module 4	Introduction to Dynamics: Kinematics and Kinetics; Newton's laws of motion; Law of gravitation & acceleration due to gravity; Rectilinear motion of particles; determination of position, velocity and acceleration under uniform and non-uniformly accelerated rectilinear motion; construction of x-t, v-t and a-t graphs.	**4**

Books Recommended:

1. Engineering Mechanics [Vol I & II] by Meriam & Kraige – Wiley India
2. Engineering Mechanics: Statics & Dynamics by R.C. Hibbeler – Pearson
3. Vector Mechanics for Engineers [Vol I & II] by F. P. Beer and E. R. Johnston, TMH
4. Engineering Mechanics by Timoshenko, Young and Rao – TMH

ESC	**ECEUGES01**	**Basic Electronics Engineering** **(for CEN,MEN & CSE)**	**3L-0T-0P**	**3 Credits**

Course Outcomes:

Module	Content	Lecture
Module 1	**Semiconductor Basics:** Energy band theory, Fermi levels, Conductors, Semiconductors and Insulators: electrical properties, Semiconductors: intrinsic and extrinsic, P-type and N-type semiconductors; electrical conduction phenomenon, drift and diffusion carriers, mass action law.	**7**
Module 2	**Rectifying Devices:** Formation of P-N junction, formation of depletion zone, Junction capacitance-I characteristics, Zener breakdown, Avalanche breakdown. Linear piecewise model; rectifiers: half wave, full wave, ripple factor, efficiency, Clipper and Clamper circuits	**6**

Module 3	**Transistors:** Formation of PNP / NPN junctions, principle of operation, configurations, transistor characteristics. Biasing and Bias stability: small signal low frequency operation of transistors; equivalent circuits h parameters, Transistors as amplifier: voltage gain, current gain, input impedance and output impedance, Decibel power.	7
Module 4	**Field Effect Transistor:** Construction and characteristics of JFET and MOSFET characteristics; depletion and enhancement type, FET small signal model.	4
Module 5	**Feed Back Amplifier:** Block diagram, properties, positive and negative feedback, loop gain, topologies of feedback amplifier; effect of feedback on gain, output impedance, input impedance, sensitivities(qualitative),bandwidth stability	4
Module 6	**Operational Amplifier:** Introduction to integrated circuits, operational amplifier and its terminal properties; concept of virtual earth, Gain-frequency and Slew rate; inverting and non-inverting mode of operation, voltage summing, difference, voltage follower, integrator, and differentiator.	4
Module 7	**Electronic Instruments:** Principle of operation of CRO; Electron ballistics and electron beam deflection; Concept of time base; Measurement of voltage, and frequency.	4

Text Books:

1. Rakshit & Chattopadhyay, Foundation of Electronics, New Age
2. Cathey, Electronic Devices and Circuits, Shaum series, TMH
3. Boylestead & Nashlesky, Electronic Devices and Circuits, Pearson
4. Millman and Halkias, Integrated Electronics, TMH

BSC	**MATUGBS01**	**Engineering Mathematics I**	**4L-0T-0P**	**4 Credits**

Course Outcomes:

Module	Content	Lecture
Module 1	Basics of sequence and series ; Power series, Limit, Continuity.	**14**
Module 2	Differentiation, Mean value theorems and its application; Taylor's theorem, Maclaurin's infinite series; Maxima and minima; L Hospital's rule.	**12**

Module 3	Reduction formulae, Beta and Gama functions.	2
Module 4	Lines and planes, Polar coordinates, Quadric surfaces, Volume, Area, length.	10
Module 5	Continuity, Differentiability of vector functions, Arc length; Curvature, Torsion, Serret-Frenet formulas, Double, triple integrals, Jacobian .	10
Module 6	Green theorem, Gauss theorem and Stokes Theorems and its application.	6

References:

1. Advanced Engineering Mathematics : Erwin Kreyszig
2. Advanced Engineering Mathematics : R.K. Jain & S. R. K lyengar
3. Advanced Engineering Mathematics : C. R. Wylle & L. C. Barrett
4. Differential & Integral Calculus : N. Plskunov

BSC	**PHYUGBS01**	**Engineering Physics**	**3L-0T-0P**	**3 Credits**

Course Outcomes:

Module	Content	Lecture
Module 1	**Mechanics** **Classical mechanics:** scalars and vectors, vector multiplication, central force, mechanics of system of particles, elastic properties, rotational motion, fluid dynamics: viscocity, Stoke's law, streamline flow, equation of continuity, Reynold's number, Bernoulli's theorem **Quantum mechanics:** Photoelectric effect, de-Broglie's hypothesis, matter wave, Hysenberg's uncertainty principle, wave function, Schrodinger equation and simple problems **Statistical mechanics:** Necessity of statistical mechanics, Maxwell-Boltzman, Bose-Einstein and Fermi-Dirac distribution formula	12

Module 2	**Optics** Huygen's principle, Interference of light, Young's double-slit experiment, Newton's ring; Diffraction: Fresnel and Fraunhofer class, Fresnel's half-period zones, zone plate, Fraunhofer diffraction due to single slit and plane transmission grating (elementary theory); Polarization: plane, circular and elliptically polarized light, Brewster's law, Polaroid, optical activity. Coherence length and time; Einstein's A and B coefficients; spontaneous and induced emissions, condition for laser action, population inversion, He-Ne laser Optical Fiber, core and cladding; total internal reflection; optical fiber and waveguide; communication through optical fiber, energy loss, attenuation and dispersion	6
Module 3	**Electrostatics & Electricity** Coulomb's law, intensity and potential of point charge, Gauss's theorem and simple applications, electric-dipole, Electric displacement, capacitor, parallel plates and cylindrical. Thermoelectricity, Magnetic effects of currents, Self-inductance, Mutual inductance, Transformer Electric circuit elements and AC, DC circuit analysis.	6
Module 4	**Solid State Physics** Crystalline nature of solid, diffraction of X-ray, Bragg's law, Mosley's law, explanation from Bohr's theory, Origin of the energy gap, band theory; metal, semiconductor and insulators; intrinsic and extrinsic semiconductors, dia, para and ferro magnetic materials, superconductivity	6
Module 5	**Nuclear Physics** Binding energy of nucleus, Binding energy curve and stability, Radioactivity, successive disintegration, radioactive equilibrium, radioactive dating, radioisotope and their uses, Nuclear transmutation, fission & fusion, nuclear reactor	6

Text Book:

ESC	CENUGES01	Engineering Graphics & Design	0L-1T-3P	2.5 Credits

Course Outcomes:

Module	Content	Lecture
Module 1	**Introduction to Engineering Graphics:** Drawing instruments and accessories, BIS – SP 46. Use of plane scales, Diagonal Scales and Representative Fraction. **Engineering Curves:** Classification and application of Engineering Curves, Construction of Conics, Cycloid Curves, Involutes and Spirals along with normal and tangent to each curve.	30
Module 2	**Projections of Points and Lines:** Introduction to principal planes of projections, Projections of the points located in same quadrant and different quadrants, Projections of line with its inclination to one reference plane and with two reference planes. True length and inclination with the reference planes. **Projections of Planes:** Projections of planes (polygons, circle and ellipse) with its inclination to one reference plane and with two reference planes, Concept of auxiliary plane method for projections of the plane	30
Module 3	**Projections of Solids and Section of Solids:** Classification of solids. Projections of solids (Cylinder, Cone, Pyramid and Prism) along with frustum with its inclination to one reference plane and with two reference planes. Section of such solids and the true shape of the section	20
Module 4	**Drawing practice:** Drawing practise using software like AUTO CAD	20

Reference Books:

1. A Text Book of Engineering Graphics by P.J.Shah S.Chand & Company Ltd., New Delhi.
2. Elementary Engineering Drawing by N.D.Bhatt Charotar Publishing House, Anand.
3. A text book of Engineering Drawing by R.K.Dhawan, S.Chand & Company Ltd., New Delhi.

ESC	ECEUGES02	Basic Electronics Engineering Lab (for CEN,MEN & CSE)	0L-0T-3P	1.5 Credits

Course Outcomes:

Module	Content	Lecture
Module 1	Familiarization of Electrical and Electronics Components	3
Module 2	Familiarization of Various Instruments like Power Supply, Digital Multimeter, Function	3
Module 3	Generator, CRO etc.	3
Module 4	Study of Junction Diode Characteristics	3
Module 5	Study of Zener Diode Characteristics	3
Module 6	Study of Clipping Circuits	3
Module 7	Study of Clamping Circuits	3
Module 8	Study of Rectifier Circuits	3
Module 9	Study of BJT Characteristics	3
Module 10	Study of FET Characteristics	3
Module 11	Study of fundamental characteristics of OP-AMP	3
Module 12	Determination of Slew rate and bandwidth of an OP-AMP.	3

BSC	PHYUGBS02	Engineering Physics Lab	0L-0T-3P	1.5 Credits

Course Outcomes:

Module	Content	Lecture
Module 1	Measurements of length (or diameter) using vernier scale, slide caliper, screw gauge and travelling microscope.	3
Module 2	Determination of the radius of curvature of a spherical surface by using spherometer.	3
Module 3	Determination of moment of inertia of (a) a cylinder and (b) a rectangular solid bar.	3

Module 4	To determine the focal length of a concave lens by combination method and hence to determine the refractive index of the material of the lens by measuring the radii of curvature of both lenses	**3**
Module 5	Determination of the average resistance per unit length of the meter bridge wire by Carey-Foster's method and hence to determine an unknown resistance	**3**
Module 6	Determination of the horizontal component of the earth's magnetic field and the magnetic moment of a magnet by employing magnetometers	**3**
Module 7	Determination of Young's Modulus of elasticity of a material of a bar by the method of flexure.	**3**
Module 8	Determination of rigidity modulus of a material of a wire by static method.	**3**
Module 9	Determination of rigidity modulus of a material of a wire by dynamic method.	**3**
Module 10	Determination of unknown frequency of a tuning fork by using a sonometer.	**3**

MC	**UCCUGAU01**	**Elementary Arabic & Islamic Studies**	**4L-0T-0P**	**0 Credits**

Course Outcomes:

SYLLABUS

TEXT BOOKS NOT MENTIONED

Semester II (First year)

ESC	CSEUGES01	Programming for Problem Solving	3L-0T-0P	3 Credits

Course outcomes:

Module	Content	Lecture
Module 1	**Introduction to computing:** block architecture of a computer, bit, bytes, memory, and representation of numbers in memory.	1
Module 2	**Introduction to problem solving:** Basic concepts of an algorithm, program design methods, flowcharts.	1
Module 3	**Introduction to C programming:** A Brief History of C, C is middle-level Language, is a Structured Language, Complier Vs Interpreters, The Form of a C Program, Library & Linking, Compilation & Execution process of C Program . [2]	2
Module 4	**Variables, Data Types, Operator & Expression:** Character Set, Token, Identifier & Keyword, Constant, Integer, Floating Point, Character, String, Enumeration, Data Types in C, Data Declaration & Definition Operator & Expression, Arithmetic, Relational, Logical, Increment & Decrement, Bit wise, Assignment, Conditional, Precedence & Associability of Operators.	3
Module 5	**Console I/O:** ntroduction, Character input & Output, String Input & Output, Formatted Input/Output (scanf/printf), sprintf & sscanf.	2
Module 6	**Control Statement:** Introduction, Selection Statements, Nested if, if-else-if, The "?" Alternative, The Conditional Expression, switch, Nested switch, Iteration Statements, for loop, while loop, do-while loop, Jump Statements, Goto & label, break & continue, exit() function.	4
Module 7	**Array & String:** Single Dimension Arrays, Accessing array elements, Initializing an array, Multidimensional Arrays, Initializing the arrays, Memory Representation, Accessing array elements, String Manipulation Functions, searching, sorting an array.	6
Module 8	**Function:** Introduction, advantages of modular design, prototype declaration, Arguments & local variables, Returning Function Results by reference & Call by value, passing arrays to a function, Recursion.	4

Module 9	**Storage Class & Scope:** Meaning of Terms, Scope - Block scope & file scope, Storage Classes Automatic Storage, Extern Storage, Static, Storage, Register Storage.	**2**
Module 10	**Pointers:** Introduction, Memory Organization, The basics of Pointer, The Pointer operator Application of Pointer, Pointer Expression, Declaration of Pointer, Initializing Pointer, De-referencing Pointer,Void Pointer, Pointer Arithmetic, Precedence of &, * operators Pointer to Pointer, Constant Pointer, Dynamic memory allocation, passing pointer to a function, array of pointers, accessing arrays using pointers, handling strings using pointers.	**4**
Module 11	**Structure, Union, Enumeration & typedef:** Structures, Declaration and Initializing Structure, Accessing Structure members, Structure, Assignments, Arrays of Structure, Passing, Structure to function, Structure Pointer, Unions.	**2**
Module 12	**C Preprocessor:** Introduction, Preprocessor Directive, Macro Substitution, File Inclusion directive, Conditional Compilation.	**2**
Module 13	**File handling:** Introduction, File Pointer, Defining & Opening a File, Closing a File, Input/Output Operations on Files, Operations on Text mode files and binary mode files, Error Handling During I/O Operation, Random Access To Files, Command Line Arguments	**3**

Suggested Books:

1. B.S. Gottfried: Programming in C; TMH.
2. B.W. Kernighan and D.M. Ritchie: The C Programming Language; PHI.
3. H. Schildt: C++: The Complete Reference; TMH, 4e.
4. B. Stroustrup: The C++ Programming Language; Addison-Wesley.
5. E. Balagurusamy: Programming in ANSI C; TMH.
6. Yashwant Kanetkar: Let Us C; BPB Publications.
7. K. N. King: C Programming: A Modern Approach, W. W. Norton and Company. Pradip Dey and Manas Ghosh: Programming in C, Oxford University Press

ESC	EENUGES01	Basic Electrical Engineering	3L-0T-OP	3Credits

Course outcomes:

Module	Content	Lecture
Module 1	**Introduction:** Basic concepts of Electrostatics and Electromagnetic.	4
Module 2	**DC Circuit**: Introduction of Electric Circuit & Elements, Loop Analysis, Node analysis, Star (Y) - Delta (Δ) & Delta (Δ)-Star (Y) Transformations.	6
Module 3	**DC Network Theorem**: Superposition Theorem, Thevenin's theorem, Norton's theorems, Maximum Power Transfer Theorem, Reciprocity Theorem, Time-domain analysis of first-order RL and RC circuits.	8
Module 4	**Single-phase AC Circuits** Generation of Sinusoidal Voltage Waveform (AC) and Some Fundamental Concepts, Representation of Sinusoidal Signal by a Phasor, Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.	8
Module 5	**Transformer:** Definition, working principle & construction, EMF equation, Equivalent circuit, Open circuit & Short circuit tests, Efficiency & Regulation.	4
Module 6	**DC Machines**: Constructional Features of D.C Machines , Principle of Operation of D.C Machines, EMF & Torque Equation , D.C Generators, D.C Motors, Losses, Efficiency, 3-point Starter and speed control of DC shunt Motor.	4
Module 7	**Three-phase Induction Motor**: Introduction to 3-phase induction motor	1
Module 8	**Introduction to Power System:** Basic concepts of Power System	1

Text book:

BSC	**MATUGBS02**	**Engineering Mathematics II**	**4L-0T-0P**	**4 Credits**

Course Objective:

Module	Content	Lecture
Module 1	Matrices: Matrix operations (Addition, Multiplication, Transpose), invertible matrix.	**4**
Module 2	Determinant and their properties.	**2**
Module 3	Row reduced echelon form; Rank of a matrix. Solution of the matrix equation Ax = b; Cramer's rule. Eigenvalues and eigenvectors, characteristic polynomial of a matrix, Cayley–Hamilton theorem and its application. Linear dependence and independence of vectors, basis and dimension. Complex numbers and Complex integrals. Inequalities, Theory of equations.	**32**
Module 4	Complex numbers and Complex integrals. Inequalities, Theory of equations.	**18**
Module 5	Differential equation of first order and first degree: Exact, separable and homogeneous differential equations, Bernoulli's equation, ODEs of first order but not of first degree; Clairaut's equation.	**7**
Module 6	Higher order linear equation with constant coefficients: Complementary function, Particular integral, Symbolic Operator D.	**4**
Module 7	Method of undetermined coefficients, Euler's homogeneous equation and deduction to an equation of constant coefficients.	**4**
Module 8	Second order linear equation with variable coefficients: exact equation: reduction of order; variation of parameters; reduction to normal form; change of independent variables. Simple eigenvalue problems.	**4**

Module 9	System of linear differential equations with constant coefficients.	2

References:

1. Advanced Engineering Mathematics : Erwin Kreyszig
2. Advanced Engineering Mathematics : R.K. Jain & S. R. K Iyengar
3. Advanced Engineering Mathematics : C. R. Wylle & L. C. Barrett
4. Differential & Integral Calculus : N. Plskunov

BSC	**CHMUGBS01**	**Engineering Chemistry**	**3L-0T-0P**	**3Credits**

Course Outcomes:

Module	Content	Lecture
Module 1	**Thermodynamics :** Importance and scope, definitions of system and surroundings; type of systems; Extensive and intensive properties; Steady state and equilibrium; Zeroth law of thermodynamics; First law of thermodynamics, internal energy and Enthalpy as a state function; Second law of thermodynamics; Kelvin, Planck and Clausius statements; Carnot cycle and refrigerator; Carnot's theorem; Physical concept of entropy.	
Module 2	**Water and its treatment :** Sources of water, Impurities in water, Hardness of water, Determination of hardness of water, Water quality parameter, Treatment of water for domestic purpose, Waste water.	
Module 3	**Polymers :** Terminology, Classification of polymers, Polymerization techniques, Molecular weight of polymers, Plastics, Rubbers, Fibers, Conducting and semiconducting polymers, Natural polymers.	
Module 4	**Green Chemistry :** Definition and concept of green chemistry, Emergence of green chemistry, Alternative solvents, Design of safer chemicals, Microwave radiation of green synthesis, Green laboratory Technology.	

Books referred

1. K. S. Maheswaramma and M. Chugh, Engineering Chemsitry, Pearson, 2016.

2. Wiley Engineering Chemistry, Wiley, 2nd Edn., 2014.

HSMC	ENGUGHU01	Communicative English	3L-0T-0P	3Credits

Objectives of the Course: To impart basic Communication skills to the first year UG students in the English language through rigorous practice and use of various categories of common words and their application in sentences; to enable them to achieve effective language proficiency for their social, professional & inter personal communication both in speaking & writing.

Module	Content	Lecture
Module 1	**Fundamentals of Communication:** Communication: Meaning, Nature, Process, Importance and Function of Communication; Levels of Communication: Intra-personal, Interpersonal, Organizational, Mass Communications; The Flow of Communication: Downward, Upward, Lateral or Horizontal, Diagonal, Grapevine Communication; Network in an Organization; Principles for Effective Communication; Verbal and Non-Verbal Communication; Barriers to Communication, Gateways to Communication.	
Module 2	**Listening and Speaking Skills:** The Process of Listening; Barriers to Listening; Types of Listening: Active and Passive Listening; Methods for improving listening skills, Benefits of Effective Listening. Presentation Strategies: Defining Purpose; Organizing Contents; Preparing Outline; Audio-visual Aids; Nuances of Delivery; Body Language; Dimensions of Speech – Accent, Pitch, Rhythm, Intonation, Strong and Weak Forms, Connected Speech- Assimilation and Elision, Paralinguistic Features of Voice; Articulation of Speech Sounds- Vowels and Consonants; Spelling and Pronunciation; Problems of Indian speakers of English and their remedial measures.	
Module 3	**Reading and Writing Skills :** **Reading Skills:** Purpose, Process, Methodologies, and Strategies; Special Reading Situations – Skimming and Scanning, Intensive and Extensive Reading, Critical Reading, Drawing Inferences, Reading Technical Reports, etc. **Writing Skills:** Words and Phrases: Word Formation, Synonyms and Antonyms, Homophones, One Word Substitutes, Words Often Confused, Word Choice - Right Words, Appropriate Words, Idioms and Phrases; Correct Usage: Parts of Speech, Modals, Concord, Articles, Infinitives, Requisites of Sentence Construction. Elements of Effective Writing, Main Forms of Written	

	Communication: Paragraph - Techniques and Methods (Inductive, Deductive, Linear, Spatial, Chronological etc.), The Art of Condensation- various types (Précis, Summary and Abstract, etc.), Description, Agenda, Minutes, Notices, Circulars, Memo, Advertisements, Drafting an E-mail, Press Release.	
Module 4	Business Communication: Business Letters: Principles; Sales & Credit letters; Claim and Adjustment Letters; Job application and Résumés. Reports: Types; Significance; Structure, Style & Writing of Reports. Technical Proposal; Parts; Types; Writing of Proposal. Negotiation & Business Presentation skills.	

Suggested Readings:.

1. Sethi, J & et al. *A Practice Course in English Pronunciation*, Prentice Hall of India, New Delhi.
2. Berry Cicely: *Your Voice and How to Use it Successfully*, George Harp & Co. Ltd, London
3. Bansal, R.K. and J.B. Harrison. *Spoken English*, Orient Longman.
4. Hornby's, A.S. *Oxford Advanced Learners Dictionary of Current English*, 7th Edition.
5. Pillai, Sabina & Agna Fernandez: *Soft Skills & Employability Skills.* Cambridge Univ. Press.
6. Sudharshana, N.P. & C. Savitha: *English for Technical Communication*, Cambridge Univ. Press.
7. Raman, Meenakshi & Sangeeta Sharma: *Technical Communication: Principles and Practice.* Oxford Univ. Press.
8. Prasad, P. *The Functional Aspects of Communication Skills*, Delhi.
9. McCarthy, Michael. *English Vocabulary in Use*, Cambridge University Press, Cambridge.
10. Leech, G & Svartvik, J. *A Communicative Grammar of English.* Pearson Education. New Delhi.
11. Narayanaswamy V.R. *Strengthen your Writing.* Orient Longman, London.
12. Dean, Michael. *Write it*, Cambridge University Press, Cambridge.
13. Sen, Leena. *Communication Skills*, Prentice Hall of India, New Delhi. Bown, G. *Listening and Spoken*

English , Longman, London

ESC	CSEUGES02	Programming for Problem Solving Lab	0L-0T-4P	2 Credits

Course Outcomes:

Module	Content	Lecture
Module 1	Primary goal of this course is to make acquaint the students to know the programming language and also to know how 'C' can be used to write serious program to solve the problems. Programs will be based on the theoretical paper and to cover the concept of basic arithmetic operations, control statements, functions, recursions, arrays, strings, pointers, structures, unions, file handling etc.	

Suggested Books:

1. B.S. Gottfried: Programming in C; TMH.
2. B.W. Kernighan and D.M. Ritchie: The C Programming Language; PHI.
3. H. Schildt: C++: The Complete Reference; TMH, 4e.
4. B. Stroustrup: The C++ Programming Language; Addison-Wesley.
5. E. Balagurusamy: Programming in ANSI C; TMH.
6. Yashwant Kanetkar: Let Us C; BPB Publications.
7. K. N. King: C Programming: A Modern Approach, W. W. Norton and Company.
8. Pradip Dey and Manas Ghosh: Programming in C, Oxford University Press

ESC	EENUGES01	Basic Electrical Engineering Lab (CSE,CEN & MEN)	3L-0T-0P	3 Credits

Course Outcomes:

Module	Content	Practical
Module 1	Verification of Thevenin's Theorem	**3**
Module 2	Verification of Norton's Theorem	**3**
Module 3	Verification of Superposition Theorem	**3**
Module 4	Power Measurement of Fluorescent Lamp	**3**
Module 5	V-I characteristics of Incandescent Lamp	**3**
Module 6	Speed Control of DC motor Using Field and Armature Control	**3**

	Method	
Module 7	Starting and reversing of DC motor	**3**
Module 8	Open circuit and Short circuit test of Single Phase Transformer	**3**
Module 9	Calibration of Voltmeter and Ammeter	**3**
Module 10	Characteristics of Series R-L-C Circuit	**3**
Module 11	Characteristics of Parallel R-L-C Circuit	**3**
Module 12	Resistance measurement and continuity test of DC motor using Megger	**3**

ESC	MENUGES02	Workshop Practice	0L-1T-2P	2 Credits

Module	Content	Lecture
Module 1	Introduction to various hand tools e.g. allen keys, spanners, punch, files, hacksaw, hammers, chisels, vices, marking block, angle plates, etc.	
Module 2	Introduction to basic instruments: Vernier Caliper, Micrometer, Tri-square, Surface Plate, Height Gauge, Vernier Bevel Protractor, Screw Pitch Gauge, Radius Gauge, etc.	
Module 3	Demonstration on different machines and Equipments: Lathe, Milling, Drilling, Shaping, Radial Drilling, Grinding, Welding, Power Saw, Power Press, Planer Machine, Microscope, Profile Projector, etc.	
Module 4	Practical Exercises: Exercises involving the following operations: measuring and marking, sawing, chipping, filing, maintaining of perpendicularity of all surfaces by filing, making of taper surface by filing, making of curved surface by filing, plain turning, step turning and drilling.	

Reference books

1. Hazra Choudhury & Hazra Choudhury – Elements of Workshop Technology, Vol. I & II – Media Promoters and Publishers Pvt. Ltd.
2. Rajender Singh - Introduction to Basic Manufacturing Process and Workshop Technology, New Age International.

BSC	CHMUGBS02	Engineering Chemistry Lab	0L-0T-3P	1.5 Credits

Course Outcomes:

Module	Content	Lecture
Module 1	Acidimetric estimation of Sodium Carbonate and Sodium bi-Carbonate in their mixture.	**3**
Module 2	Estimation of Total Hardness of water by Complexometric method	**3**
Module 3	Estimation of Fe^{II} in Mohr's Salt by Permanganometric Titration.	**3**
Module 4	Qualitative analysis of single solid organic compounds.	**3**

HSMC	ENGUGHU02	Language Lab	0L-0T-2P	1 Credits

Course outcomes:

Objectives of the Course: To impart basic Communication skills to the first year UG students in the English language through rigorous practice and use of various categories of common words and their application in sentences; to enable them to achieve effective language proficiency for their social, professional & inter personal communication both in speaking & writing; to improve their English pronunciation

Module	Content	Lecture
Module 1	Group Discussion: Practical based on Accurate and Correct Grammatical Patterns.	
Module 2	Conversational Skills under suitable Professional Communication Lab conditions with emphasis on Kinesics: Interview, Greeting and Introducing, Leave taking, Asking Questions and Giving Replies, Inviting Friends and Colleagues, Negotiating, Persuading, Taking Initiatives, Praising and Complementing People, Expressing Sympathy, Seeking and Giving Permission, Complaining and Apologizing, Official/Public Speaking, Telephoning etc.	
Module 3	Communication Skills for Seminars/Conferences/Workshops with emphasis on Paralinguistic/ Kinesics.	
Module 4	Presentation Skills for Technical Paper/Research Paper/Project Reports/ Professional Reports based on proper Stress and Intonation Mechanics	
Module 5	Extempore, Argumentative Skills, Role Play Presentation with Stress and Intonation.	

Module 6	Comprehension Skills based on Reading and Listening Practical on a model Audio-Visual Usage.	

Reference Books

1. Bansal R.K. & Harrison: *Phonetics in English*, Orient Longman, New Delhi.
2. Sethi & Dhamija: *A Course in Phonetics and Spoken English*, Prentice Hall, New Delhi.
3. Pandey, L.U.B. & R.P.Singh: *A Manual of Practical Communication*, A.I.T.B.S. Pub. India Ltd. Krishan Nagar, Delhi.
4. Joans, Daniel, *Cambridge English Pronouncing Dictionary*, Cambridge Univ. Press.
5. Sudharshana, N.P. & C. Savitha: *English for Technical Communication*, Cambridge Univ. Press.

Semester III (Second year]
Branch/Course: Mechanical Engineering

MATUGBS03	**Mathematics III**	**3L:1T:0P**	**4 credits**

Objectives:

1. To enable the students to apply the knowledge of Mathematics in various engineering fields by making them to understand the method of solving algebraic, transcendental equations .
2. To determine the approximate value of the derivative & definite integral for a given data using numerical techniques.
3. Able to expand the given periodic function defined in the given range in terms of sine and cosine multiple of terms as a Fourier series.
4. Able to extremise the functional using integration technique.
5. Able to form and solve the partial differential equation using different analytical techniques.

Module-1

Numerical Analysis: Bisection Method, Newton-Raphson method.Finite differences, forward and backward difference operators (no derivations on relations between operators) Newton-Gregory forward and backward interpolation formulae. (Without proof), Lagrange's and Newton's divided difference interpolation formulae (without proof) Numerical differentiation using Newton's forward and backward formulae-problems.

Numerical solutions of first order ODE: Taylors Series Method, Euler's and Modified Euler's method, Runge-Kutta 4th order method, Milne's predictor and corrector method (problems only).

13Hours

Module-2

Numerical integration: Trapezoidal rule, Simpson's one third rule, Simpson's three eighth rule and Weddle's rule (no derivation of any formulae)-problems.

Fourier series: Periodic functions, Conditions for Fourier series expansions, Fourier series expansion of continuous and functions having finite number of discontinuities, even and odd functions. Halfrange series, practical harmonic analysis.

13Hours

Module-3

Fourier transforms: Infinite Fourier transforms and inverse Fourier transforms simple properties, complex Fourier transform, Fourier sine and Fourier cosine transforms, Inverse Fourier sine and cosine transforms.

Calculus of Variations Variation of a function and a functional, extremal of a functional, variational problems, Euler's equation, standard variational problems including geodesics, minimal surface of revolution, hanging chain and Brachistochrone problems.

13Hours

Module-4

Partial Differential Equations Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions, Solution of equation of the type: $Pp + Qq = R$, Charpit's method. Solution of PDEs by the method of separation of variables. Derivation of one-dimensional heat and wave equations.

9Hours

Course outcomes:

On completion of this course, students are able

1. To know how root finding techniques can be used to solve practical engineering problems.
2. To apply the concept of numerical analysis to find the relative strengths and weaknesses of each computation method and know which are most applicable for given problem.
3. To apply the analytical technique to express periodic function as a Fourier sine and cosine series.
4. To apply partial differential techniques to solve the physical engineering problems.
5. To implement integration technique to determine the extreme values of a functional.

References:

1. Numerical Methods for Engineers by Steven C Chapra &Raymond P Canale.
2. Higher Engineering Mathematics by Dr. B.S. Grewal, Khanna Publishers, New Delhi.
3. Advanced Engineering Mathematics By H. K. Das, S. Chand & company Ltd. Ram Nagar, New Delhi.
4. Advanced Engineering Mathematics by E Kreyszig (John Wiley & Sons).

MENUGES03	Material Engineering	3L: 1 T: 0 P: 0	3 credits

Objectives:

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

Contents:

Module-1: Introduction to Engineering Materials: Types & Applications; Material Selection criteria.

02 Hours

Module-2: Material Testing: True stress and Engineering stress; Tensile, compressive, impact testing processes. Theory of mechanical failure: Fracture, fatigue, creep.

04 Hours

Module-3: Crystal Structure: Unit cells, 14 Bravais Lattices, packing efficiency and coordination number; Crystal Imperfection: Dislocations.

06 Hours

Module-4: Theory of plastic deformation, Mechanical testing of metallic materials; Strengthening Mechanisms. Recovery, Recrystallization, Grain Growth, Grain Size Measurement, Hall-Petch Equation.

06 Hours

Module-5: Phase Transformation: Theory of solidification, Solidification time, Nucleation and growth; Zone refining.

04 Hours

Module-6: Phase rule, Binary phase diagram, Eutectic system, iron-carbon system, T-T-T diagram, C-C-T diagram

10 Hours

Module-7: Introduction to Heat Treatment: Annealing, Normalising, Hardening, Case Hardening

Alloying in steel, Effects of alloying elements.

04 Hours

Course Outcomes:
Student will be

1. able to identify crystal structures for various materials and understand the defects in such structures
2. Understand how to tailor material properties of ferrous and non-ferrous alloys
3. How to quantify mechanical integrity and failure in materials

TEXT BOOKS: 1. Introduction to Engineering Materials by B.K.Agarwal, TMH.
2. Elements of Material Science & Engineering, Van Black, Pearson Education

REFERENCES : 1. Material Science and Engineering by V.Raghavan, Prentice Hall.
2. Mechanical Metallurgy by G.E.Dieter, McGrawhill.
3. Physical Metallurgy Principles by R.E.Reedhill, East-West Publishers.
4. Principles of Materials Science by W.F.Smith, 3rd ed., McGrawhill.
5. Steel and its Heat Treatment by K.E.Theling, Butterworth.

6. Material Science by J. C. Anderson, K. D. Leaver, R. D. Rawlings and J. M. Alexander, Chapman Hall, 4th Ed., 1992.
7 .Material Science,Palanisamy,Scitech

MENUGPC01	**Strength of Materials**	**3L:1T:0P**	**4 credits**

Objectives:

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

Contents:

Module: 1

Stress & Strain:

Definitions of stress and strain - Linear stress-strain laws - deformation of axially loaded members - statically indeterminate problems - elastic constants & their relationships - Bi-axial stress system – Generalized stress system - principle stresses & strains and principal- planes, Mohr's circle of stresses. **[10 Hours]**

Module: 2

Shear Force & Bending Moments Analysis:

Shear Force & Bending Moments: Definitions, SF & BM diagrams for cantilevers - simply supported beams with or without over-hang and calculation of maximum BM & SF - the point of contra-flexure under concentrated loads and uniformly distributed loads over whole span or a part of it - combination of concentrated loads and uniformly distributed loads - uniformly varying loads - application of moments. **[10 Hours]**

Module: 3

Torsion:

Torsion of circular Members - Torsion of thin circular tube - Solid and hollow circular shafts, tapered shaft, stepped shaft & composite circular shafts - combined bending and torsion - equivalent torque. **[4 Hours]**

Module: 4

Stresses in Beams:

Bending & shear Stresses in Beams - Bending stresses in beams with derivation & application to beams of circular, rectangular, I,T and channel sections - composite beams - shear stresses in beams with derivation combined bending torsion & axial loading of beams. **[8 Hours]**

Module: 5

Deflection of beams:

Relationship between bending moment, slope & deflection - method of integration - Macaulay's method - calculations for slope and deflection of cantilevers and simply supported beams with or without overhang under concentrated load - Uniformly distributed loads or combination of concentrated and uniformly distributed loads. **[8 Hours]**

Module: 6

Thin and Thick Cylinders:

Circumferential and longitudinal stresses in thin cylindrical shells and thin spherical shell under internal pressure - Stresses in thick and compound cylinders.

Column and Strut:

Column under axial load - concept of instability and buckling - slenderness ratio - derivation of Euler's formulae for the elastic buckling load – Euler's, Rankine, Gordom's formulae.

[8 Hours]

Course Outcomes:

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

Text Books:-

1. Mechanics of Materials – Beer F.P. and Johnston R., McGraw-Hill Education Pvt. Ltd.
2. Elements of Strength of Materials –Timoshenko S.P. and Young, EWP.

Reference Books:-

1. Engineering Mechanics of Solids – Popov E.P., Prentice Hall of India.
2. Strength of Materials – Dr. Sadhu Singh, Khanna Publishers.
3. Strength of Materials – Ryder G.H., McMillan India.
4. Strength of Materials – Pytel A. and Singer I.L., Addison-Wesley Longman.
5. Strength of Materials – Nag and Chandra, Wiley India.
6. Strength of Materials – Jindal, Pearson Education.
7. Strength of Materials – R. Subramanian, Oxford University Press, 2007.

MENUGPC02	**Fluid Mechanics**	**3L:1T:0P**	**4 credits**

Objective : In this unit student will be exposed to the basic laws of fluids, flow patterns.The students completing this course are expected to understand the properties of fluids, its kinematic and dynamic behavior through various laws of fluids like continuity, Euler's, Bernoulli's equations, energy and momentum equations and it's applications. The students shall be able to expose viscous flow through ducts and their corresponding problems. Further, the student shall be able to understand the theory of boundary layer and dimensional analysis.

Contents:

Module 1:

Fluid properties: Definition of fluid, Newton's law of viscosity, Units and dimensions – properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility

and surface tension.

(2 hrs)

Fluid statics: pressure at a point, Pascal's law, forces on plane and curved surfaces, buoyant forces and stability of submerged and floating bodies.

(5 hrs)

Fluid Kinematics: preliminaries of Eulerian and Lagrangian description of fluid flow; velocity and acceleration of fluid particles in rectilinear and curvilinear co-ordinates; different types of flow-steady and unsteady flow, uniform and non-uniform flow,, rotational and ir-rotational flow; stream line, streak line, path line & stream tube; velocity potential, linear and angular deformation and rotation; vortex motion

(9 hrs)

Module 2:

Fluid dynamics: principle of conservation of linear momentum, Euler's equation of motion along a stream line and for unsteady 3D flow; derivation of Bernoulli's equation and physical significance of different terms; application of Bernoulli's equation in flow measurement; Differential governing equation: Continuity equation, Navier- Stokes equation, Flow between parallel infine fixed plates, Couette flow, laminar flow through pipe-Hagen Poiseuille equation, turbulent flows in pipe

(11 hrs)

Characteristics of Laminar and Turbulent Flow: Reynolds experiment, critical Reynolds number, Darcy Weisbach equation, friction factor, Moody's diagram, minor losses in pipes, Pipe networks-Hardy Cross Method.

(7hrs)

Module 3:

Concept of boundary layer, measures of boundary layer thickness, momentum thickness and energy thickness. Prandtl boundary layer equation. Flow over flat plate, Von Karman momentum integral equation for a boundary layer

(6hrs)

Dimensional Analysis and Similitude: Buckingham π - theorem and its applications, Similitude: Geometric, Kinematics and Dynamic similarity; dimensionless numbers Reynolds, Froude, Euler, Mach, Weber Number.

(7hrs)

Course Outcomes:

1. Knowledge of basic principles of fluid mechanics.
2. Knowledge of properties of fluids, its kinematic and dynamic behavior through various laws of fluids like continuity,Euler's, Bernoulli's equations, energy and momentum equations and it's applications.
3. Ability to analyze fluid flow problems with the application of the momentum and energy equations.
4. Ability to analyse viscous flow through ducts and their corresponding problems.
5. Ability to analyse different types of losses.
6. Ability to solve the problems on the theory of boundary layer and dimensional analysis.

Book:

1. Munson, B.R., Okiishi, T.H., Huebsch, W.W. and Rothmayer, A.P., 2013. Fluid mechanics. Singapore: Wiley.

2. Introduction to Fluid Mechanics, F.M.White,McGraw Hill

3.Fluid Mechanics, Cengel and Cimbala, McGraw Hill

4. Introduction to Fluid Mechanics and Fluid Machines by SK Som, G Biswas and S.Chakraorty, TMH

5.Fundamentals of Fluids by I.G.Currie Publisher Marcel Dekker

6 Fluid Mechanics and Machinery, M.K. Khan, Oxford University press

MENUGPC03	**Thermodynamics**	**3L:1T:0P**	**4 credits**

Objectives:

1. To learn about work and heat interactions, and balance of energy between system and its surroundings.
2. To learn about application of 1st law to various energy conversion devices.
3. To evaluate the changes in properties of substances in various processes.
4. To understand 2nd law of thermodynamics and its utility.

Contents:

Module-1

Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work - Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work.

6 Hours

Module-2

Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy.

6Hours

Module-3

Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables and R134a tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart.

8Hours

Module-4

First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady, 1st law applications for system and control volume.

5Hours

Module-5

Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale.

7Hours

Module-6

Clausius inequality; Definition of entropy; Demonstration that entropy is a property; Evaluation of entropy for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Principle of increase of entropy; Illustration of processes in T-s coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles- Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis.

10Hours

Module-7

Thermodynamic cycles – Basic Rankine cycle; Basic Brayton cycle; Basic Vapour compression cycle and comparison with Carnot cycle.

6Hours

Course Outcomes:

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

Text Books:

1. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.

2. Fundamentals of Thermodynamics by Claus Borgnakke, Richard E. Sonntag, Wiley; Seventh edition
3. Engineering Thermodynamics by P. K Nag, McGraw Hill Education; Sixth edition.
4. Thermodynamics: An Engineering Approach (SIE) by Yunus A Cengel; Michael A Boles, McGraw Hill Education; Eighth edition

UCCUGAU03	**Indian Constitution**	**0L:0T:0P**	**0 credits**

Course outcomes:

Basic features and fundamental principles

The Constitution of India is the supreme law of India. Parliament of India can not make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of m"Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The historic revolutions in France, England,
America and
particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America. The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India's legacy of "diversity". It has been said that Indian constitution reflects ideals of its freedom movement; however, few critics have argued that it does not truly incorporate our own ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950. The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and it gradually made it "as one of the strongest court in the world".

Module	Content	Lecture
Module 1	Meaning of the constitution law and constitutionalism	
Module 2	Historical perspective of the Constitution of India	
Module 3	Salient features and characteristics of the Constitution of India	
Module 4	Scheme of the fundamental rights	
Module 5	The scheme of the Fundamental Duties and its legal status	

Module 6	The Directive Principles of State Policy – Its importance and implementation	
Module 7	. Federal structure and distribution of legislative and financial powers between the Union and the States	
Module 8	Parliamentary Form of Government in India – The constitution powers and status of the President of India	
Module 9	Amendment of the Constitutional Powers and Procedure	
Module 10	The historical perspectives of the constitutional amendments in India	
Module 11	Emergency Provisions : National Emergency, President Rule, Financial Emergency	
Module 12	Local Self Government – Constitutional Scheme in India	
Module 13	Scheme of the Fundamental Right to Equality	
Module 14	. Scheme of the Fundamental Right to certain Freedom under Article 19	
Module 15	Scope of the Right to Life and Personal Liberty under Article 21	

Open elective	**Will be offered by other departments**	**3L:0T:0P**	**3 credits**

MENUGPC04	**Mechanical Engineering Lab-I (Material Testing Laboratory)**	**0L:0T:3P**	**1.5 credits**

Objective:

The main objective of the material testing laboratory is to demonstrate the basic principles in the area of strength and mechanics of materials and structural analysis to the undergraduate students through a series of experiments. In this lab, students will have the opportunity to apply

loads to various materials under different equilibrium conditions. The student will perform tests on materials in tension, torsion, bending, and buckling. Also they have the opportunity to examine the deformation of metal specimens when a hardened steel ball is pressed into it under different normal loads and to determine how such indentations should be used to give an indication of the properties of the specimen. In this lab the experiments are performed to measure the properties of the materials such as impact strength, tensile strength, compressive strength, hardness, ductility etc.

Contents:

The list of experiments under material testing laboratory are given below:

1. To study the Universal Testing Machine (UTM) and perform the tensile test.
2. To study the Universal Testing Machine (UTM) and perform the compression test.
3. To study the Universal Testing Machine (UTM) and perform the bending test.
4. To study the Universal Testing Machine (UTM) and perform the shear test.
5. To study the Brinell and Rockwell Hardness Testing Machine and perform the Brinell and Rockwell Hardness test.
6. To study the Impact Testing Machine and perform the Impact tests like Izod and Charpy.
7. To study the Torsion Testing Machine and perform the Torsion Test.
8. To study the Deflection of Beam and perform the Beam deflection for different types of loading.
9. To study the Helical Spring and perform the compression test on it.
10. To study the Screw Jack and determine the M.A, V.R and Efficiency.

Outcome:

Upon completion of this lab student should be able to:

- ✓ Analyze and design structural members subjected to tension, compression, torsion, bending, shear and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials.
- ✓ Utilize appropriate materials in design considering engineering properties, sustainability, cost and weight.
- ✓ Perform engineering work in accordance with ethical and economic constraints related to the design of structures and machine parts.

Semester IV (Second year)
Branch/Course: Mechanical Engineering

MENUGPC05	**Applied Thermodynamics**	**3L:0T:0P**	**3 credits**

Objectives:

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

Contents:

Module-1

Introduction to solid, liquid and gaseous fuels– Stoichiometry, exhaust gas analysis- First law analysis of combustion reactions- Heat calculations using enthalpy tables- Adiabatic flame temperature- Chemical equilibrium and equilibrium composition calculations are using free energy.

4Hours

Module-2

Vapor power cycles Rankine cycle with superheat, reheat and regeneration, exergy analysis. Super-critical and ultra super-critical Rankine cycle

6Hours

Module-3

Gas power cycles, Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle,effect of reheat, regeneration and intercooling- Combined gas and vapor power cycles-Vapor compression refrigeration cycles, refrigerants and their properties.

8Hours

Module-4

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

6Hours

Module-5

Basics of compressible flow. Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow- Flow of steam and refrigerant through nozzle, super saturation- compressible flow in diffusers, efficiency of nozzle and diffuser.

8Hours

Module-6

Analysis of steam turbines, velocity and pressure compounding of steam turbines.

4Hours

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

Text Books:

1. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.
2. Eastop, T.D. and McConkey, A., 1986. *Applied thermodynamics*. Longman Group, London
3. Engineering Thermodynamics by P. K nag, McGraw Hill Education; Sixth edition.
4. Fundamentals of Thermodynamics by Claus Borgnakke, Richard E. Sonntag, Wiley; Seventh edition
5. Thermodynamics: An Engineering Approach (SIE) by Yunus A Cengel; Michael A Boles, McGraw Hill Education; Eighth edition
6. Power plant engineering by P.K Nag. McGraw Hill Education; Fourth edition

MENUGPC06	**Manufacturing Processes-1**	**3L:0T:0P**	**3 credits**

Objectives:

1. This course provides an introductory study of manufacturing processes i.e. casting, forming and welding processes with which the students able to understand principles associated with basic operations involving the forming, machining and welding of engineering materials.
2. The student will be able to interpret the advantages and limitations of each process
3. The student can analyse the practical applications of a variety of forming and machining processes

Contents:

Module 1: Casting:

Introduction: Concept of Manufacturing process, its importance. Classification of Manufacturing processes. Introduction to Casting process & steps involved. Varieties of components produced by casting process. Advantages & Limitations of casting process.

1Hours

Patterns: Definition, functions, Materials used for pattern, various pattern allowances and their importance. Classification of patterns, BIS color coding of Patterns. Binder: Definition, Types of binder used in moulding sand. Additives: Need, Types of additives used and their properties.

3 Hours

Sand Mould. Moulding sand mixture ingredients for different sand mixtures. Method used for sand moulding, such as Green sand, dry sand and skin dried moulds. Cores: Definition, Need, Types. Method of making cores, Binders used, core sand moulding.

4 Hours

Melting of metals. Gases in metals. Concept of Gating & Risers for pouring. Design of Gating system. Solidification pattern. Fettling and cleaning of castings.

4 Hours

Melting furnaces. Casting defects: causes and remedies.

2 hours

Different casting Process: Shell Mould Casting, Centrifugal casting, Investment Casting, No bake Moulding, Flaskless Casting, Chemical Sand Moulding Processes, Sodium Silicate Moulding, Gravity Die casting, Low and High Pressure Die Casting, Special Casting Processes: Lost Wax, Ceramics Shell Moulding, Evaporative Pattern Casting, Vacuum Sealed Moulding, Squeeze Casting, Slush casting, Thixo-casting and Continuous Casting Processes.

4 Hours

Module 2: Forming:

Introduction of materials forming, stress-strain relationship, work of plastic deformation; yield criteria,

2 Hours

Mechanics of various Forming processes overview of various forming operations;

4 Hours

Sheet metal forming processes; advanced forming processes; different features of various types of metal forming dies; forming of plastics materials.

4 Hours

Module 3: Welding:

introduction to different fabrication processes. Welding process: Definition, Principles, Classification, Application, Advantages & limitations of welding. Oxy – Acetylene welding, Chemical Reaction in Gas welding, Flame characteristics.

2 Hours

Arc Welding: Heat energy sources and their characteristics, modes of Metal transfer in Arc Welding and Gas Metal Reaction, Welding fluxes and coating, weldability and welding of various metals and alloys.

2 Hours

Metal Arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG), Submerged Arc Welding (SAW) and various advanced Welding processes, metallurgical characteristics of welded joints; weld testing and inspection. Principles of soldering & brazing.

4 Hours

Course Outcomes:

With this subject of manufacturing processes involving casting, forming and welding, students now able to understand principles associated with basic operations involving the forming, machining and welding of engineering materials. Also, they can analyse the practical applications of a variety of forming and machining processes.

Text Books:

1. Ghosh & Mallik, Manufacturing Science
2. P.N. Rao - Manufacturing Technology – Foundry, Forming and Welding, TMH

BIOUGBS01	**Biology for Engineers**	**2L:0T:0P**	**2 credits**

Course Outcomes:

Module	Content	Lecture
Module 1	Diversity of Life-prokaryotes and eukaryotes, non chordates and chordates; Origin of life and Darwinian Evolution, Synthetic theory of evolution	5
Module 2	Cell and Cell theory, Cellular structure and function, central dogma of molecular Biology, Concept of Gene and Allele, Genetic disorder, Genetic code, Understanding inheritance patterns through pedigree	5
Module 3	Organismal physiology, Bioenergetics, Exothermic and endothermic vs. Exergonic and endergonic reaction (include Glycolysis, Krebs cycle and photosynthesis)	4
Module 4	Biomolecules, monomers and polymers, Nucleotides and DNA/RNA, Amino acids and proteins, carbohydrates and lipids, hierarchy of protein structure, structure function correlation , enzymes and their mode of action	5
Module 5	Immunology- Self vs. Non Self, pathogens, human immune system , antigen-antibody reactions, Vaccines, Nervous system- impulse transmission	4
Module 6	Biosafety, bioresources, Drug design principle	2
Module 7	Engineering designs inspired by examples in biology (compare eye and camera, bird flight and aircraft	3
Module 8	Engineering aspects of some Nobel Prizes in physiology and Medicine	2

MC	**UCCUGMC02**	**Environmental Science**	**2L-0T-0P**	**0 Credits**

Course Outcomes:

Module	Content	Lecture
Module 1	**Environmental Ecosystem** Definition, concept, structure and function, Flow of energy, Food chain and food web, Biogeochemical cycles, Carbon cycle, Nitrogen cycle, Phosphorous cycle, Sulphur cycle, Ecological pyramids, Ecological Succession	8
Module 2	**Biodiversity** Ecosystem Biodiversity, Species and Genetic Diversity, The value of biodiversity, Categories of threatened species, Reasons of biodiversity loss, Biodiversity conservation (In-situ and Ex-situ conservation), Biodiversity Hot spot, Biosphere reserve	6
Module 3	**Environmental Pollution** Definition, Sources, effects and control measures of air, water and noise pollution	4
Module 4	**Global Environmental Problems** Greenhouse effect, Global warming and Climate change, Ozone depletion, Acid rain	3
Module 5	**Sustainable Development** Concept of sustainable development, Objectives of sustainable development, Need for sustainable development, Renewable and Non-renewable sources of energy	3

MENUGPC07	Mechanism and Machines	3L:1T:0P	4credits

Objectives:

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

Detailed Syllabus:

Module: 1

Basics of Mechanisms:

Definitions – Link, Kinematic pair, Kinematic chain, Mechanism and Machine - Degrees of Freedom – Kinematic Inversions of four-bar chain and slider crank mechanism - Mechanical Advantage - Description of common Mechanisms - Offset slider mechanism as quick return mechanisms, Pantograph - Hooke's joint, Toggle mechanism. **[8 Hours]**

Module: 2

Kinematic Analysis:

Analysis of simple mechanisms (Single slider crank mechanism and four bar mechanism) - Graphical Methods for displacement, velocity and acceleration - Shaping machine mechanism– Corriolis acceleration – Klien's Construction - Analytical method of analysis of slider crank mechanism and four bar mechanism. **[8 Hours]**

Module: 3

Gear and Gear Trains:

Classification of gears – Gear tooth terminology - Fundamental Law of toothed gearing and involute gearing – Length of path of contact and contact ratio - Interference and undercutting - Gear trains – Simple, compound and Epicyclic gear trains – Differential Gears. **[6 Hours]**

Module: 4

Turning Moment and Flywheel:

Approximate analytical method for velocity and acceleration of a piston - Forces on the reciprocating parts of an engine neglecting the weight of the connecting rod - Turning moment diagram - Fluctuation of energy - Determination of maximum fluctuation of energy - Coefficient of fluctuation of energy & speed - Energy stored in a flywheel – Flywheel design - Flywheel in punching press. **[8 Hours]**

Module: 5

Belt Drives:

Open and crossed belt drives - velocity ratio - slip – Creep - material for belts - law of belting-length of belts - ratio of tensions - centrifugal tension - power transmitted by belts and ropes - initial tension.

Cam Analysis:

Types of cams and followers - various motions of the follower - Construction of Cam profiles - Analysis for velocities and accelerations of tangent and circular arc cams with roller and flat-faced followers. **[10 Hours]**

Module: 6

Mechanical Vibration Analysis:

Basic features of vibratory systems - Basic elements and lumping of parameters - Degrees of freedom - Single degree of freedom - Free vibration - Equations of motion - natural frequency - Types of Damping - Damped free vibration. **[8 Hours]**

Course Outcomes:

- ❖ After completing this course, the students can design various types of linkage mechanisms for obtaining specific motion and analyze them for optimal functioning
- ❖ The students will be able to know the mechanism and functioning of the different mechanical devices like gear, cam etc.
- ❖ Also the student will be able to gather the knowledge about vibrations

Text Books:-

1. Theory of Machine – Rattan S.S., Tata McGraw-Hill Publications.
2. Theory of Mechanisms and Machines – Ghosh A. and Mallik A.K., East West Press Pvt. Ltd.

Reference Books:-

1. Theory of Machines and Mechanisms – Shigley J.E. and John Joseph Uicker, McGraw-Hill Publications.
2. The Theory of Machine – Bevan T., CBS Publishers.
3. Theory of Machine – Ballaney P.L., Khanna Publishers.
4. Mechanism and Machine Theory – Rao J.S. and Dukkipati R.V., New Age International.
5. Theory of machines – Khurmi R.S., S. Chand & Company Ltd.
6. Mechanisms of Machines - CleghornW.L. , Oxford University Press, 2005.
7. Kinematics and Dynamics of Machinery - Robert L. Norton, Tata McGrawHill, 2009.

MENUGPC08	Fluid Machinery	3L:0T:0P	3 credits

Objective:

In this unit student will know the hydrodynamic forces acting on vanes and their performance evaluation and they will be able to draw velocity triangles at inlet and outlet of hydraulic turbines and pumps. At the end of this unit student will be aware of the importance, function and performance of hydro machinery. In this unit student will be in a position to evaluate the performance characteristics of hydraulic turbines and pumps. Also a little knowledge on hydraulic systems and fluidics is imparted to the student.

Module1:

Introduction: Classification of fluid machines: Positive displacement and rotodynamic machines, Impact of jet: stationary flat vertical plate, stationary flat inclined plate, stationary curved plate, moving flat plates, moving curved plate.

(6 hrs)

Module2:

Turbines: Classification of Hydraulic turbines- Impulse and reaction turbines, Heads and efficiencies, Pelton Turbine-Governing mechanism, velocity triangles and output power, Reaction turbine: Francis Turbine, Kaplan Turbine, Draft tube, Governing mechanism of reaction turbines, cavitation, Unit and Specific quantities, performance characteristics curves of turbines.

(14hrs)

Module 3:

Pumps: Classification of pumps, Centrifugal pump, pumping system and net head developed by a pump, slip, Cavitation, manometric efficiency, losses in centrifugal pumps, head- discharge and power-discharge characteristics of a centrifugal pump, NPSH. Reciprocating pump, slip, effect of piston acceleration, effect of friction, Air vessels, gear pump.

Axial flow pump. Matching of pump systems characteristics , pumps in series and parallel. Characteristics curves.

Fluid coupling, Crane, ram.

(20 hrs)

Course Outcomes

1. Ability to analysethe hydrodynamic forces acting on vanes and their performance evaluation.
2. Knowledge about velocity triangles at inlet and outlet of hydraulic turbines and pumps.
3. Ability to analyse the importance, function and performance of hydro machinery.
4. Ability to evaluate the performance characteristics of hydraulic turbines and pumps. Also a little knowledge on hydraulic systems and fluidics is imparted to the student.

Book

1. Douglas, J.F., Gasiorek, J. and Swaffield, J., 1986. Fluid mechanics, Addision-Wesley Longman. *Harlow, Essex, England.*
2. Introduction to Fluid Mechanics and Fluid Machines by SK Som, G Biswas, TMH
3. Fluid Mechanics and Hydraulics by JagdishLal, METROPOLITAN BOOK CO.PVT LTD.
4. Fluid Mechanics and Machinery by D. Rama Durgaiah, New Age International.

OEC 202	**Will be offered by other departments**	**3L:0T:0P**	**3 credits**

MENUGPC09	**Mechanical Engineering Lab-II (Fluid Mechanics and Machinery)**	**0L:0T:3P**	**1.5 credits**

Objective:

1) To compare the results of analytical models introduced in lecture to the actual behavior of real fluid flows.
2) To discuss and practice standard measurement techniques of fluid mechanics and their applications.
3) To learn and practice writing technical reports.

Contents:

1. Venturi and Orifice meter
2. Reynolds experiment
3. Verification of Bernoulli's equation
4. Pipe friction
5. Open channel flow
6. Performance test of centrifugal pump
7. Performance test of francis turbine
8. Pelton wheel

Course Outcomes:

Upon completion of this course, students will get practical knowledge about fluid flow problem and they will be able to apply their theoretical information

Semester V (Third year)
Branch/Course: Mechanical Engineering

MENUGPC10	**Heat Transfer**	**3L:1T:0P**	**4 credits**

Objectives:

1. The aim of the course is to build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.
2. Rigorous treatment of governing equations and solution procedures for the three modes will be provided, along with solution of practical problems using empirical correlations.
3. The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.
4.

Module1

Units, definitions, Basic modes of Heat transfer-conduction, convection and radiation

2Hours

Module2

Thermal conductivity and other relevant properties, Heat diffusion equations, boundary and initial conditions. One dimensional, steady state heat conduction without and with heat generation through plane slabs, cylinders and spheres, Concept of thermal resistance, Electrical analogy, Heat transfer through composite slabs, cylinders and spheres, contact resistance. Critical thickness of insulation for cylinder and sphere.

8Hours

Module 3:

Extended surface heat transfer, Steady state heat conduction through fins of uniform cross section, fin effectiveness and fin efficiency

4Hours

Module 5:

Transient conduction in solids with negligible internal temperature gradients (lumped parameter), Biot number and Fourier number. One dimensional transient conduction in slab and radial systems: exact and approximate solutions. Finite difference methods: explicit and implicit formulations.

6Hours

Module 6:

Flow over a body, velocity and thermal boundary layers, drag coefficient and heat transfer coefficient. Flow inside a duct; Hydrodynamics and thermal entry lengths; Fully developed and developing flow. Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow, Use of various correlations in forced convection heat transfer, flow over a flat plate, and flow across a single cylinder and tube bundles. Free convection heat transfer from vertical surface and vertical cylinder, horizontal surface and horizontal cylinders.

12Hours

Module 7:

Boiling and Condensation (3) Different regimes of boiling, mechanism of condensation, Nusselt's theory of film condensation on a vertical surface, use of correlations in solving film wise condensation on plane surfaces, horizontal tubes and tube banks.

4Hours

Module 8:

Definitions, concept of a black body, Kirchoff's law, Lambert's Cosine Law, Stefan- Boltzman's law, Plank's distribution law, Wein's displacement law, configuration factor. Radiation heat exchange between two parallel plates, radiation shielding, radiation heat exchange in an enclosure.

6Hours

Module 9:

Heat exchanger types, flow arrangements, overall heat transfer coefficient, foulingfactor, LMTD for parallel flow and counter flow heat exchangers. Effectiveness-NTU method, expression for effectiveness of a parallel flow and counter flow heat exchangers. Multi-pass and cross flow heat exchangers.

6Hours

Course Outcomes:

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

References:

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

MENUGPC11	**Machine design-I**	**3L: 1 T: 0 P: 0**	**3 credits**

Objective:

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

1. A strong background in mechanics of materials based failure criteria (static condition) under safety-critical design of machine components.
2. An understanding of the origins, nature and applicability of empirical design principles, based on safety considerations.
3. An overview of codes, standards and design guidelines for different elements.

Module: 1

Basic Procedure of Machine Design, Basic Requirement of Machine Elements for Design, Traditional Design Methods, Design Synthesis, Standards in Design, Selection of Preferred Sizes, Aesthetic and Ergonomics Considerations in Design, Concurrent Engineering.

2Hours

Mechanical Properties of Engineering Materials, Cast Iron, Heat Treatment of Steel, Case Hardening of Steels, Cast Steel, Alloys, Ceramics, Plastics, Plastics, Natural and Synthetic Rubbers, Creep, Selection of Materials.

3Hours

Selection of Manufacturing Methods, Hot and Cold Working of Metals, Design Consideration of Welded Assemblies, DFMA, Tolerances, Fits, Surface Roughness.

3Hours

Module: 2

Design Against Static Load, Modes of Failure, Factor of Safety, Maximum Principal Stress Theory, Maximum Share Stress Theory, Distortion-Energy Theory, Selection of Failure Theories, Fracture Mechanics, Residual Stresses.

8Hours

Module: 3

Power Screws, Types of Power Screw Threads, Multiple Threaded Screws, Torque Equations, Efficiency, Trapezoidal and ACME Threads, Collar Friction Torque, Overall Efficiency, Recirculating Ball Screw.

4Hours

Module: 4

Threaded Joints, Basic Types of Screw Fastening, Cap Screws, Set Screws, Bolt of Uniform Strength, Locking Methods of Threads, Metric Threads, Eccentrically Loaded Bolted Joints in Shear, Perpendicular to Axis of Bolt, and on Circular Base, Elastic Analysis of Bolted Joints, Gasket Joints.

6Hours

Riveted Joints, Types of Riveted Joints, Types of Failure, Strength Equations, Efficiency of Joint, Caulking and Fullering.

4Hours

Module: 5

Welded Joints, Strength of Butt Welds, Strength of Parallel and Transverse Fillet Welds, Maximum Shear Stress in Parallel and Transverse Fillet Welds, Axially Loaded Unsymmetrical Welded Joints, Eccentric Load in Plane of Welds, Welded Joint Subjected to Bending and Torsional Moment.

6Hours

Course Outcomes:

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

Text books:

1. Design of Machine Elements by V.B. Bhandari.
2. Shigley's Mechanical Engineering Design (S.I. Units) by R.G. Budynas and J.K. Nisbett.

REFERENCE BOOKS:

1. Machine Design by R.S. Khurmi and J.K. Gupta.
2. Machine Design: Fundamentals and Applications by P.C. Gope.

MENUGPC12	**Manufacturing processes-II**	**3L: 1 T: 0 P: 0**	**3 credits**

Objective:

Identify and define the necessity of "manufacturing and Machine Tools.
2. State the main purposes of characteristics of cutting geometry of various single and multi point cutting tools.
3. Study the mechanism of chip formation for machining various materials and sources of heat generation
4. Study the Concept of Generatrix and Directrix with different machining processes
5. Designing of SGB with various layout and other constructional features

Module 1:

Geometry of Cutting Tools: Tool nomenclature, geometry of single point cutting tool; geometry of multi point cutting tool-milling cutters, drills, conversion of tool angles, orthogonal and

oblique cutting.

(6 Hours)

Module 2:

Mechanism of Machining: Mechanism of chip formation for ductile and brittle materials, types of chips; mechanism of chip formation in drilling and milling, generation of cutting forces and their effects, analysis and estimation of cutting forces in turning, drilling, milling, Merchant's circle diagram, measurements of cutting forces, Tool force dynamometers, turning dynamometer, drilling dynamometer, milling dynamometer.

(6 Hours)

Module 3:

Heat Generation and Cutting Temperature: cause of heat generation in machining, effect of cutting temperature on job and cutting tool, estimation and control of cutting temperature.

(3 Hours)

Module 4:

Life of Cutting Tools: Cause of cutting tools failure, wear of cutting tools, tool life, cutting tool materials, estimation of machining time in turning, milling, drilling, shaping.

(3 Hours)

Module 5:

Machinability: Definition, control of chips and chip breakers, special techniques to improve machinability.

(3 Hours)

Module 6:

Machine Tools: Definition, major components of machine tools, general configurations of major machine tools, Concept of Generatrix and Directrix, examples of Generatrix and Directrix for for major machining processes, tool-work motions.

(3 Hours)

Module 7:

Machine Tool Power Drives: power sources of machine tools, types of power sources, estimation of power of machine tool drives.

(2 Hours)

Module 8:

Kinematic Structure of Machine Tools: Role of kinematic structure in machine tools, various forms of kinematic structures, various mechanisms used in machine tools, method of changing speed and feed in machine tools.

(3 Hours)

Module 9:

Speed Gear Box: Steps of designing of SGB, various layouts of spindle speeds of SGB, Ray Diagram, estimation of gear and shaft dimensions of SGB.

(3 Hours)

Module 10:

Specifications and Features of Conventional Machine Tools: Lathe, Drilling Machines, Shaping and Slotting machines, Milling Machines, Grinding Machines. Milling Indexing: Purpose of

indexing, simple, compound, differential and angular indexing with calculations
(4 Hours)

Course Outcomes:

1. The graduate students will be able to understand the various geometries of single and multi point cutting tools with various tool geometry systems.
2. The graduate students will be able to understand the mechanisms involving the chip formations while machining the ductile as well as brittle materials
3. The graduate students will be able to understand the sources of heat generation in machining and how to reduce the heat generation
4. The graduate students will be able to understand the classification of machine tools with various power drives and kinematic structures.
5. The graduate students will be able to understand the constructional features of various machine tools.

Text books:

1. A.B. Chattopadhyay, Machining and Machine Tools, Wiley India Pvt. Ltd.
2. Ghosh & Mallick, Manufacturing Science, Affiliated East-West Press Pvt. Ltd.
3. P.N. Rao, Manufacturing Technology – Metal Cutting and Machine Tools, TMH

Reference Books:

1. Hajra Choudhary, Elements of Workshop Technology –Vol-II, Media Promoters
2. G.K. Lal, Introduction to Machining Science, New Age International
3. Mohd. Mukhtar Alam, D.N. Naresh, Girish Chitoshiya, Machining and Machine Tools, Genius Publications
4. Sen & Bhattacharyya, Principles of Machine Tools, New Central Book Agency Pvt. Ltd

MENUGPC13	**Measurement and Instrumentation**	**3L: 1 T: 0 P: 0**	**3 credits**

Objectives:

1. The main objective of this course is to make students familiar with the mechanical measuring systems, and the standard measurement methods. It further aims to make them to understand the basic measurement systems in the real time engineering applications.
2. To provide essential elements of electrical circuit analysis with a definite focus on Mechanical Engineering application.
3. To provide an introduction to instrumentation and devices used for measurements in electromechanical systems and introduction to automatic control systems.

Contents:

Module1: Introduction
Introduction to Measurement and Measuring Instruments-Functional Elements-Units of Measurement.

(6 hrs)

Module 2: Static Performance Characteristics
Error Source-Error-Analysis-Methods of Elimination or Reduction of Error-Sensitivity-Linearity-Resolution etc. of Instrument.

(8 hrs)

Module 3: Dynamic Performance Characteristics, Zero-First and Second Order Instruments.

(6 hrs)

Module 4:
Signal Conditioners, Bridge Circuits-Amplifiers-Filters etc.

(8 hrs)

Module 5:
Measurements, Displacement-Velocity-Flow-Acceleration-Force-Torque-Pressure-Strain-Frequency-Temperature etc.

(8 hrs)

Course Outcomes:

Upon completion of this course, students will get an overview of Measurement and Instrumentation.

1. Explain different measuring instruments to measure the qualitative and quantitative characteristics of different mechanical components.
2. Differentiate the accuracy of instruments.
3. An understanding of basic measuring devices including transformers, transducers, and pressure, flow rate, and temperature measurement devices.
4. Methods for rating instrument devices including dynamic range, resolution, accuracy and precision.
5. Calibrating and analyzing the characteristics of measuring instruments.
6. Determine error and analyzing uncertainty in the measurements.

Text Books:

1. T.G.Beckwith,R.D.Marangoni and J.H.Lienhard V, "Mechanical Measurements", Pearson Publication.
2. R.K.Rajput, "Mechanical Measurements and Instrumentation", KatsonBooks.

Reference Books:

1. E.O.Doebelin and D.M.Manik, "Measurement System", Tata McGraw Hill Publication.
2. K.M.Reddy and P.S.R.Krishnudu,"Instrumentation and Control System", Scitech Publication.

OEC 301	**Will be offered by other departments**	**3L:0T:0P**	**3 credits**

MENUGPR01	**Project-I**	**0L:0T:2P**	**1 credits**

May be done as vocational internship

MENUGPC14	**Mechanical Engineering Lab -III (Thermal, IC Engine & Heat Transfer)**	**0L:0T:3P**	**1.5credits**

Objectives:

- To expose the students to the basic knowledge of thermal equipments and help them to develop experimental skills.
- To study the concepts and applications of the thermal engineering laboratory.
- To demonstrate and conduct experiments, interpret and report results of testing.

Course contents:

1. Performance test of a vapour compression refrigeration test rig.
2. Experimental study on air conditioning test rig.
3. Study of conduction heat transfer and determination of thermal conductivity.
4. Study of heat transfer through a fin and determination of fin performance parameters.
5. Study of forced convective heat transfer and determination and validation of heat transfer coefficient and Nusselt number.
6. Determination of heat exchanger performance parameters.
7. Study of radiation heat transfer: determination of emissivity of gray surface.
8. Study of working of multi-cylinder four stroke diesel engine.
9. Study of injection system of a direct injection diesel engine.
10. Study of cooling system of internal combustion engines.
11. Performance test on a single cylinder CI engines test rig.
12. Study and perform Morse test on multi-cylinder four stroke SI engine.

Course Outcomes: On successful completion of the course, the student will be able to,

- Demonstrate conduction, convection and radiation heat transfer through experiments.
- Estimate the cooling load of air conditioning system.
- Evaluate performance and emission characteristics of internal combustion engines.

MENUGPC15	**Mechanical Engineering Lab -IV (Design, CAD & DOM)**	**0L:0T:3P**	**1.5credits**

Semester VI (Third year)
Branch/Course: Mechanical Engineering

MENUGPC16	**Advanced Manufacturing Technology**	**3L:0T:0P**	**3 credits**

Objectives:

1. This course provides an introductory course of advanced / non-traditional machining processes and finishing technologies.
2. The course is designed to expand the knowledge of new manufacturing technologies and their application in modern manufacturing.
3. This course will provide you with an understanding of specific advanced and emerging manufacturing technologies and skills relating to the implementation of these technologies in modern industry within both global and local contexts.

Contents:

Module 1:
Introduction: Unconventional machining process – Need – Classification – Brief overview of all techniques – Merits and demerits

(2 Hours)

Module 2:
Mechanical Energy Based Processes: Abrasive Jet Machining (AJM) – Water Jet Machining (WJM) – Ultrasonic Machining (USM) – Working principles – Equipment used – Process parameters – MRR – Variation in techniques used – Applications

(6 Hours)

Module 3:
Electrical Energy Based Process: Electric Discharge Machining (EDM) – Working Principles – Equipments – Process parameters – MRR – Electrode / Tool – Power circuits – Tool wear – Dielectric – Flushing – Wire cut EDM – Applications

(6 Hours)

Module 4:
Chemical And Electro Chemical Energy Based Process: Chemical Machining (CHM) – Electro-Chemical Machining (ECM) – Etchants – Maskant – Techniques of applying maskants – Process parameters – MRR – Applications – Principles of ECM – Equipments – MRR – Electrical circuit – Process parameters – ECG and ECH applications

(8 Hours)

Module 5:

Thermal Energy Based Process: Laser Beam Machining (LBM) – Plasma Arc Machining (PAM) – Electron Beam Machining (EBM) – Principles – Equipment – Types – Beam control techniques – Applications

(6 Hours)

Module 6:

Hybrid Machining Processes. Classifications, advantages and applications, electrochemical discharge machining (ECDM), abrasive flow finishing (AFF), magnetic abrasive finishing (MAF), magnetorheological finishing (MRF), magnetorheological abrasive flow finishing (MRAFF), chemical mechanical polishing (CMP)

(8 Hours)

Course Outcomes:

1. The students should be able to demonstrate an appropriate degree of competency in the evaluation of various manufacturing technologies and their application in modern manufacturing processes.
2. Define and describe the fundamentals and principals of advanced manufacturing processes.
3. Explain non-traditional manufacturing processes via experimental and theoretical analyses.

Text Books:

1. Advanced Machining Processes, Vijay Kumar Jain, Allied Publishers Pvt. Ltd
2. Modern Machining Processes, by P Pandey and H Shan, McGraw Hill Education
3. Nonconventional Machining, by P. K. Mishra, Narosa Publishing House

Reference Books:

1. Gary F.Benedict-Non-Traditional Manufacturing Process, Marcel Dekkar Inc. New York.
2. Fundamentals of Machining Processes: Conventional and Nonconventional Processes, Hassan Abdel-Gawad El-Hofy, CRC Press
3. Unconventional Machining Processes, Jagadeesha T, IK International Publishing House Pvt. Ltd

MENUGPC17	**Machine Design-II**	**3L:0T:0P**	**3 credits**

Objective:

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

1. A strong background in mechanics of materials based failure criteria (dynamic conditions) under safety-critical design of machine components.
2. An appreciation of parameter optimization and design iteration.
3. An appreciation of relationships between level design and overall machine system design and performance.

Contents:

Module 1:
Fluctuating Load, Stress Concentration,Fatigue Failure, Endurance Limit, Low Cycle and High Cycle Fatigue, Notch Sensitivity, Design for Finite and Infinite Life, Cumulative Damage.

4Hours

Soderberg and Goodman Lines, Modified Goodman Diagrams, Gerber Equation, Fatigue Design under Combined Stresses.

4Hours

Module 2:
Transmission Shafts, Shaft Design on Strength Basis, Shaft Design on Torsional Rigidity Basis, Design of Hollow Shaft on Strength Basis, Design of Keys, Splines, Couplings

4Hours

Module 3:
Springs, Types of Springs, Stress and Deflection Equations, Series and Parallel Connections, Design Against Fluctuating Load, Concentric Springs, Optimum Design of Helical Springs, Surge in Spring, Helical Torsion Springs, Spiral Springs, Leaf Springs.

4Hours

Module 4:
Clutches, Friction Clutches, Torque Transmitting Capacity, Multi-Disk Clutches, Cone Clutches, Centrifugal Clutches, Energy Equation, Thermal Considerations.

Brakes, Energy Equations, Block Brake with Short Shoe, Block Brake with Long Shoe, Pivoted Block Brake with Long Shoe, Internal Expanding Brake, Band Brakes, Disk Brakes, Thermal Considerations.

8Hours

Module 5:
Bearings, Types of Rolling Contact Bearings, Selection of Bearing Type, Stribeck's Equation, Dynamic Load Carrying Capacity, Equivalent Bearing Load, Load Factor, Design for Cyclic Loads and Speeds, Bearing with a Probability of Survival, Bearing Failure-Causes and Remedies, Lubrication of Rolling Contact Bearings.

Sliding Contact Bearings, Lubrication, Viscosity, Viscosity Index, Petroff's Equation, McKee's Investigation, Viscous Flow Through Rectangular Slot, Hydrostatic Bearing, Reynold's

Equation, Raimondi and Boyd Method, Temperature Rise, Selection Parameters for Sliding Contact Bearing, Bearing Failure-Causes and Remedies, Comparison of Rolling and Sliding Contact Bearings.

8Hours

Module 6:
Gear Drives, Classification of Gears, Force Analysis, Beam Strength of Gear Tooth, Permissible Bending Stress, Effective Load on Gear Tooth, Wear Strength of Gear Tooth, Internal gear, Gear Lubrication, Helical Gears, Bevel Gears, and Worm Gears.

4Hours

Course Outcomes:

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

TEXT BOOKS:

1. Design of Machine Elements by V.B. Bhandari.
2. Shigley's Mechanical Engineering Design (S.I. Units) by R.G. Budynas and J.K. Nisbett.

REFERENCE BOOKS:

3. Machine Design by R.S. Khurmi and J.K. Gupta.
4. Machine Design : Fundamentals and Applications by P.C. Gope.

MENUGPE01	**Advance Engineering Materials**	**3L:0T:0P**	**3 credits**

Objectives of the course

1. To obtain knowledge on classification, processing, characterization and applications of Advanced Ceramics and composite materials.
2. To obtain knowledge on mechanical properties and failure mechanisms of composites under loading conditions for engineering applications
3. To get knowledge on processing techniques for advanced engineering materials.

Course Content:

Module-1: Composite Material: Introduction: Definition, history, characteristics, classifications, advantages and limitations, industrial scenario and applications, Material and microstructural parameters of composites. Unidirectional-fibre composites: Fibre characteristics. Longitudinal strength and modulus of composites, minimum and critical fibre volume fractions, factors affecting strength. Transverse strength and modulus. Particulate composites: Large-particle composites and dispersion-strengthened composites. Cermets. Zirconia toughened ceramics. Properties of composites: Static mechanical properties, fatigue, impact and creep properties, fracture behaviour and damage tolerance.

Nanocomposites, hybrid composites, sandwich composites, in-situ composites, smart composites, self-healing composites, and carboncarbon composites.

[10 Hours]

Module-2: Ceramics: Introduction: Definition, history, characteristics, classifications, advantages and limitations, industrial scenario and applications, microstructural parameters of ceramic material.

[08 Hours]

Module-3: Powder Metallurgy: Metal and ceramic powder production, characterization, mixing techniques; Mechanical alloying and process variables; Various compaction techniques and the process variables; Mechanism of sintering and various sintering techniques, viz., solid state sintering, liqui phase sintering, hot pressing, HIP; Infiltration and Impregnation, Recent advances in powder metallurgy like Ospray and Deposition techniques. **[12 Hours]**

Module-4: Metallography: Inspection, polishing, etching, microscopy and macroscopy.

[06 Hours]

Course Outcomes

After completing this course, students will have:

1) Knowledge on classification, processing, characterization and applications of various composite materials & Ceramics

2) Ability to arrive at different deformation and failure mechanisms of composite materials under different loading conditions in engineering applications

3) Knowledge on Powder Metallurgical process and its application.

TEXT BOOKS: 1. Manufacturing Process for Engineering Materials, Kalpakjian, Schmid, Pearson Education

REFERENCES: 1. Fundamentals of Solidification by W.Kurtz and D.J.Fisher, Trans. Tech Publication.

2. Modern Ceramic Engineering by D.W.Richardson, Marcel Dekker Inc.

MENUGPE02	**IC Engines**	**3L:0T:0P**	**3 credits**

Course Objectives:

- To learn different types of internal combustion engines and their applications.
- To describe and analyse the power cycles of internal combustion engines.
- To understand the requirements of fuel quality and combustion processes in SI and CI engines.
- To recognize the implications of a trade-off between performance, efficiency and emissions.
- To understand and explain engine friction and lubrication and analyse parameters affecting engine performance.

Course content

Module-1

Historical overview of IC Engine Development, Classification of IC Engines, Working principles of SI and CI engine, comparison of two stroke & four stroke engines, Comparison between SI & CI engines, Air standard cycles and their analysis, Comparison of cycles, worked out examples.

6 Hours

Module-2

Fuel air cycles and their analysis, Actual cycles and their analysis. Classification of engine fuels, Petroleum base liquid fuels, Structure and composition of IC engine fuels, Rating of fuels, Important qualities of SI and CI engine fuels.

5 Hours

Module-3

Carburetion, Principle of carburetion, Factors affecting carburetion, Essential parts of a carburettor, Fuel air requirement for idling, cruising and maximum power range, Air- fuel ratio calculation, Aspects in modern carburettors, worked out examples.

5 Hours

Module-4

Fuel Injection, Spray Atomization, Penetration and Evaporation. Mechanical injection system, Functional requirements of an injection system, classification of injection system, Fuel feed pump, Fuel injector, Fuel discharging nozzle, worked out examples.

4 Hours

Module-5

Stages of combustion, Combustion equations. Stages of combustion in SI engines, Flame front propagation. Factors affecting flame speed, knocking in SI engines, Factors affecting engine knock. Stages of combustion in CI engines, Factors affecting delay period. Knocking in CI engines, Comparison of knock in SI and CI engines.

6 Hours

Module-6

Engine friction and lubrication, Frictional losses, Blowby losses, Pumping losses, Factors affecting friction, Function of lubrication, Mechanism of lubrication, Properties of lubricants, Types of lubrication, Crankcase ventilation. Engine cooling system - air cooling, liquid cooling.

4 Hours

Module-7

Engine emissions & their control, Engine measurements and testing, Measurement of friction power, Indicated power and brake power, Fuel and air consumption measurement, Performance parameters and characteristics, Variables affecting performance characteristics and methods to improve engine performance, worked out examples.

6 Hours

Text Books/Reference

- Internal Combustion Engines: V. Ganesan, McGraw Hill Education, 4th Edition.
- Internal Combustion Engine Fundamentals: J. B. Heywood, McGraw Hill Publications.
- Fundamentals of Internal Combustion Engines: Gill, Smith and Ziurys, Oxford and IBH.
- The Internal Combustion Engine in Theory and Practice: C. F. Taylor, MIT Press, Cambridge.
- Advanced Engine Technology: Heinz Heisler, ISBN 0340568224, SAE Publications.
- Internal Combustion Engines: Lester C. Lichty, McGraw Hill Publications.

Course outcome:

Upon successful completion of the course, students should be able to:

- Learn different types of internal combustion engines and their applications.
- Describe and analyse the power cycles of internal combustion engines.

- Understand the requirements of fuel quality and combustion processes in SI and CI engines.
- Recognize the implications of a trade-off between performance, efficiency and emissions.
- Understand and explain engine friction and lubrication and analyse parameters affecting engine performance.

OEC	**Will be offered by other departments**	**3L:0T:0P**	**3 credits**

MENUGPE05	**Mechatronics Engineering**	**3L:0T:0P**	**3 credits**

Objectives:

1. To understand the need of Mechatronics systems, the principle of operation of various sensors and transducers.
2. To provide knowledge on electrical circuits, signal conditioning
3. To make familiar about control system and power electronics in designing Mechatronics system
4. To understand the structure of microprocessors and their applications in mechanical devices
5. To understand the principle of automatic control and real time motion control systems, with the help of electrical drives and actuators
6. To understand the use of micro-sensors and their applications in various fields

Contents:

Module 1: Introduction

Introduction to Mechatronics-Systems-Measurement Systems-Control Systems-Mechatronics Approach.

6Hours

Module 2: Sensors and Transducers:

Introduction-Performance, Terminology- Displacement, Position and Proximity-Velocity and Motion Fluid Pressure- Temperature Sensor-Light Sensor-Signal Processing.

10Hours

Module 3:Signal Conditioning and Data Acquisition System:

Introduction-Operational Amplifiers Circuits-Digital to Analog converters (DAC)-Analog to Digital converters (ADC)-Sample and Hold Circuits- Multiplexer and De-Multiplexer- Block diagram of DAC-Component of DAC-Application of DAC.

10Hours

Module 4:8085 Microprocessor:

Introduction-Architecture-Pin Configuration- Instruction Set- Programming of Microprocessors using 8085 Instructions- Applications.

4Hours

Module 5: Basic Control Schemes:

Introduction-Classification of Control Systems-Open loop and Close loop Systems- P, PI, PD and PID Controller.

6Hours

Module 6 :Actuation Systems:

Pneumatic and Hydraulic Systems- Control Valves. Mechanical Actuation Systems-Cams-Gear Trains-Bearings. Electrical Actuation Systems-Electric Motor (AC and DC Motor, Servo Motor, Stepper Motor, Synchronous Motor and Induction Motor).

10Hours

Module 7: Programmable Logic Controllers:

Introduction-Basic Structure-Input/output Processing, Basic PLC Programming.

2Hours

Course Outcomes:

Upon completion of this course, students will get an overview of mechatronics applications and the use of micro-sensors and microprocessors.

1. A student should be able to: Design and analyze issues in mechatronics systems using mechanical, electronics, and computer hardware and software
2. Understand the mechanism and applications of finite state design methods to mechatronics systems.
3. Apply mechatronics principles in the construction and troubleshoot of Mechanical and Electronics Engineering disciplines.
4. Appreciate the risks and benefits of mechatronics as to minimize human error accidents and increase productivity in the work force.
5. Describe mechatronic systems and overview of control systems & actuators.
6. Differentiate between various sensors, transducers and actuators and their applications.
7. Relate various signal conditioning units, amplifiers, logic gates and their role in programmable logic controllers.
8. Explain various applications of design of mechatronic system

Text Books:

1. N.P. Mahalik, "Mechatronics", Tata McGraw Hill Publication.
2. A. Smaili and F. Arnold, "Mechatronics", Oxford University Press, Indian Edition.

Reference Books:

1. W. Bolton, "Mechatronics", Pearson Education.
2. F.H. Raven, "Automatic Control Engineering", McGraw Hill International.
3. Ramachandran, "Mechatronics", Wiley.

MENUGPE06	**Control systems**	**3L:0T:0P**	**3 credits**

Objectives:

1. To introduce the elements of control system and their modelling using various Techniques.
2. To introduce methods for analysing the time responses, the frequency response and the stability of systems
3. To introduce the state variable analysis method.

Contents:

Module 1: Control System Modelling:

Basic Elements of Control system -Open loop and Closed loop systems -Differential equation-Transfer function, modelling of Electric systems, Translational and rotational mechanical systems & signal flow graph. (16hrs)

Module 2: Time Response Analysis:

Time response analysis - First Order systems - Impulse and step response analysis of second order systems -steady state errors (P, PI, PD and PID Compensation, Analysis using MATLAB. (16hrs)

Module 3: Frequency Response Analysis:

Frequency response - Bode Plot, Polar Plot, Nyquist Plot-frequency Domain specifications from the plots – Constant -M and N Circles, Nichol's Chart -use of Nichol's Chart in Control system Analysis. Lead, Lag, and Lead-Lag Compensators. (16hrs)

Course Outcomes:

Upon completion of this course, students will get an overview idea of Control System:

1. Perform time domain and frequency domain analysis of control systems required for stability analysis.
2. Design the compensation technique that can be used to stabilize control systems.

Text Books:

1. J.Nagrath and M.Gopal, "Control System Engg.", New Age International Publisher.
2. K.Ogata, "Modern Control Engineering", Practice Hall of India Ltd.

Reference Books:

1. K. Ogata, "Discrete Time Control System", Pearson Publication.
2. K.P.Ramachandran, "Control Engineering", Wiley

MENUGPR02	**Project-II**		**3credits**

May be executed as vocational internship

MENUGPC18	**Mechanical Engineering Lab-V (Machine Shop, Foundry & Welding Practice)**	**0L:0T:4P**	**4credits**

Objectives: The course has been designed to provide the student with extensive hands-on laboratory experience utilizing various machine tools such as Lathe, Drilling, Milling, Shaping, Grinding Machines and to manufacture various profile on workpiece. In addition, the course is designed for conducting various hand-on practice using CNC lathe, CNC milling, EDM system, Wire-EDM system, ECM, Laser beam machining system, etc.

List of Experiments:

1. Detailed demonstration of different machine tools such as lathe, milling, shaping, drilling, grinding
2. Plain, step and taper turning, grooving, knurling operation on mild steel materials
3. External and internal thread cutting on mild steel materials
4. Key way cutting or slot making
5. Drilling of holes on flat workpiece and tapping
6. Spur gear cutting in milling machine by indexing methods
7. Plain and step grinding, taper grinding operations
8. Experiments for various cutting operations using CNC Lathe and CNC milling machine
9. Experiments for cavity generation on mild steel in EDM machine
10. Experiments for cutting of mild steel in wire-EDM machine
11. Experiments for cavity generation in ECM machine
12. Experiments for various operations in laser beam machining system.

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Outcomes: The students will be able to manufacture various profiles on various materials such as metals, alloys, ceramics, composites, etc. The students will be able to understand the basic mechanism of material removal with practical experience and the applications of various machine tools (conventional and advanced machines) for different type of cutting and material processing.

Semester VII (Fourth year)
Branch/Course: Mechanical Engineering

MENUGPC19	**Automation in Manufacturing**	**3L:0T:0P**	**3credits**

Objectives:

1. To understand the importance of automation in the of field machine tool based manufacturing
2. To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC.

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

Module 1:
Introduction: Introduction to automation, Current trends, Basic control scheme, CAD, CAM, CIM; Rigid automation: Part handling, Machine tools.

(4 Hours)

Flexible automation: Computer control of Machine Tools and Machining Centers, NC and CNC, Concept of robotic system, Automated Material handling. Assembly, Flexible fixturing.

(6 Hours)

Module 2:
Computer Aided Design: Fundamentals of CAD - Hardware in CAD-Computer Graphics Software and Data Base, Geometric modelling for downstream applications and analysis methods;

(10 Hours)

Computer Aided Manufacturing: CNC technology, PLC, Micro-controllers, CNC-Adaptive Control.

(5 Hours)

Module 3:
Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies

(4 Hours)

Module 4:
Introduction to Modeling and Simulation: Product design, process route modeling, Optimization techniques, Case studies & industrial applications.

(7 Hours)

Course Outcomes:

Upon completion of this course, the students will get a comprehensive picture of computer based automation of manufacturing operations

Text Books:

1. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall
2. SeropeKalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th edition,Pearson
3. YoramKoren, Computer control of manufacturing system, 1st edition
(iv) Ibrahim Zeid , CAD/CAM : Theory & Practice, 2nd edition.

MENUGPE10	**Robotics**	**3L:0T:0P**	**3credits**

Objectives:

4. To develop the student's knowledge in various robot structures and their workspace.
5. To develop student's skills in performing spatial transformations associated with rigid body motions.
6. To develop student's skills in perform kinematics analysis of robot systems.
7. To provide the student with knowledge of the singularity issues associated with the operation of robotic systems.
8. To provide the student with some knowledge and analysis skills associated with trajectory planning.
9. To provide the student with some knowledge and skills associated with robot control.

Contents:

Module 1:

Introduction:

Definition of robot-Classification of robots according to coordinate system and control method-Main components of robots–Manipulator, Sensors, Controller etc.-Robot characteristics– Payload, Reach, Repeatability, Accuracy, Resolution.

(10hrs)

Module 2:

Kinematics of Robot:

Homogenous coordinates-Homogeneous transformation matrices-Direct and Inverse Kinematics of robots-Trajectory Planning.

(6hrs)

Module 3: Types-Mechanical grippers-Other types of grippers-Tools as end effecters-Characteristics of actuating systems-Actuating System – Hydraulic devices, pneumatic devices, electric motors.

(10hrs)

Module 4: Sensors and Artificial Intelligence:

Introduction- Characteristics of Sensors- Position sensors, Velocity sensors, Acceleration sensors, Force sensors, Pressure sensors, Torque sensors, Micro switches, Touch and Slip sensors-Function of Artificial Intelligence-Robot Vision System-Robot programming Languages–VAL, AML/2, ARM BASIC.

(12hrs)

Module

5: Application of Robots :

Handling-Loading-Unloading-Welding-Spray-Painting-Assembly-Machining-Inspection-Rescue robots-Under-water robots- Parallel robot and Medical robot.

(4hrs)

Module 6:

Mechatronic Elements of Modern CNC Machines:

Introduction-Machine Structure-Basic CNC programming. (6hrs)

Course Outcomes:

Upon completion of this course, students will get an overview idea of CNC and Robotics.

10. Students will demonstrate knowledge of Importance of robotics in today and future goods production
11. Students will demonstrate knowledge of Robot configuration and subsystems
12. Students will demonstrate knowledge of Principles of robot programming and handle with typical robot
13. Students will demonstrate knowledge of the relationship between mechanical structures of industrial robots and their operational workspace characteristics
14. Students will demonstrate an ability to apply spatial transformation to obtain forward kinematics equation of robot manipulator
15. Students will demonstrate an ability to obtain the Jacobian matrix and use it to identify singularities
16. Students will demonstrate an ability to generate joint trajectory for motion planning
17. Students will demonstrate knowledge of robot controllers
18. Students will demonstrate knowledge of architecture of CNC machine and basic CNC part programming.

Text Books:

1. M.P.Groover, M.Weiss, R.M.Nagel, N.G.Odrey and A.Dutta,"Industrial Robotics", McGraw Hill Publication.
2. R.D.Klafter, T.A.Chmielewski and M.Negin,"Robotic Engineering", Prentice Hall of India Pvt. Ltd. Publication.

Reference Books:

1. J.J. Chaig, "Introduction to Robotics", AWL(Addison and Wesley) Publication.
2. R.C.Nagarajan, "Introduction to Industrial Robotics", Pearson Publication.
3. Saeed B.Niku, "Introduction to Robotics: Analysis, Control, Applications",Wiley.

MENUGPE11	**Industrial automation and control**	**3L:0T:0P**	**3credits**

Objectives:

19. To understand the need of Automation systems, the principle of operation of various sensors and transducers.
20. To provide knowledge on Actuators And Signal Conditioning
21. To make familiar about various Control Method
22. To understand about the principle of PLC, DCS & SCADA
23. To understand about PLC part programming

Contents:

Module 1: Introduction:

Processes-Classification of Control System- Open loop and Close loop System-Elements used in Feedback Control System-Control Actions.
(10hrs)

Module 2: Sensors, Actuators and Signal Conditioning:

Sensors: Displacement Sensors-Force Sensors-Ultrasonic Sensors-Temperature Sensors-Pressure Sensors etc.-Actuators: DC Motor-Servo Motor-Steeper Motor-Piezoelectric Actuators-Pneumatic Actuators etc.-Signal Conditioning: Filtering-Amplifying-Isolation-ADC-DAC-Sensor Protection Circuits-Signal Transmission and Noise Suppression-Estimation of Error and Calibration.

(14hrs)

Module 3: Controller Tuning:

PI Controller-PD Controller-PID Controller-Tuning Methods: Ziegler-Nichols Tuning Method-Cohen Coon Method.

(10hrs)

Module 4: Automation:

PLC (Programmable Logic Controller): Overview-Operation and Architecture-PLC Programming-Applications.
DCS(Distributed Control Systems): Overview-Advantages-Functional Requirements of DCS-Communication for Distributed Control-Application.
SCADA (Supervisory Control and Data Acquisition): Introduction to SCADA-SCADA System Components-Architecture and Communication-Application.

(14hrs)

Course Outcomes:

Upon completion of this course, students will get an overview of mechatronics applications and the use of micro-sensors and microprocessors.

24. A student should be able to: Design and analyze issues in Automation systems using mechanical, electronics, and computer hardware and software
25. Apply Automation principles in the construction and troubleshoot of Mechanical and Electronics Engineering disciplines.
26. Appreciate the risks and benefits of automation as to minimize human error accidents and increase productivity in the work force.
27. Overview concept of control systems & actuators.
28. Differentiate between various sensors, transducers and actuators and their applications.
29. Relate various signal conditioning units, amplifiers, logic gates and their role in programmable logic controllers.

Text Books:

1. K.Kant, "Computer-Based Industrial Control", Practice Hall of India Ltd.
2. W.C.Dunn, "Fundamentals of Industrial Instrumentation and Process Control", Tata McGraw Hill.

Reference Books:

1. M.Abdelati, "Modern Automation Systems", University Science Press.
2. K.Ogata, "Modern Control Engineering", Practice Hall of India Ltd.

MENUGPE14	**Refrigeration and Air conditioning**	**3L:0T:0P**	**3credits**

Course objectives:

- To understand the vapour compression and vapour absorption system operation.
- To analyse the refrigeration cycle and methods for improving performance.
- To designing of air conditioning system using cooling load calculation.
- To know the application of air conditioning and refrigeration system.

Course content

Module-1

Revision of basic thermodynamic concepts of refrigeration. Unit of refrigeration, Refrigerants – Desirable properties of refrigerants, Designation of refrigerants and their impact on the environment.

4 Hours

Module-2

Simple vapour compression refrigeration system with schematic, T-s and p-h diagrams. Sub-cooling, Super-heating and their effects; Effect of evaporator pressure and condenser pressure on COP; Dry compression, wet compression and their effects; Actual vapour compression cycle.

5 Hours

Module-3

Effects of flash chamber and flash intercooler; Elements of a vapour compression refrigeration system: Compressor, Condenser, Expansion valve and Evaporator, and worked out examples.

4 Hours

Module-4

Bell Coleman cycle, Aircraft refrigeration- Simple, Bootstrap, Regenerative and Reduced ambient air refrigeration systems, DART and worked out examples.

5 Hours

Module-5

Simple vapour absorption refrigeration system, Comparison between vapour absorption and vapour compression systems. Limitations of vapour absorption refrigeration system, Lithium bromide-water and Aqua-ammonia systems, Temperature-concentration and enthalpy-concentration diagrams.

Introduction to some non-conventional refrigeration systems (Thermoelectric, Vortex and Pulse tube, Steam jet refrigeration).

5 Hours

Module-6

Thermodynamics of moist air, Basic definitions related to psychometry, Psychrometry of air conditioning processes, Psychometric chart, Bypass factor, Sensible heat factor, ADP.

6 Hours

Module-7

Solar radiation and interaction with building structures, outside air and ventilation, Cooling and heating load estimation, Air washer, Duct sizing and design, worked out examples.

6 Hours

Recommended Books:

1. Refrigeration and Air Conditioning: Stocker and Jones, McGraw Hill Publications.Dossat, R.J. *Principles of refrigeration*. John Wiley & Son
2. .efrigeration and Air Conditioning: C. P. Arora, McGraw Hill Publications.
3. Refrigeration and Air Conditioning: Manohar Prasad, New Age International Publishers.
4. *Refrigeration, Air Conditioning and Heat Pumps:* Hundy, Trott and Welch, Elsevier.
5. Handbook of Air Conditioning and Refrigeration: Shan K. Wang, McGraw Hill.

Course outcomes:

Upon successful completion of the course, students should be able to:

- Demonstrate the operations of vapour compression, vapour absorption and air refrigeration systems and the impact of refrigerants on the environment.
- Demonstrate the need and importance of HVAC technology, the typical and some advanced and innovative schematic designs, and the goals of HVAC engineering and HVAC systems.
- Demonstrate thermal comfort conditions with respect to temperature, humidity and human clothing, activities and its impact on human comfort, productivity and health.
- Demonstrate an understanding of psychometry and its application in HVAC.

MENUGPE15	**Power plant engineering**	**3L:0T:0P**	**3credits**

Objective:

1. To introduce students to different aspects of power plant engineering.
2. To familiarize the students to the working of power plants based on different fuels.
3. To expose the students to the principles of safety and environmental issues.

Module 1

Thermal Power Plant:

General layout of modern thermal power plant, Site selection, Presents status of power generation in India

(4 hrs)

Module 2

High Pressure Boilers:

Unique features and advantages of high pressure boilers, supercritical boilers, Supercharged and fluidized bed combustion, Methods of superheat control, Corrosion in boilers and its prevention.

(4 hrs)

Module 3

Coal and Ash Handling Systems:

Coal storage, Burning systems, Types of stokers and their working, Pulverized fuel handling systems, Unit and central systems, Pulverized mills- ball mill, Bowl mill, Ball & race mill, Impact or hammer mill, Pulverized coal burners, Oil burners, Necessity of ash disposal, mechanical; hydraulic; pneumatic and steam jet ash handling system, Dust collection and its disposal, Mechanical dust collector, Electrostatic precipitator.

(4 hrs)

Module 4

Draught System

Natural draught – estimation of height of chimney, Maximum discharge condition, Forced; induced and balanced draught, Power requirement by fans.

(6 hrs)

Module 5

Diesel, Gas Turbine And Combined Cycle Power Plants

Otto, Diesel, Dual & Brayton Cycle – Analysis & Optimisation. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Principle of operation, types of steam turbines, compounding of steam turbines, impulse turbine

(4 hrs)

Module 6

Condensers and Cooling Towers:

Types of condensers, sources of air in condenser, condenser efficiency, Mass of cooling water required, Necessity of cooling ponds and cooling towers, Condenser water cooling systems, Types of cooling towers and cooling ponds.

(4 hrs)

Module 7

Feed Water Treatment:
Necessity of feed water treatment, Different impurities found in feed water, Effect of impurities,
(4 hrs)

Module 8
Nuclear Power Plant:
Nuclear fusion and fission, Chain reaction, Nuclear fuels, Components of nuclear reactor, Classification of reactors, Pressurized water reactor, Boiling water reactor, Gas cooled reactor,
(2 hrs)

Module 9
Economics of Power Generation:
Load curves, Load duration curves, Connected load, Maximum load, Peak load, Base load and peak load power plants, Load factor, Plant capacity factor, Plant use factor, Demand factor, Diversity factor, Cost of power plant, Performance and operating characteristics of power plant.
(4 hrs)

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

1. Describe and analyze different types of sources and mathematical expressions related to thermodynamics and various terms and factors involved with power plant operation.

2. Analyze the working and layout of steam power plants and the different systems comprising the plant and discuss about its economic and safety impacts

3. Combine concepts of previously learnt courses to define the working principle of diesel power plant, its layout, safety principles and compare it with plants of other types.

4. Describe the working principle and basic components of the nuclear power plant and the economic and safety principles involved with it.

5. Discuss the working principle and basic components of the hydro electric plants and the economic principles and safety precautions involved with it.

6. Discuss and analyze the mathematical and working principles of different electrical equipments involved in the generation of power.

TEXT BOOK:
Nag. P.K., "Power Plant Engineering", Third Edition, Tata McGraw – Hill Publishing Company Ltd., 2008.
El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.

Black & Veatch, Springer, "Power Plant Engineering", 1996.
Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw – Hill, 1998.
Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.
Sukhatme. S.P.& J. K. Naik, "Solar Energy Principles of Thermal Collection & Storage", Tata McGraw Hill Publishing Company Ltd., New Delhi,.

MBAUGHU01	Industrial Economics & Management	3L:0T:0P	3credits

Course Outcomes:

Module	Content	Lecture
Module 1	**Economics:** Introduction and Basic Economics Terms: Nature and Significance of Economics, Role of Economics in Engineering and Technology, Basic Economic: Utility, Saving, Investment, Equilibrium, Micro and Macro Economics, Liberalization, Privatization, Globalisation. Demand Analysis, Elasticity of Demand, Demand Forecasting, Factors of Production. Money Banking and Trade: Functions of money, supply & demand for money, money price level & inflation, black money, meaning, magnitude & consequences. Banking system in India, Functions of Commercial banks, Function of RBI, Sources of public revenue,	10
	principles of taxation, direct and indirect taxes, balance of trade and payment.	
Module 2	**Organizational Behavior:** **Basic concepts of management, objectives, classification and hierarchy, Different Schools of Management Thought, Motivation: Concept, Different Theories (Maslow, ERG, Herzberg) Communication: Purpose, process, Barriers to effective communication, Guidelines to make communication effective. Perception: Process, Importance, Factors influencing perception, Shortcuts for judging people- Halo effect, Stereotyping, Projection.**	5

Module 3	Human Resource Management: Recruitment and selection, Training, Performance appraisal, Industrial Relations, Trade Union, Collective Bargaining	5
Module 4	Quality Management: Concept, Dimensions for goods and services, Cost of Quality, Statistical Quality Control, Control Charts, Acceptance Sampling (single). Quality circle. Total Quality Management: Concept, benefits, Criticism. New Quality Tools: Kaizen, Six Sigma, Quality Circles.	5
Module 5	Productions Management: Concept, Difference from Operations Management, Types of Production (Mass, Batch, Project), Functions of Production Management. Productivity: Concept, Different Inputs and Productivity Measures, Efficiency and Effectiveness, Measures to increase Productivity.	6
Module 6	Marketing Management: Basic Concepts of Marketing, Difference between Selling and Marketing, Elements of Marketing Mix- the 4 P's., STP. Marketing Research: Definition, Process, Importance, SWOT Analysis, BCG Matrix, GE Matrix.	6
Module 7	Financial Management: Use of management science for the efficient administration of economic units, cost benefit analysis, present work and breakeven analysis, budgetary control.	6
Module 8	Materials Management: Concept, Functions, EOQ Models, Selective Inventory Control—ABC, VED, FSN analysis	5

Books:

1. A Text Book of Industrial Engineering (Vol.1) , L. C. Jhamb ,
Publisher: Everest Publishing House

2. Management: Principles, Processes and Practices , Anil Bhat & Arya Kumar, Publisher: OUP
3. Industrial & Business Management , Martand T. Telsang, Publisher: S. Chand.
4. Rajan Misra, (2009). Engineering Economics, University Science Press, An imprint of Laxmi Publiactions Pvt. Ltd., New Delhi

OEC401	**Open Elective course Will be offered by others department**	**3L:0T:0P**	**3credits**

MENUGPR03	**Preoject-III**	**6**	**3credits**

Some components will be design and fabricated in the mechanical workshop

MENUGPC20	**Mechanical Engineering Lab-VI (Measurement & Control)**	**0L:0T:3P**	**3credits**

Objectives:

1. To understand about the calibration of various transducer.
2. To understand the deformation of PLC.
3. To understand about various mechatronics systems.
4. To understand the demonstration of CNC part programming
5. To understand about the operation of Robotic Manipulator.
6. To impart knowledge on measurement, static and dynamic characteristics of measurement systems, accuracy, loading effect, reliability, choice and economics of measurement systems.

Contents:

1. Study of transducers (RTD and LVDT).
2. Basic PLC programming.
3. Experiments in Pneumatic and Hydraulic Circuits.
4. Modelling and analysis of Hydraulic and Pneumatic system using Lab-View.
5. Study of Microprocessor instruction set; Simple programs using 8085 microprocessor.
6. Write and execution of part Programme using G codes & M codes for Turning & Taper turning.
7. Write and execution of part Programme using G codes & M codes for Thread cutting operation.
8. DOF measurement of Robot.
9. Calibration of Vernier and Micrometer.

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10. Calibration of Load Cell.
11. Measurement of Temperature using Thermocouple.
12. Measurement using Strain Gauge.
13. Calibration of Flow Measurement.

Course Outcomes:

Students who have undergone the course will be able to understand about various mechatronic and robotic system. Student can gain sufficient knowledge about CNC part programming which can be helped in various research work. Student can understand the various measurement systems, Implement static and dynamic characteristics for analyzing measurement systems and learn about the accuracy of the measurement system and statistical analysis of errors.

Semester VIII (Fourth year)
Branch/Course: Mechanical Engineering

MENUGPE18	**Non-conventional Energy Utilization**	**3L:0T:0P**	**3credits**

Course objectives:

To impart the knowledge of basics of different non conventional types of power generation & power plants in detail so that it helps them in understanding the need and role of Non-Conventional Energy sources particularly when the conventional sources are scarce in nature.

Module 1
Basic of Solar Energy, Solar Geometry, Sun Path diagram,. Sun rise time sun set time, equation of time correction. Incident Solar Flux on the earth surface.

(6 hrs)

Module 2
Thermal Conversion, Technology of Selective Coating, Fundamentals of Flat Plate Collector and Evacuated Collector, Solar Concentrator, Solar thermal energy storage. Solar Refrigeration system.

(8hrs)

Module 3
Analysis of wind regimes –statistical analysis of wind regimes, Dynamic data acquisition, Time distribution, Frequency distribution. Statistical modelling.

(4 hrs)

Basic of Wind Energy conversion principles,Betz limit General introduction, types and classification of WECS, Power, Torque Speed Characteristics, maximum power coefficient, wind velocity measuring instrument, factors effecting the wind energy output, Principles of wind pump, Performance analysis of wind pump, Wind electric generator.

(8 hrs)

Module 4

Brief Concept about semiconductor devices and Technology, Basics of Photovoltaic Conversion technology and PV systems, PV system design methodologies, Materials for photovoltaic conversions, Si and non-Si materials, crystalline, semi crystalline, polycrystalline and amorphous materials. Technology for Si extraction, purification, Method of doping and junction fabrication. Cell fabrication and metallisation techniques. Networking the PV cell. Characterization of PV generators, Technology for the fabrication of thin film cells. Optical concentration. Effect of temperature on cell performance, Thermo photovoltaic effect, Solar simulator, Testing and performance assessment of PV generator. Balance of system solar PV generators, Electronic control and regulation. Power conditioning, Converters and Inverters. Concentrating system. System design and configuration. Application of PV for lighting, water pumping. Telecommunication, Cathodic protection, etc. PV Power Plant,Grid integration

(8 hrs)

Module 5

Basics of Bio-energy conversion, biomethanation technology, Thermochemical Conversion through Pyrolysis, Gasification and Esterification, Bio Oil,Biomethanation technology, bio diesel, improved wood stove, bio -hydrogen generation, electricity generation from biomass gasifier, engine systems, petrol, diesel and duel fuel engine.

(6 hrs)

Module 6

Thermal Gradient and Geothermal gradient for power generation, Basics of hydropower, Tidal and Wave power,

(2 hrs)

Course outcomes:

After completion of this course students will be able to

1. Understand the different non conventional sources and the power generation techniques to generate electrical

2. Design a prescribed engineering sub-system

3. Recognize the need and ability to engage in lifelong learning for further developments in this field.

1. Duffie, J.A., Beckman, W.A. and Worek, W.M., 2013. *Solar engineering of thermal processes* (Vol. 3). New York: Wiley.

2. Sukhatme. S.P., "Solar Energy", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
3. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 1996.
4. Tiwari. G.N., Solar Energy – "Fundamentals Design, Modelling & Applications", Narosa Publishing House, New Delhi, 2002.
5. Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
6. Johnson Gary, L. "Wind Energy Systems", Prentice Hall, New York, 1985
7. David M. Mousdale – "Introduction to Biofuels", CRC Press, Taylor & Francis Group, USA 2010
8. Chetan Singh Solanki, Solar Photovoltaics, "Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2009.

MENUGPE19	**Finite Element Method**	**3L:0T:0P**	**3credits**

Objectives:

1. To illustrate the principle of mathematical modeling of engineering problems.
2. To introduce the basics and application of Finite Element Method.

Module-1

A General Procedure for Finite Element Analysis, History of the Finite Element Method, Examples of Finite Element Analysis. Finite Element of Linear Spring, Elastic Bar, Truss Element, Strain Energy, Castigliano's First Theorem, Minimum Potential Energy.

6Hours

Module-2

Truss Structures: The Direct Stiffness Method, Nodal Equilibrium Equations, Element Transformation, Direct Assembly of Global Stiffness Matrix, Boundary Conditions, Constraint Forces, Element Strain and Stress, Three Dimensional Trusses.

5Hours

Module-3

Elementary Boundary Theory, Flexure Element Stiffness Matrix, Element Load Vector, Work Equivalence for Distributed Loads, Flexure Element with Axial Loading, General Three Dimensional Beam Element.

7Hours

Module-4

Method of Weighted Residuals, Galerkin's Finite Element Method, Application of Galerkin's Method to Structural Elements.

4Hours

Module-5

Continuity, Compatibility and Completeness, Polynomial Forms of One-dimensional Elements and Geometric Isotropy, Triangular Elements, Rectangular Elements, Three-dimensional Elements, Iso-parametric Formulation, Numerical Integration: Gaussian Quadrature. Applications.

8Hours

Module-6

Structural Dynamics, Simple Harmonic Oscillator, Multiple Degree of Freedom Systems, Bar Elements: Consistent Mass Matrix, Beam Elements.

6Hours

Course Outcomes:

Upon completion of the course, students will understand the FEM formulation and its application to simple structural problems.

TEXT BOOKS:

1. David V. Hutton, Fundamentals of Finite Element Analysis.
2. Chandrupatla&Belegundu, Introduction to Finite Elements in Engineering.

REFERENCE BOOKS:

3. Reddy J.N., An Introduction to Finite Element Method.
4. Rao S.S., The Finite Element Method in Engineering.

MBAUGHU02	Professional Values & Ethics	2L:0T:0P	2credits

Module	Content	Lecture
Module 1	**Human Values :** Objectives , Morals ,Values , Ethics , Integrity, Work ethics, Service learning , Virtues, Respect for others , Living peacefully, Caring , Sharing, Honesty, Courage, Valuing time , Cooperation , Commitment , Empathy, Self-confidence, Challenges in the work place ,Spirituality,	5
Module 2	**Engineering Ethics :** Overview, Senses of engineering ethics , Variety of moral issues , Types of inquiries , Moral dilemma , Moral autonomy ,Moral development (theories) , Profession , Models of professional roles ,Theories about right action (Ethical theories)	5
Module 3	**Engineering as Social Experimentation :** Engineering as experimentation, Engineers as responsible experimenters, Codes of ethics, Industrial standards.	4

Module 4	**Safety, Responsibilities and Rights :** Safety definition, Safety and risk, Risk analysis, Assessment of safety and risk, Conflict of interests, Occupational crime, Human rights, Employee rights, Whistle blowing, Intellectual property rights.	**5**
Module 5	**Global Issues :** Globalization, Multinational corporations,Environmental ethics, Computer ethics, Engineers as managers, Engineers as advisors in planning and policy making, Moral leadership, Codes of ethics.	**5**

Books:

1. A Textbook of Professional Ethics and Human Values, R.S. Naagarazan, New Age International Publishers
2. Blending the best of the East & West, Dr. Subir Chowdhury, EXCEL
3. Ethics & Mgmt. & Indian Ethos, Ghosh, VIKAS
4. Business Ethics,Pherwani,EPH
5. Ethics, Indian Ethos & Mgmt., Balachandran, Raja, Nair,

Shroff Publishers Business Ethics: concept and cases,
Velasquez, Pearson.

OEC402	**Open Elective course** **Will be offered by others department**	**3L:0T:0P**	**3credits**

MENUGPR04	**Preoject-IV**	**6**	**3credits**

Developed components in project –III will be assembled for demonstrating certain principles of mechanical Engineering.