Mechanical Engineering

July-2019

Part-I

Course Structure

AS PER NEW AICTE MODEL CURRICULUM
Department of Mechanical Engineering

1st Year 1st Semester Curriculum:

Theory								
Sl. No	**Category**	**Course Code**	**Course Title**	**Contact Hrs per Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	Basic Science Courses	PHYS1001	Physics-I	3	1	0	4	4
2	Basic Science Courses	MATH 1101	Mathematics-I	3	1	0	4	4
3	Engineering Science Courses	CSEN 1001	Programming for Problem Solving	3	0	0	3	3
			Total Theory	**9**	**2**	**0**	**11**	**11**
Laboratory/Practical								
				L	**T**	**P**	**Total**	
1	Basic Science Courses	PHYS 1051	Physics-I Lab	0	0	3	3	1.5
2	Engineering Science Courses	CSEN 1051	Programming for Problem Solving Lab	0	0	4	4	2
3	Engineering Science Courses	MECH 1051	Workshop/Manufacturing Practices	1	0	4	5	3
			Total Laboratory	**1**	**0**	**11**	**12**	**6.5**
Total Semester				**10**	**2**	**11**	**23**	**17.5**

Honours Course								
Sl. No.	**Category**	**Course Code**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	Engineering Science Courses	ECEN 1011	Basic Electronics	3	0	0	3	3
2	Engineering Science Courses	ECEN 1061	Basic Electronics Lab	0	0	2	2	1
Total Semester with Honours				**13**	**2**	**13**	**28**	**21.5**

1st Year 2nd Semester Curriculum:

Theory								
Sl. No	**Category**	**Course Code**	**Course Title**	**Contact Hrs per Week**				**Credit Point**
				L	**T**	**P**	**Total**	
1	Humanities	HMTS 1202	Business English	2	0	0	2	2
2	Basic Science Courses	CHEM 1001	Chemistry-I	3	1	0	4	4
3	Basic Science Courses	MATH 1201	Mathematics-II	3	1	0	4	4
4	Engineering Science Courses	ELEC 1001	Basic Electrical Engineering	3	1	0	4	4
			Total Theory	**11**	**3**	**0**	**14**	**14**
Laboratory/Practical								
1	Humanities	HMTS 1251	Language Lab	0	0	2	2	1
2	Basic Science Courses	CHEM 1051	Chemistry-I Lab	0	0	3	3	1.5
3	Engineering Science Courses	ELEC 1051	Basic Electrical Engineering Lab	0	0	2	2	1
4	Engineering Science Courses	MECH 1052	Engineering Graphics & Design	1	0	4	5	3
			Total Laboratory	**1**	**0**	**11**	**12**	**6.5**
Total Semester				**12**	**3**	**11**	**26**	**20.5**

Honours Course								
Sl. No.	**Category**	**Course Code**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	Humanities	HMTS 1011	Communication for Professionals	3	0	0	3	3
2	Humanities	HMTS 1061	Professional Communication Lab	0	0	2	2	1
Total Semester with Honours				**15**	**3**	**13**	**31**	**24.5**

2nd Year 1st Semester Curriculum:

Theory								
Sl. No.	**Category**	**Course Code**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	Basic Science Courses	PHYS 2101	Physics – II	3	1	0	4	4
2	Basic Science Courses	MATH 2001	Mathematical Methods	3	1	0	4	4
3	Engineering Science Courses	BIOT 2105	Biology	2	0	0	2	2
4	Engineering Science Courses	MECH 2101	Engineering Mechanics	3	0	0	3	3
5	Professional Core Courses	MECH 2102	Fluid Mechanics & Hydraulics	3	0	0	3	3
6	Humanities	HMTS 2001	Human Values & Professional Ethics	3	0	0	3	3
7	Mandatory Course	EVSC 2016	Environmental Science	2	0	0	2	0
Total Theory				**19**	**2**	**0**	**21**	**19**

Laboratory/Practical								
1	Professional Core Courses	MECH 2156	Machine Drawing-I	0	0	3	3	1.5
2	Professional Core Courses	MECH 2157	Workshop Practice-II	0	0	3	3	1.5
			Total Laboratory	**0**	**0**	**6**	**6**	**3**
Total Semester				**19**	**2**	**6**	**27**	**22**

List of Paper offered by ME Department for other departments (EE & CHE):

1. MECH 2106 : Mechanics for Engineers

2nd Year 2nd Semester Curriculum:

Theory								
Sl. No.	**Category**	**Course Code**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	Professional Core Courses	MECH 2201	Strength of Materials	3	1	0	4	4
2	Professional Core Courses	MECH 2202	Fluid Machinery	3	0	0	3	3
3	Engineering Science Courses	MECH 2203	Engineering Thermodynamics	3	1	0	4	4
4	Professional Core Courses	MECH 2204	Manufacturing Processes	3	0	0	3	3
5	Professional Core Courses	MECH 2205	Kinematics of Machines	3	0	0	3	3
Total Theory				**15**	**2**	**0**	**17**	**17**
Laboratory/Practical								
1	Professional Core Courses	MECH 2251	Applied Mechanics Lab	0	0	2	2	1
2	Professional Core Courses	MECH 2252	Fluid Mechanics & Hydraulic Machines Lab	0	0	3	3	1.5
3	Professional Core Courses	MECH 2256	Machine Drawing-II	0	0	3	3	1.5
Total Practical				**0**	**0**	**8**	**8**	**4**
Total of Semester				**15**	**2**	**8**	**25**	**21**

Honours Course								
Sl. No.	**Category**	**Course Code**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	Professional Core Courses	MECH 2211	Mechanical Measurement and Instrumentation	3	0	0	3	3
2	Professional Core Courses	MECH 2261	Mechanical Measurement and Instrumentation Lab	0	0	2	2	1
Total Semester with Honours				**18**	**2**	**10**	**30**	**25**

3rd Year 1st Semester Curriculum:

Theory								
Sl. No.	**Category**	**Course Code**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	Professional Core Courses	MECH 3101	Machine Design-I	3	0	0	3	3
2	Professional Core Courses	MECH 3102	Heat Transfer	4	0	0	4	4
3	Professional Core Courses	MECH 3103	Engineering Materials	3	0	0	3	3
4	Professional Core Courses	MECH 3104	Machining & Machine Tools	3	0	0	3	3
5	Professional Core Courses	MECH 3105	Dynamics of Machines	3	0	0	3	3
6	Professional Elective Courses	MECH 3131-3134	Professional Elective - I	3	0	0	3	3
7	Mandatory Courses	INCO 3016	Indian Constitution and Civil Society	2	-	-	2	0
Total Theory				**21**	**0**	**0**	**21**	**19**
Laboratory/ Practical								
1	Professional Core Courses	MECH 3152	Applied Thermodynamics & Heat Transfer Lab	0	0	3	3	1.5
2	Professional Core Courses	MECH 3155	Dynamics of Machines Lab	0	0	3	3	1.5
3	Professional Elective Courses	MECH 3181-3184	Professional Elective - I Lab	0	0	3	3	1.5
Total Practical				**0**	**0**	**9**	**9**	**4.5**
Total of Semester				**21**	**0**	**9**	**30**	**23.5**

List of Professional Elective I:

1. MECH 3131 : Fluid Power Control
2. MECH 3132 : Refrigeration & Air Conditioning
3. MECH 3133 : Electrical Machines
4. MECH 3134 : Data Structure & RDBMS

List of Professional Elective I Lab:

1. MECH 3181 : Fluid Power Control Lab
2. MECH 3182 : Refrigeration & Air Conditioning Lab
3. MECH 3183 : Electrical Machines Lab
4. MECH 3184 : RDBMS Lab

3rd Year 2nd Semester Curriculum:

Theory								
Sl. No.	**Category**	**Course Code**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	Humanities	HMTS 3201	Economics for Engineers	3	0	0	3	3
2	Professional Core Courses	MECH 3201	Machine Design- II	3	0	0	3	3
3	Professional Elective Courses	MECH 3231-3233	Professional Elective - II	3	0	0	3	3
4	Professional Elective Courses	MECH 3236-3239	Professional Elective - III	3	0	0	3	3
5	Open Elective Courses		Open Elective-I	3	0	0	3	3
Total Theory				**15**	**0**	**0**	**15**	**15**
Laboratory/ Practical								
1	Professional Core Courses	MECH 3256	Machining & Machine Tools Lab	0	0	3	3	1.5
2	Professional Elective Courses	MECH 3281-3283	Professional Elective –II Lab	0	0	2	2	1
3	Seminar	MECH 3293	Seminar & Term Thesis	0	0	4	4	2
Total Practical				**0**	**0**	**9**	**9**	**4.5**
Total of Semester				**15**	**0**	**9**	**24**	**19.5**
Honours Course								
Sl. No.	**Category**	**Course Code**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	Professional Core Courses	MECH 3211	IC Engine	3	0	0	3	3
2	Professional Core Courses	MECH 3261	IC Engine Lab	0	0	2	2	1
Total Semester with Honours				**18**	**0**	**11**	**29**	**23.5**

List of Professional Elective – II			**List of Professional Elective Lab – II**			
Sl.No.	**Code**	**Paper Name**	**Sl.No.**	**Code**	**Paper Name**	
1	MECH 3231	Finite Element Method	**1**	MECH 3281	Finite Element Method Lab	
2	MECH 3232	Mechatronics & Control systems	**2**	MECH 3282	Mechatronics & Control systems Lab	
3	MECH 3233	Advanced Fluid Mechanics	**3**	MECH 3283	Advanced Fluid Mechanics Lab	

List of Professional Elective – III		
Sl.No.	**Code**	**Paper Name**
1	MECH 3236	Total Quality Management (TQM)
2	MECH 3237	Turbo Machinery
3	MECH 3238	Aerodynamics
4	MECH 3239	Tool Engineering

List of Open Elective I (Emerging Field**)**

MECH 3221: Computational Fluid Dynamics
MECH 3222: Advanced Welding Technology
MECH 3223: New Product Development

4th Year 1st Semester Curriculum:

Theory								
Sl. No.	**Category**	**Course Code**	**Course Title**	**Contact Hrs/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	Humanities	HMTS 4101	Principles of Management	3	0	0	3	3
2	Professional Elective Courses	MECH 4141-4144	Professional Elective – IV	3	0	0	3	3
3	Open Elective Courses		Open Elective-II (Emerging Field)	3	0	0	3	3
4	Open Elective Courses		Open Elective-III (Emerging Field)	3	0	0	3	3
Total Theory				**12**	**0**	**0**	**12**	**12**
Sessional								
1	Project/ Summer internship	MECH 4191	Industrial Training /Summer internship	-	-	-	-	2
2	Project	MECH 4195	Project - I	0	0	8	8	4
Total Sessional				**0**	**0**	**8**	**8**	**6**
Total of Semester				**12**	**0**	**8**	**20**	**18**
Honours Course								
Sl. No.	**Category**	**Course Code**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	Professional Core Courses	MECH 4111	Automation in Manufacturing	3	0	0	3	3
2	Professional Core Courses	MECH 4161	Automation in Manufacturing Lab	0	0	2	2	1
Total Semester with Honours				**15**	**0**	**10**	**25**	**22**

List of Professional Elective – IV

MECH 4141 : Maintenance Engineering
MECH 4142 : Materials Handling
MECH 4143 : Operations Research
MECH 4144 : Automobile Engineering

List of Open Elective- II :Emerging Field (Mech) or other departmental subjects

1. MECH 4121 : CAD/CAM
2. MECH 4122 : Nano Manufacturing
3. CIVL 4121 : Project Planning and Management
4. AEIE 4121 : Instrumentation and Telemetry

List of Open Elective- III :Emerging Field (Mech) or other departmental subjects

1. MECH 4126 : Renewable Energy Systems
2. MECH 4127 : Industrial Robotics
3. CHEN 4122 : Industrial Pollution Control

List of Free Electives offered by ME Department for other departments:

1. MECH 4124 : Mechanical Handling of Materials
2. MECH 4125 : Computational Methods in Engineering
3. MECH 4129 : Quality Control & Management
4. MECH 4130 : Ecology and Environmental Engineering

4th Year 2nd Semester Curriculum:

Theory								
Sl. No.	**Category**	**Course Code**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	Professional Elective Courses	MECH 4241-4244	Professional Elective - V	3	0	0	3	3
2	Open Elective Courses		Open Elective-IV (Other departments)	3	0	0	3	3
Total Theory				**6**	**0**	**0**	**6**	**6**
Laboratory/ Practical								
1	Professional Core Courses	MECH 4251	Advanced Manufacturing Lab	0	0	2	2	1
Total Practical				**0**	**0**	**2**	**2**	**1**
Sessional								
1	Professional Core Courses	MECH 4256	Design of an Industrial Product	0	0	4	4	2
2	Project	MECH 4295	Project - II	0	0	16	16	8
3	Comprehensive Viva	MECH 4297	Comprehensive Viva-voce	-	-	-	-	1
Total Sessional				**0**	**0**	**20**	**20**	**11**
Total of Semester				**6**	**0**	**22**	**28**	**18**

List of Professional Elective – V

1. MECH 4241 **:** Quantity Production Method
2. MECH 4242 : Power Plant Engineering
3. MECH 4243 **:** Gas Dynamics and Jet Propulsion

List of Open Elective- IV (Other Departments)

1. CIVL 4222 **:** Building Materials
2. HMTS 4221 : Introduction to Industrial Sociology
3. HMTS 4222 : Elementary Spanish for Beginners
4. AEIE 4221 : Process Instrumentation

List of Free Electives offered by ME Department for other departments:

1. MECH 4221 : Quantitative Decision Making
2. MECH 4222 : Modern Manufacturing Technology

DISTRIBUTION OF COURSE CREDIT

Semester wise Credit Point and contact hours

Semester	Credit (AICTE)	Credit for Hons	Contact hour	Total Contact hour
1 st semester	17.5	4	23	23+5=28
2nd semester	20.5	4	26	26+5=31
3rd semester	22	0	27	27
4th semester	21	4	25	25+5=30
5th semester	23.5	0	30	30
6th semester	19.5	4	24	24+5=29
7th semester	18	4	20	20+5=25
8th semester	18	0	28	28
TOTAL	**160**	**20**	**203**	**228**

Category of Course Distribution of Credit Points

Sl. No.	Categories	Semesters								Total	Total as per AICTE	
		1st	2nd	3rd	4th	5th	6th	7th	8th			
1.	Basic Science Courses	9.5	9.5	8						**27**	**25**	
2.	Engineering Science Courses	8	8	5	4					**25**	**24**	
3.	Humanities		3	3			3	3		**12**	**12**	
4.	Mandatory Courses			0		0				**0**	**0**	
5.	Professional Core Courses			6	17	19	4.5		3	**49.5**	**48**	
6.	Open Elective Courses						3	6	3	**12**	**18**	
7.	Professional Elective Courses					4.5	7	3	3	**17.5**	**18**	
8.	Internship/Seminar/Projects/Grand Viva						2	6	9	**17**	**15**	
	Total	17.5	20.5	22	21	23.5	19.5	18	18	**160**	**160**	
9	Honours Course	4	4		4		4	4		**20**	**As per MAKAUT**	
10	Grand Total with Honours	21.5	24.5	22	25	23.5	23.5	22	18	**180**		

Definition of Credit (as per AICTE):

- 1 Hour Lecture (L) per Week = 1 Credit; 1 Hour Tutorial (T) per Week = 1 Credit
- 1 Hour Practical (P) per Week = 0.5 Credit ; 2 Hours Practical (Lab) per Week = 1 Credit

Range of Credit (as per AICTE):

- A total of 160 credits will be necessary for a student to be eligible to get B. Tech. degree.
- A student will be eligible to get B. Tech. degree with Honours if he/she completes an additional 20 credits. These could be acquired through various Honours Course offered by the department.
- A part or all of the above additional credits may also be acquired through MOOCs. Any student completing any course through MOOC will have to submit an appropriate certificate to earn the corresponding credit.
- For any additional information, the student may contact the concerned HOD.

Part-II

Detailed Syllabus

Course Name: PHYSICS I					
Course Code: PHYS-1001					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

Course Outcomes:

1. Interpret oscillations under different conditions, with the understanding of Resonance phenomena followed by calculation of Q factor
2. Analyze the Quantum phenomenon like Black body radiation , Compton effect and origin of X-ray spectrum
3. Understand the wave character of light through the phenomenon of interference, diffraction and polarization.
4. Study of various crystal structures and classification of different crystal planes.
5. Explain the working principle of LASER, and apply the knowledge in different lasing system and their engineering applications in holography
6. Understand the dual nature of matter, Heisenberg's uncertainty relation and it's various application.

Module 1 : Mechanics (7+5)= 12L

Elementary concepts of grad, divergence and curl. Potential energy function; F=-grad V, Equipotential surfaces and meaning of gradient; Conservative and non-conservative forces, Curl of a force field; Central forces ; conservation of angular momentum; Energy equation and energy diagrams; elliptical, parabolic and hyperbolic orbit; Kepler Problem; Application : Satellite manoeuvres .

Non-inertial frames of reference; rotating coordinate system; five term acceleration formula-centripetal and coriolis accelerations; applications: Weather system, Foucault pendulum.

Module 2 : Optics (4 +3+ 5) = 12 L

Oscillatory Motion:

Damped harmonic motion – Over damped, critically damped and lightly damped oscillators; Forced oscillation and resonance. Electrical equivalent of mechanical oscillator, Wave equation, plane wave solution.

Optics:

Elementary features of polarization of light waves. Double refraction, Production and analysis of linearly, elliptic and Circularly polarized light, Polaroid and application of polarizations.: Polarimeter.

Laser & Fiber Optics:

Characteristics of Lasers, Spontaneous and Stimulated Emission of Radiation, Meta-stable State, Population Inversion, Lasing Action, Einstein's Coefficients and Relation between them, Ruby Laser, Helium-Neon Laser, Semiconductor Diode Laser, Applications of Lasers.

Fiber optics - principle of operation, numerical aperture, acceptance angle, Single mode , graded indexed fiber.

Module 3: **Electrostatics (8+4) = 12 L**

Electrostatics in free space

Calculation of electric field and electrostatic potential for a charge distribution, Divergence and curl of electrostatic field, Laplace's and Poisson's equation for electrostatic potential. Boundary conditions of electric field and electrostatic potential. Method of images , energy of a charge distribution and its expression in terms of electric field.

Electrostatics in a linear dielectric medium

Electrostatic field and potential of a dipole, Bound charges due to electric polarization, Electric displacement, Boundary conditions on displacement, Solving simple electrostatic problem in presence of dielectric – point charge at the centre of a dielectric sphere, charge in front of dielectric slab, Dielectric slab and dielectric sphere in uniform electric field.

Module 4: **(6+3+3)= 12L**

Magnetostatics :

Biot-Savart law, divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; equation for vector potential and it's solutions for given current densities .

Magnetostatics in a linear magnetic medium:

Magnetization and associated bound currents; Auxiliary magnetic field $\vec{H}$; boundary conditions on $\vec{B}$ and $\vec{H}$. Solving for magnetic field due to simple magnet like a bar magnet; Magnetic susceptibility ; ferromagnetic , paramagnetic and diamagnetic materials; Qualitative discussion of magnetic field in presence of magnetic materials.

Faraday's Law:

Differential form of Faraday's law expressing curl of electric field in terms of time derivative of magnetic field and calculating electric field due to changing magnetic fields in quasi static approximation. Energy stored in a magnetic field.

Books of reference :

1. Optics – **Eugene Hecht** Pearson Education India Private Limited
2. Introduction to Electrodynamics, **David J. Griffiths**, Pearson Education India Learning Private Limited
3. Waves and Oscillations by **N.K. Bajaj**
4. Principles of Physics, 10ed, **David Halliday, Robert Resnick Jearl Walker** , Wiley
5. Electricity, Magnetism, and Light, **Wayne M. Saslow**, Academic Press
6. Classical mechanics, **Narayan Rana, Pramod Joag**, McGraw Hill Education
7. Introduction to Classical Mechanics, **R Takwale, P Puranik**, McGraw Hill Education
8. Optics, **Ghatak**, McGraw Hill Education India Private Limited
9. Refresher Course in B.Sc. Physics – Vol1 and Vol 2 – **C.L.Arora**

Course Name: MATHEMATICS-I					
Course Code: MATH 1101					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	1	0	4	4

Course Outcomes:

1. Apply the concept of rank of matrices to find the solution of a system of linear simultaneous equations.
2. Develop the concept of eigen values and eigen vectors.
3. Combine the concepts of gradient, curl, divergence, directional derivatives, line integrals, surface integrals and volume integrals.
4. Analyze the nature of sequence and infinite series
5. Choose proper method for finding solution of a specific differential equation.
6. Describe the concept of differentiation and integration for functions of several variables with their applications in vector calculus.

Module I [10L]

Matrix:

Inverse and rank of a matrix; Elementary row and column operations over a matrix; System of linear equations and its consistency; Symmetric, skew symmetric and orthogonal matrices; Determinants; Eigen values and eigen vectors; Diagonalization of matrices; Cayley Hamilton theorem; Orthogonal transformation.

Module II [10 L]

Vector Calculus:

Vector function of a scalar variable, Differentiation of a vector function, Scalar and vector point functions, Gradient of a scalar point function, divergence and curl of a vector point function, Directional derivative, Related problems on these topics,

Infinite Series:

Convergence of sequence and series; Tests for convergence: Comparison test, Cauchy's Root test, D' Alembert's Ratio test(statements and related problems on these tests), Raabe's test; Alternating series; Leibnitz's Test (statement, definition); Absolute convergence and Conditional convergence.

Module III [10 L]

First order ordinary differential equations:

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

Ordinary differential equations of higher orders:

General linear ODE of order two with constant coefficients, C.F. & P.I., D-operator methods,
Method of variation of parameters, Cauchy-Euler equations.

Module IV [10L]

Calculus of functions of several variables

Introduction to functions of several variables with examples, Knowledge of limit and continuity, Determination of partial derivatives of higher orders with examples, Homogeneous functions and Euler's theorem and related problems up to three variables,

Multiple Integration

Concept of line integrals, Double and triple integrals. Green's Theorem, Stokes Theorem and Gauss Divergence Theorem.

Suggested Books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2000.
2. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2006.
3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. K. F. Riley, M. P. Hobson, S. J. Bence. Mathematical Methods for Physics and Engineering, Cambridge University Press, 23-Mar-2006.
4. S. L. Ross, Differential Equations", Wiley India, 1984.
5. G.F. Simmons and S.G. Krantz, Differential Equations, McGraw Hill, 2007.
6. Vector Analysis(Schaum's outline series): M.R. Spiegel, Seymour Lipschutz, Dennis Spellman (McGraw Hill Education)
7. Engineering Mathematics: S. S. Sastry (PHI)
8. Advanced Engineering Mathematics: M.C. Potter, J.L. Goldberg and E.F. Abonfadel (OUP),Indian Edition.
9. Linear Algebra (Schaum's outline series): Seymour Lipschutz, Marc Lipson (McGraw Hill Education)

Course Name: PROGRAMMING FOR PROBLEM SOLVING					
Course Code: CSEN 1001					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

1. Understand and remember functions of the different parts of a computer.

2. Understand and remember how a high-level language (C programming language, in this course) works, different stages a program goes through.

3. Understand and remember syntax and semantics of a high-level language (C programming language, in this course).

4. Understand how code can be optimized in high-level languages.

5. Apply high-level language to automate the solution to a problem.

6. Apply high-level language to implement different solutions for the same problem and analyze why one solution is better than the other.

Module I: [10L]
Fundamentals of Computer
History of Computers, Generations of Computers, Classification of Computers.
Basic Anatomy of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices. Basic Concepts of Assembly language, High level language, Compiler and Assembler.
Binary & Allied number systems (decimal, octal and hexadecimal) with signed and unsigned numbers (using 1's and 2's complement) - their representation, conversion and arithmetic operations. Packed and unpacked BCD system, ASCII. IEEE-754 floating point representation (half- 16 bit, full- 32 bit, double- 64 bit).
Basic concepts of operating systems like MS WINDOWS, LINUX
How to write algorithms & draw flow charts.

Module II: [10L]
Basic Concepts of C
C Fundamentals:
The C character set identifiers and keywords, data type & sizes, variable names, declaration, statements.
Operators & Expressions:
Arithmetic operators, relational and logical operators, type, conversion, increment and decrement operators, bit wise operators, assignment operators and expressions, precedence and order of evaluation. Standard input and output, formatted output -- printf, formatted input scanf.
Flow of Control:
Statement and blocks, if-else, switch-case, loops (while, for, do-while), break and continue, go to and labels.

Module III: [10L]

Program Structures in C

Basic of functions, function prototypes, functions returning values, functions not returning values. Storage classes - auto, external, static and register variables – comparison between them. Scope, longevity and visibility of variables.

C preprocessor (macro, header files), command line arguments.

Arrays and Pointers:

One dimensional arrays, pointers and functions – call by value and call by reference, array of arrays. Dynamic memory usage– using malloc(), calloc(), free(), realloc(). Array pointer duality.

String and character arrays; C library string functions and their use.

Module IV: [10L]

Data Handling in C

User defined data types and files:

Basic of structures; structures and functions; arrays of structures.

Files – text files only, modes of operation. File related functions – fopen(), fclose(), fscanf(), fprintf(), fgets(), fputs(), fseek(), ftell().

Text Books

1. Schaum's outline of Programming with C – Byron Gottfried
2. Teach Yourself C- Herbert Schildt
3. Programming in ANSI C – E Balagurusamy

Reference Books

1. C: The Complete Reference – Herbert Schildt
2. The C Programming Language- D.M.Ritchie, B.W. Kernighan

Course Name: PHYSICS- I LAB					
Course Code: PHYS 1051					
Contact Hours per week	L	T	P	Total	Credit Points
	0	0	3	3	1.5

Course Outcomes:

1. Transform the theoretical knowledge into experimental set design
2. Understand principle, concept, working and application of new technology and comparison of results with theoretical calculations.
3. Analyze the result obtained through experiment.
4. Gain knowledge of new concept in the solution of practical oriented problems and to understand more deep knowledge about the solution to theoretical problems.
5. Understand measurement technology, usage of new instruments and real time applications in engineering studies.
6. Develop skills to impart practical knowledge in real time solution.

Minimum of six experiments taking at least one from each of the following four groups :

Group 1 : Experiments in General Properties of matter

1. Determination of **Young's modulus** by **Flexure Method**
2. Determination of **bending moment** and **shear force** of a rectangular beam of uniform cross-section.
3. Determination of **modulus of rigidity** of the material of a rod by **static method**
4. Determination of **rigidity modulus** of the material of a **wire by dynamic method.**
5. Determination of **coefficient of viscosity** by Poiseulle's capillary flow method.

Group 2: Experiments in Optics

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

Group 3: Electricity & Magnetism experiments

1. Determination of **dielectric constant** of a given dielectric material.
2. Determination of resistance of **ballistic galvanometer by half deflection** method and study of variation of **logarithmic decrement** with series resistance.
3. Determination of the **thermo-electric power** at a certain temperature of the given thermocouple.
4. Determination of **specific charge (e/m)** of electron.

Group 4: Quantum Physics Experiments

1. Determination of **Planck's constant**.
2. Determination of **Stefan's radiation** constant.
3. Verification of **Bohr's atomic orbital** theory through **Frank-Hertz experiment**.
4. Determination of **Rydberg constant** by studying **Hydrogen/ Helium** spectrum.
5. Determination of **Hall co-efficient of semiconductors.**
6. Determination of **band gap** of semiconductors.
7. To study current-voltage characteristics, load response, areal characteristics and spectral response of photo voltaic solar cells.

Text Books

1. Advanced Practical Physics (vol. 1 and vol. 2)
B. Ghosh and K. G. Mazumdar.
2. Advanced course in practical physics
D. Chattopadhyay and P.C. Rakshit.

Course Name: PROGRAMMING FOR PROBLEM SOLVING LAB					
Course Code: CSEN1051					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**4**	**4**	**2**

Course Outcomes:

After completion of this course the students should be able:

1. To write simple programs relating to arithmetic and logical problems.
2. To be able to interpret, understand and debug syntax errors reported by the compiler.
3. To implement conditional branching, iteration (loops) and recursion.
4. To decompose a problem into modules (functions) and amalgamating the modules to generate a complete program.
5. To use arrays, pointers and structures effectively in writing programs.
6. To be able to create, read from and write into simple text files.

Software to be used: GNU C Compiler (GCC) with LINUX
NB: Cygwin (Windows based) may be used in place of LINUX

Topic 1: LINUX commands and LINUX based editors
Topic 2: Basic Problem Solving
Topic 3: Control Statements (if, if-else, if-elseif-else, switch-case)
Topic 4: Loops - Part I (for, while, do-while)
Topic 5: Loops - Part II
Topic 6: One Dimensional Array
Topic 7: Array of Arrays
Topic 8: Character Arrays/ Strings
Topic 9: Basics of C Functions
Topic 10: Recursive Functions
Topic 11: Pointers
Topic 12: Structures
Topic 13: File Handling

Text Books

1. Schaum's outline of Programming with C – Byron Gottfried
2. Teach Yourself C- Herbert Schildt
3. Programming in ANSI C – E Balagurusamy

Course Name: WORKSHOP /MANUFACTURING PRACTICES					
Course Code: MECH 1051					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	1	**0**	**4**	**5**	**3**

Course Outcomes:

Upon completion of this course

1. The students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.
2. The students will be able to fabricate components with their own hands.
3. They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
4. By assembling different components, they will be able to produce small devices of their interest.
5. The students will be able to describe different components and processes of machine tools.
6. The students will be able to apply the knowledge of welding technology and they can perform arc and gas welding to join the material.

(i) Lectures & videos: (13 hours)
Detailed contents

1. Introduction on Workshop and Safety Precautions. **(1 lecture)**
2. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods **(3 lectures)**
3. CNC machining, Additive manufacturing **(1 lecture)**
4. Fitting operations & power tools **(1 lecture)**
5. Electrical & Electronics **(1 lecture)**
6. Carpentry **(1 lecture)**
7. Plastic moulding, glass cutting **(1 lecture)**
8. Metal casting **(1 lecture)**
9. Welding (arc welding & gas welding), brazing **(2 lecture)**
10. Viva-voce **(1 lecture)**

(ii) Workshop Practice :(52 hours)[L : 0; T:0 ; P : 4 (2 credits)]

1. Machine shop **(12 hours)**
2. Fitting shop **(8 hours)**
3. Carpentry **(4 hours)**
4. Electrical & Electronics **(4 hours)**
5. Welding shop **(Arc welding 4 hrs + gas welding 4 hrs)** **(8 hours)**
6. Casting **(4 hours)**
7. Smithy **(4 hours)**
8. Plastic moulding& Glass Cutting **(4 hours)**
9. Sheet metal Shop **(4 hours)**

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

Suggested Text/Reference Books:

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

Course Name : BASIC ELECTRONICS					
Course Code: ECEN 1011					
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

Course Outcomes:

After going through this course, the students will be able to

1. Categorize different semiconductor materials based on their energy bands and analyze the characteristics of those materials for different doping concentrations based on previous knowledge on semiconductors acquired.

2. Describe energy band of P-N Junction devices and solve problems related to P-N Junction Diode both from device and circuit perspectives.

3. Design different application specific circuits associated with diodes operating both in forward and reverse bias.

4. Analyze various biasing configurations of Bipolar Junction Transistor and categorize different biasing circuits based on stability.

5. Categorize different field-effect transistors based on their constructions, physics and working principles and solve problems associated with analog circuits based on operational amplifiers.

6. Design and implement various practical purpose electronic circuits and systems meant for both special purpose and general purpose and anlayze their performance depending on the type of required output and subsequently the applied input.

Module I [10 L]

Basic Semiconductor Physics:
Crystalline materials, Energy band theory, Conductors, Semiconductors and Insulators, Concept of Fermi Energy level, intrinsic and extrinsic semiconductors, drift and diffusion currents in semiconductor

Diodes and Diode Circuits:
Formation of p-n junction, Energy Band diagram, forward & reverse biased configurations, V-I characteristics, load line, breakdown mechanisms, Zener Diode and its Application.
Rectifier circuits: half wave & full wave rectifiers: ripple factor, rectification efficiency.

Module II [8 L]
Bipolar Junction Transistors (BJT):
PNP & NPN BJT structures, current components in BJT, CE, CB, CC configurations, V-I Characteristics of CB & CE modes, regions of operation, Base width modulation & Early effect, thermal runaway, Concept of Biasing: DC load line, Q-point, basics of BJT amplifier operation, current amplification factors, different biasing circuits: fixed bias, collector to base bias, voltage divider bias.

Module III [9 L]
Field Effect Transistors (FET):
n-channel Junction Field Effect Transistor (JFET) structure & V-I characteristics.

Metal Oxide Semiconductor Field Effect Transistor (MOSFET): enhancement & depletion type MOSFETs (for both n & p channel devices), drain & transfer characteristics.
MOSFET as a digital switch, CMOS inverter, voltage transfer characteristic (VTC), NAND & NOR gate realization using CMOS logic.
Moore's Law, evolution of process node, state of integration (SSI, MSI, LSI, VLSI, ULSI),
Classification of Integrated circuits (IC) and their applications.

Module IV [9 L]

Feedback in amplifiers :

Concept of feedback, advantages of negative feedback (qualitative), Barkhausen criteria.

Operational Amplifier:

Ideal OPAMP characteristics, OPAMP circuits: inverting and non-inverting amplifiers, Adder, Subtractor, Integrator, Differentiator, Basic Comparator.

Special Semiconductor Devices:

Light Emitting Diode (LED), Silicon Controlled Rectifier (SCR), Photodiode: Operations, characteristics & applications.

References:

1. Boylestad & Nashelsky:Electronic Devices & Circuit Theory
2. R.A Gayakwad:Op Amps and Linear IC's, PHI
3. D. Chattopadhyay, P. C Rakshit : Electronics Fundamentals and Applications
4. Adel S. Sedra, Kenneth Carless Smith: Microelectronics Engineering
5. Millman & Halkias: Integrated Electronics.
6. Salivahanan: Electronics Devices & Circuits.
7. Albert Paul Malvino: Electronic Principle.

Course Name : BASIC ELECTRONICS LABORATORY					
Course Code: ECEN1061					
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	2	2	1

Course Outcomes:

1. The students will correlate theory with diode behavior.
2. They will design and check rectifier operation with regulation etc.
3. Students will design different modes with BJT and FET and check the operations.
4. They will design and study adder, integrator etc. with OP-AMPs.

List of Experiments (from)

1. Familiarization with passive and active electronic components such as Resistors, Inductors, Capacitors, Diodes, Transistors (BJT) and electronic equipment like DC power supplies, multi-meters etc.
2. Familiarization with measuring and testing equipment like CRO, Signal generators etc.
3. Study of I-V characteristics of Junction diodes.
4. Study of I-V characteristics of Zener diodes.
5. Study of Half and Full wave rectifiers with Regulation and Ripple factors.
6. Study of I-V characteristics of BJTs in CB mode
7. Study of I-V characteristics of BJTs in CE mode
8. Study of I-V characteristics of Field Effect Transistors.
9. Determination of input-offset voltage, input bias current and Slew rate of OPAMPs.
10. Determination of Common-mode Rejection ratio, Bandwidth and Off-set null of OPAMPs.
11. Study of OPAMP circuits: Inverting and Non-inverting amplifiers, Adders, Integrators and Differentiators.

Course Name : BUSINESS ENGLISH					
Course Code: HMTS 1202					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	2	0	0	2	2

Course Outcomes:

The learner will
1. Acquire competence in using English language to communicate.
2. Be aware of the four essential skills of language usage-listening, speaking, reading and writing.
3. Be adept at using various modes of written communication at work.
4. Attain the skills to face formal interview sessions.
5. Write reports according to various specifications.
6. Acquire the skill to express with brevity and clarity

Module- I (6hrs.)
Grammar (Identifying Common Errors in Writing)

- Subject-verb agreement
- Noun-pronoun agreement
- Misplaced Modifiers
- Articles
- Prepositions
- Redundancies

Module- II (6hrs.)
Basic Writing Strategies
Sentence Structures

- Use of phrases and clauses in sentences
- Creating coherence
- Organizing principles –accuracy, clarity, brevity
- Techniques for writing precisely
- Different styles of writing: descriptive,narrative, expository
- Importance of proper punctuation

Module- III (8hrs)

Business Communication- Scope & Importance

Writing Formal Business Letters:Form and Structure-Parts ofa Business letter, Business Letter Formats, Style and Tone, Writing strategies.

Organizational Communication: Agenda & minutes of a meeting, Notice, Memo, Circular

Organizing e-mail messages, E-mail etiquette

Job Application Letter: Responding to Advertisements and Forced Applications, Qualities of well-written Application Letters: The You-Attitude, Length, Knowledge of Job Requirement, Reader-Benefit Information, Organization, Style, Mechanics – Letter Plan: Opening Section, Middle Section, Closing Section

Resume and CV: Difference, Content of the Resume – Formulating Career Plans: Self Analysis, Career Analysis, Job Analysis, Matching Personal Needs with Job Profile – Planning your Resume – Structuring the Resume: Chronological Resume, The Functional Resume, Combination of Chronological and Functional Resume, Content of the Resume: Heading, Career Goal or Objectives, Education, Work Experience, Summary of Job Skills/Key Qualifications, Activities, Honors and Achievements, Personal Profile, Special Interests, References

Module- IV (6hrs)

Writing skills

- Comprehension: Identifying the central idea, inferring the lexical and contextual meaning, comprehension passage - practice
- Paragraph Writing: Structure of a paragraph, Construction of a paragraph, Features of a paragraph, Writing techniques/developing a paragraph.
- Précis: The Art of Condensation-some working principles and strategies. Practice sessions of writing précis of given passages.
- Essay Writing:Characteristic features of an Essay, Stages in Essay writing, Components comprising an Essay, Types of Essays-Argumentative Essay, Analytical Essay, Descriptive Essays, Expository Essays, Reflective Essays

References:

1. Theories of Communication: A Short Introduction, Armand Matterlart and Michele Matterlart, Sage Publications Ltd.
2. Professional Writing Skills, Chan, Janis Fisher and Diane Lutovich. San Anselmo, CA: Advanced Communication Designs.
3. Hauppauge, Geffner, Andrew P. Business English, New York: Barron's Educational Series.
4. Kalia, S. &Agarwal,S. Business Communication,Wiley India Pvt. Ltd., New Delhi, 2015
5. Mukherjee, H.S., Business Communication- Connecting at work., , Oxford University Press.2nd Edition.2015
6. Raman, M. and Sharma, S., Technical Communication: Principles and Practice, 2nd Ed., 2011.

Course Name : CHEMISTRY-I					
Course Code: CHEM 1001					
Contact hrs per week:	L	T	P	Total	Credit points
	3	1	0	4	4

Course Outcomes:

The course outcomes of the subject are

1. Knowledge of understanding the operating principles and reaction involved in batteries and fuel cells and their application in automobiles as well as other sectors to reduce environmental pollution.

2. An ability to analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.for engineering applications.

3. Have knowledge of synthesizing nano materials and their applications in industry, carbon nano tube technology is used in every industry now-a-days.

4. Understanding of bulk properties and processes using thermodynamic considerations.

5 Elementary knowledge of IR, UV, NMR and X-ray spectroscopy is usable in structure elucidation and characterisation of various molecules.

6. Knowledge of electronic effect and stereochemistry for understanding mechanism of the major chemical reactions involved in synthesis of various drug molecules.

MODULE 1
Atomic structure and Wave Mechanics:

Brief outline of the atomic structure, Duel character of electron, De Broglies's equation, the Heisenberg uncertainty principle, brief introduction of quantum mechanics, the Schrodinger wave equation, Hermitian operator, solution of the Schrodinger equation for particle in a one dimensional box, interpretation of the wave function Ψ, concept of atomic orbital.

3**L**

Thermodynamics:

Carnot cycle, 2nd law of thermodynamics, entropy, Clausius inequality, free energy and work function, Clausius Clapeyron Equation, Chemical Potential, Activity and Activity coefficient. Gibbs Duhem Relation. 4**L**

Spectroscopic Techniques & Application
Electromagnetic spectrum: EMR interaction with matter - absorption and emission of radiation.
Principle and application of UV- visible and IR spectroscopy
Principles of NMR Spectroscopy and X-ray diffraction technique **3L**

MODULE 2
Chemical Bonding

Covalent bond, VSEPR Theory, hybridization, molecular geometries, Dipole moment, Intermolecular forces, V.B. and M.O. Theory and its application in Homo and Heteronuclear diatomic molecules, Band theory of solids, Pi-molecular orbitals of ethylene and butadiene.

5**L**

Periodicity

Effective nuclear charge, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electro-negativity, inert pair effect.

3L

Ionic Equilibria

Acid Base Equilibria, Salt Hydrolysis and Henderson Equation, Buffer solutions, pH indicator, Common ion Effect, Solubility product, Fractional Precipitation .

2L

MODULE 3

Conductance

Conductance of electrolytic solutions, Strong and Weak electrolytes, effect of temperature and concentration. Kohlrausch's law of independent migration of ions, transport numbers and hydration of ions. Application of conductance Acid-base and precipitation titration.

3L

Electrochemical Cell

Thermodynamic derivation of Nernst equation, Electrode potential and its application to predict redox reaction; Standard Hydrogen Electrode, Reference electrode, cell configuration, half cell reactions, evaluation of thermodynamic functions; Reversible and Irreversible cells; Electrochemical corrosion.

Electrochemical Energy Conversion: Primary & Secondary batteries, Fuel Cells.

Reaction dynamics

Rate Laws, Order & Molecularity; zero, first and second order kinetics.

Pseudo-unimolecular reaction, Arrhenius equation.
Mechanism and theories of reaction rates (Transition state theory, Collison theory).
Catalysis: Homogeneous catalysis (Definition, example, mechanism, kinetics).

3L

MODULE 4

Stereochemistry

Representations of 3- dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis.

4L

Structure and reactivity of Organic molecule

Inductive effect, resonance, hyperconjugation, electromeric effect, carbocation, carbanion, free radicals, aromaticity. **3L**

Organic reactions and synthesis of drug molecule (4 lectures)

Introduction to reaction mechanisms involving substitution, addition, elimination and oxidation- reduction reactions. Synthesis of commonly used drug molecules.

3L

TEXT BOOKS

1. Atkins' Physical Chemistry, P.W. Atkins (10^{th} Edition)
2. Organic Chemistry, I. L. Finar, Vol-1 (6^{th} Edition)
3. Engineering Chemistry, Jain & Jain,(16^{th} Edition)
4. Fundamental Concepts of Inorganic Chemistry, A. K. Das, (2^{nd} Edition)
5. Engineering Chemistry -I, Gourkrishna Dasmohapatra, (3^{rd} Edition)

REFERENCE BOOKS

1. General & Inorganic Chemistry, R. P. Sarkar
2. Physical Chemistry, P. C. Rakshit, (7^{th} Edition)
3. Organic Chemistry, Morrison & Boyd , (7^{th} Edition)
4. Fundamentals of Molecular Spectroscopy, C.N. Banwell, (4^{th} Edition)
5. Physical Chemistry, G. W. Castellan, (3^{rd} Edition)
6. Basic Stereo chemistry of Organic Molecules, Subrata Sen Gupta, (1^{st} Edition)

Course Name : MATHEMATICS-II					
Course Code: MATH 1201					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	1	0	4	4

Course Outcomes:

1. Demonstrate the knowledge of probabilistic approaches to solve wide range of engineering problem.
2. Recognize probability distribution for discrete and continuous variables to quantify physical and engineering phenomenon.
3. Develop numerical techniques to obtain approximate solutions to mathematical problems where analytical solutions are not possible to evaluate.
4. Analyze certain physical problems that can be transformed in terms of graphs and trees and solving problems involving searching, sorting and such other algorithms.
5. Apply techniques of Laplace Transform and its inverse in various advanced engineering problems.
6. Interpret differential equations and reduce them to mere algebraic equations using Laplace Transform to solve easily.

Module-I Fundamentals of Probability (10L)

- Random experiment, Sample space and events
- Classical and Axiomatic definition of probability
- Addition and Multiplication law of probability
- Conditional probability
- Bayes' Theorem
- Random variables
- General discussion on discrete and continuous distributions
- Expectation and Variance
- Examples of special distribution: Binomial and Normal Distribution

Module-II Numerical Methods (10L)

- Solution of non-linear algebraic and transcendental equations: Bisection Method, Newton-Raphson Method, Regula-Falsi Method.

- Solution of linear system of equations: Gauss elimination method, Gauss-Seidel Method, LU Factorization Method, Matrix Inversion Method.

- Solution of Ordinary differential equations: Euler's and Modified Euler's Method , Runge-Kutta Method of 4^{th} order.

Module-III Basic Graph Theory (10L)

- Graphs: Digraphs, Weighted graph, Connected and disconnected graphs, Complement of a graph, Regular graph, Complete graph, Subgraph
- Walks, Paths, Circuits, Euler Graph, Cut sets and cut vertices
- Matrix representation of a graph, Adjacency and incidence matrices of a graph
- Graph isomorphism

- Bipartite graph
- Definition and properties of a tree
- Binary tree, Spanning tree of a graph, Minimal spanning tree, properties of trees
- Algorithms: Dijkstra's Algorithm for shortest path problem, Determination of minimal spanning tree using DFS, BFS, Kruskal's and Prim's algorithms

Module-IV Laplace Transformation (10L)

- Basic ideas of improper integrals, working knowledge of Beta and Gamma functions (convergence to be assumed) and their interrelations.
- Introduction to integral transformation
- Functions of exponential order, Definition and existence of Laplace Transform(LT) (statement of initial and final value theorem only)
- LT of elementary functions, Properties of Laplace Transformations , Evaluation of sine , cosine and exponential integrals using LT
- LT of periodic and step functions
- Definition and properties of inverse LT
- Convolution Theorem (statement only) and its application to the evaluation of inverse LT
- Solution of linear ODEs with constant coefficients (initial value problem) using LT

Suggested Books:

1. **Advanced Engineering Mathematics** , E.Kreyszig, Wiley Publications
2. **Introduction to Probability and Statistics for Engineers and Scientists**, S.Ross, Elsevier
3. **Introductory methods of Numerical Analysis**, S.S. Sastry, PHI learning
4. **Introduction to Graph Theory,** D. B. West, Prentice-Hall of India
5. **Engineering Mathematics,** B.S. Grewal, S. Chand & Co.

Course Name: BASIC ELECTRICAL ENGINEERING					
Course Code: ELEC 1001					
Contact Hours per week	L	T	P	Total	Credit Points
	3	1	0	4	4

Course Outcomes:

After attending the course, the students will be able to

1. Analyse DC electrical circuits using KCL, KVL and network theorems like Superposition Theorem, Thevenin's Theorem, Norton's Theorem and Maximum Power Transfer Theorem.
2. Analyse DC Machines; Starters and speed control of DC motors.
3. Analyse magnetic circuits.
4. Analyse single and three phase AC circuits.
5. Analyse the operation of single phase transformers.
6. Analyse the operation of three phase induction motors.

Module-I:

DC Network Theorem: Kirchhoff's law, Nodal analysis, Mesh analysis, Superposition theorem, Thevenin's theorem, Norton theorem, Maximum power transfer theorem, Star-Delta conversion. [6L]

Electromagnetism: Review of magnetic flux, Force on current carrying conductors, Magnetic circuit analysis, Self and Mutual inductance, B-H loop, Hysteresis and Eddy current loss, Lifting power of magnet. [5L]

Module-II

AC single phase system: Generation of alternating emf, Average value, RMS value, Form factor, Peak factor, representation of an alternating quantity by a phasor, phasor diagram, AC series, parallel and series-parallel circuits, Active power, Reactive power, Apparent power, power factor, Resonance in RLC series and parallel circuit. [10L]

Module-III

Three phase system: Balanced three phase system, delta and star connection, relationship between line and phase quantities, phasor diagrams, power measurement by two wattmeter method. [4L]

DC Machines: Construction, EMF equation, Principle of operation of DC generator, Open circuit characteristics, External characteristics, Principle of operation of DC motor, speed-torque characteristics of shunt and series machine, starting of DC motor, speed control of dc motor. [7L]

Module-IV

Single phase transformer: Construction, EMF equation, no load and on load operation and their phasor diagrams, Equivalent circuit, Regulation, losses of a transformer, Open and Short circuit tests, Efficiency . [6L]

3-phase induction motor: Concept of rotating magnetic field, Principle of operation, Construction, Equivalent circuit and phasor diagram, torque-speed/slip characteristics, Starting of Induction Motor. [4L]

Text Books:

1. Basic Electrical engineering, D.P Kothari & I.J Nagrath, TMH, Second Edition
2. Basic Electrical Engineering, V.N Mittle & Arvind Mittal, TMH, Second Edition
3. Basic Electrical Engineering, Hughes
4. Electrical Technology, Vol-I,Vol-II,Surinder Pal Bali, Pearson Publication
5. A Text Book of Electrical Technology, Vol. I & II, B.L. Theraja, A.K. Theraja, S.Chand & Company

Reference Books:

1. Electrical Engineering Fundamentals, Vincent Del Toro, Prentice-Hall
2. Advance Electrical Technology, H.Cotton, Reem Publication
3. Basic Electrical Engineering, R.A. Natarajan, P.R. Babu, Sictech Publishers
4. Basic Electrical Engineering, N.K. Mondal, Dhanpat Rai
5. Basic Electrical Engineering, Nath & Chakraborti
6. Fundamental of Electrical Engineering, Rajendra Prasad, PHI, Edition 2005.

Course Name: LANGUAGE LAB					
Course Code: HMTS-1251					
Contact Hours per week	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcomes:

The learner will

1. Acquire the techniques to become an effective listener.
2. Acquire the skill to become an effortless speaker.
3. Organize and present information for specific audience.
4. Communicate to make a positive impact in professional and personal environment.
5. Engage in research and prepare authentic, formal, official documents.
6. Acquire reading skills for specific purpose.

Module- I (4hrs)
Listening Skills

- Principles of Listening: Characteristics, Stages.
- Types of Listening: Passive listening, Marginal or superficial listening, Projective Listening, Sensitive or Empathetic Listening, Active or Attentive listening.
- Guidelines for Effective Listening
- Barriers to Effective Listening
- Listening Comprehension

Module- II (8hrs)

- Interviewing
  Types of Interviews, Format for Job Interviews: One-to-one and Panel Interviews, Telephonic Interviews,Interview through video conferencing.
- Interview Preparation Techniques, Frequently Asked Questions, Answering Strategies, Dress Code, Etiquette, Questions for the Interviewer, Simulated Interviews.

Module- III (6hrs)

- Public Speaking:TheSpeech Process: The Message, The Audience, The Speech Style, Encoding, Feedback.
- Characteristics of a good speech : content and delivery, structure of a speech
- Modes of delivery in public speaking: Impromptu, Extemporaneous, Prepared or Memorized, Manuscript.
- Conversation: Types of conversation: formal and informal, Strategies for effective conversation, Improving fluency.
- Situational conversation practice: Greetings and making introductions, Asking for information and giving instructions, agreeing and disagreeing.
- Conversational skills in the business scenario: One-to-one and Group communication, Gender and Culture Sensitivity, Etiquette, Sample Business Conversation, Telephonic Conversation

Module- IV (8hrs)
Presentation Skills

- Speaking from a Manuscript, Speaking from Memory, Impromptu Delivery, Extemporaneous Delivery, Analyzing the Audience, Nonverbal Dimensions of Presentation

- Organizing the Presentation: The Message Statement, Organizing the Presentation: Organizing the Speech to Inform, The Conclusion, Supporting Your Ideas – Visual Aids: Designing and Presenting Visual Aids, Selecting the Right Medium.
- Project Team/Group Presentations

References:

1. Carter, R. And Nunan, D. (Eds), The Cambridge guide to Teaching English to Speakers of Other Languages, CUP, 2001
2. Edward P. Bailey, Writing and Speaking At Work: A Practical Guide for Business Communication, Prentice Hall, 3rd Ed., 2004
3. Munter, M., Guide to Managerial Communication: Effective Business Writing and Speaking, Prentice Hall, 5th Ed., 1999
4. Sen, S.,Mahendra,A. &Patnaik,P.,Communication and Language Skills, Cambridge University Press, 2015
5. Locker,Kitty O. Business and Administrative Communication McGraw-Hill/ Irwin.
6. Chaney,L.andMartin,J., Intercultural Business Communication. Prentice Hall

Course Name : CHEMISTRY-I LAB					
Course Code: CHEM 1051					
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	3	3	1.5

Course Outcomes:

The course outcomes of the subject are

1. Knowledge to estimate the hardness of water which is required to determine the usability of water used in industries.
2. Estimation of ions like Fe^{2+}, Cu^{2+} and Cl^{-} present in water sample to know the composition of industrial water.
3. Study of reaction dynamics to control the speed and yield of various manufactured goods produced in polymer, metallurgical and pharmaceutical industries.
4. Handling physico-chemical instruments like viscometer, stalagmometer, pH-meter, potentiometer and conductometer.
5. Understanding the miscibility of solutes in various solvents required in paint, emulsion, biochemical and material industries.
6. Knowledge of sampling water can be employed for water treatment to prepare pollution free water.

Experiments:

1. Estimation of iron using $KMnO_4$ self indicator.
2. Iodometric estimation of Cu^{2+}.
3. Determination of Viscosity.
4. Determination of surface tension.
5. Adsorption of acetic acid by charcoal.
6. Potentiometric determination of redox potentials.
7. Determination of total hardness and amount of calcium and magnesium separately in a given water sample.
8. Determination of the rate constant for acid catalyzed hydrolysis of ethyl acetate.
9. Heterogeneous equilibrium (determination of partition coefficient of acetic acid in n-butanol and water mixture).
10. Conductometric titration for the determination of strength of a given HCl solution against a standard NaOH solution.
11. pH-metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
12. Determination of chloride ion in a given water sample by Argentometric method (using chromate indicator solution)

Reference Books:

1. Vogel's Textbook of Quantitative Chemical Analysis-G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney.
2. Advanced Practical Chemistry- S. C. Das
3. Practicals in Physical Chemistry- P. S. Sindhu

Course Name: BASIC ELECTRICAL ENGINEERING LABORATORY					
Course Code: ELEC 1051					
Contact Hours per week	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcomes:

The students are expected to

1. Get an exposure to common electrical apparatus and their ratings.
2. Make electrical connections by wires of appropriate ratings.
3. Understand the application of common electrical measuring instruments.
4. Understand the basic characteristics of different electrical machines.

List of Experiments:

1. Characteristics of Fluorescent lamps
2. Characteristics of Tungsten and Carbon filament lamps
3. Verification of Thevenin's & Norton's theorem.
4. Verification of Superposition theorem
5. Verification of Maximum Power Transfer theorem
6. Calibration of ammeter and voltmeter.
7. Open circuit and Short circuit test of a single phase Transformer.
8. Study of R-L-C Series / Parallel circuit
9. Starting and reversing of speed of a D.C. shunt Motor
10. Speed control of DC shunt motor.
11. No load characteristics of D.C shunt Generators
12. Measurement of power in a three phase circuit by two wattmeter method.

Course Name: ENGINEERING GRAPHICS & DESIGN					
Course Code: MECH 1052					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	1	**0**	**4**	**5**	**3**

Course Outcomes:

After going through the course, the students will be able

1. To understand the meaning of engineering drawing.
2. To have acquaintance with the various standards (like lines, dimensions, scale etc.) and symbols followed in engineering drawing.
3. To represent a 3-D object into 2-D drawing with the help of orthographic and isometric projections.
4. To read and understand projection drawings.
5. To draw the section view and true shape of a surface when a regular object is cut by a section plane.
6. To use engineering drawing software (CAD).

Lecture Plan (13 L)

1. Importance and principles of engineering drawing (1 L)
2. Concepts of Conic sections and Scale (1 L)
3. Introduction to concept of projection (Projections of points, lines and surfaces) (4 L)
4. Definitions of different solids and their projections (1 L)
5. Section of solids and sectional view (1 L)
6. Isometric projection (2 L)
7. Introduction to CAD (2 L)
8. Viva Voce (1 L)

Detailed contents of Lab hours (52 hrs)

Module 1: Introduction to Engineering Drawing covering**,**
Principles of Engineering Graphics and their significance, usage of Drawing instruments, lines, lettering & dimensioning, Conic section like Ellipse (General method only); Involute; Scales – Plain, Diagonal.

(4 hrs + 4 hrs)

Module 2: Orthographic Projections covering**,**
Principles of Orthographic Projections - Conventions - Projections of Points and lines inclined to both planes; Projections on Auxiliary Planes. Projection of lamina.

(4 hrs+4 hrs + 4 hrs)

Module 3: Projections of Regular Solids covering,
those inclined to both the Planes- Auxiliary Views.

(4 hrs + 4 hrs)

Module 4: Sections and Sectional Views of Right Angular Solids covering**,**
Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids.

(4 hrs)

Module 5: Isometric Projections covering**,**
Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions.

(4 hrs + 4 hrs)

Module 6: Overview of Computer Graphics covering,
listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids.

(4 hrs)

Module 7: Customisation & CAD Drawing
consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

(2 hrs)

Annotations, layering & other functions covering
applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation.

(2 hrs)

Module 6: Demonstration of a simple team design project that illustrates
Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame.

(4 hrs)

References:

1. Bhatt, N.D., Panchal V.M. & Ingle P.R., (2014) "Elementary Engineering Drawing" ; Charotan Publishing House
2. Narayana, K.L. and Kannaaiah P "Engineering Graphics"; TMH
3. Lakshminarayanan, V. and Vaish Wanar, R.S "Engineering Graphics" Jain Brothers.
4. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Edication.
5. Agarwal B. & Agarwal C. M. (2012), Engineering graphics, TMH Publications.

Course Name: COMMUNICATION FOR PROFESSIONALS					
Course Code: HMTS-1011					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

Students will be able to

1. Write business letters and reports
2. Communicate in an official and formal environment.
3. Effectively use the various channels of communication at work place.
4. Use language as a tool to build bridges and develop interpersonal relations in multi-cultural environment.
5. Learn to articulate opinions and views with clarity.
6.Use various techniques of communicationfor multiple requirements of globalized workplaces.

Module- I (9hrs.)
Introduction to Linguistics

- Phonetics- Vowel and Consonant Sounds (Identification & Articulation)
- Word- stress, stress in connected speech
- Intonation (Falling and Rising Tone)
- Voice Modulation
- Accent Training
- Vocabulary Building
- The concept of Word Formation
- Root words from foreign languages and their use in English
- Acquaintance with prefixes and suffixes from foreign languages in Englishto formderivatives
- Synonyms, Antonyms and standard abbreviations

Module- II (10hrs.)
Communication Skills

- Definition, nature & attributes of Communication
- Process of Communication
- Models or Theories of Communication
- Types of Communication
- Levels or Channels of Communication
- Barriers to Communication

Module- III (10hrs.)
Professional Writing Skills

- Letter Writing : Importance, Types , Process, Form and Structure, Style and Tone
- Proposal Writing: Purpose,Types of Proposals, Structure of Formal Proposals.
- Report Writing: Importance and Purpose, Types of Reports, Report Formats, Structure of Formal Reports, Writing Strategies.

Module- IV (10hrs.)
Communication skills at Work

- Communication and its role in the workplace
- Benefits of effective communication in the workplace
- Common obstacles to effective communication
- Approaches and Communication techniques for multiple needs at workplace: persuading, convincing, responding, resolving conflict, delivering bad news, making positive connections,
- Identify common audiences and design techniques for communicating with each audience

References:

1 Kumar,S. &Lata, P. Communication Skills, OUP, New Delhi2011
2 Rizvi,Ashraf,M. Effective Technical Communication, Mc Graw Hill Education(India) Pvt. Ltd..Chennai,2018
3 Raman, M. and Sharma, S., Technical Communication: Principles and Practice, 2nd Ed., 2011

Course Name: **Professional Communication Lab**					
Course Code: **HMTS 1061**					
Contact hrs per week:	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcomes:

Students will be able to

1.Communicate in an official and formal environment.
2.Effectively communicate in a group and engage in relevant discussion.
3.Engage in research and prepare presentations on selected topics.
4.Understand the dynamics of multicultural circumstances at workplace and act accordingly.
5.Organize content in an attempt to prepare official documents .
6.Appreciate the use of language to create beautiful expressions.

Module- I (4hrs)
Techniques for Effective Speaking
Voice Modulation: Developing correct tone
Using correct stress patterns: word stress, primary stress, secondary stress
Rhythm in connected speech
Module- II (6hrs.)
Effective Speaking and Social awareness
The Art of Speaking

- Encoding Meaning Using Nonverbal Symbols
- How to Improve Body Language
- Eye Communication, Facial Expression, Dress and Appearance
- Posture and Movement, Gesture, Paralanguage
- Encoding meaning using Verbal symbols: How words work and how to use words
- Volume, Pace, Pitch and Pause
- Cross-Cultural Communication : Multiple aspects/dimensions of culture
- Challenges of cross-cultural communication
- Improving cross-cultural communication skills at workplace.

Module- III (6hrs)

- Group Discussion:Nature and purpose
- Characteristics of a successful Group Discussion
- Group discussion Strategies: Getting the GD started, contributing systematically, moving the discussion along, promoting optimal participation, Handling conflict, Effecting closure.

Module- IV (10hrs.)

Professional Presentation Skills
Nature and Importance of Presentation skills
Planning the Presentation: Define the purpose, analyze the Audience, Analyze the occasion and choose a suitable title.

Preparing the Presentation: The central idea, main ideas, collecting support material, plan visual aids, design the slides
Organizing the Presentation: Introduction-Getting audience attention, introduce the subject, establish credibility, preview the main ideas, Body-develop the main idea, present information sequentially and logically, Conclusion-summaries, re-emphasize, focus on the purpose, provide closure.
Improving Delivery: Choosing Delivery methods, handling stage fright
Post-Presentation discussion: Handling Questions-opportunities and challenges.

References:

1. Carter, R. And Nunan, D. (Eds), The Cambridge guide to Teaching English to Speakers of Other Languages, CUP, 2001
2. Edward P. Bailey, Writing and Speaking At Work: A Practical Guide for Business Communication, Prentice Hall, 3rd Ed., 2004
3. Munter, M., Guide to Managerial Communication: Effective Business Writing and Speaking, Prentice Hall, 5th Ed., 1999
4. R. Anand, Job Readiness For IT & ITES- A Placement and Career Companion, , McGraw Hill Education.2015
5. Malhotra, A.,Campus Placements, McGraw Hill Education.2015

Course Name: **PHYSICS-ll**					
Course Code: **PHYS 2101**					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	1	0	4	4

Course Outcomes:

1. Understanding angular momentum kinetic energy and motion of a rigid body with applications in mechanical systems.
2. Understanding calculus of variation as a core principle underlying majority of the physical laws: Newton's laws, Laplace equation (electrostatics and fluid mechanics), wave equation, heat conduction equation,control theory and many other.
3. Appreciating dynamical equations as a consequence of variationalextremization of action functional along with the use of Euler-Lagrange equation to understand the behaviour of simple mechanical systems.\
4. Appreciating the ubiquity of oscillation physics-from pendulum and spring-mass system to electrical circuit and movement of piston and comprehending the small motion of a system around stable equilibrium throughthe notion of normal modes—the meaning of eigenvalue problem in oscillation physics.
5. Fluid Mechanics – An elucidation of the basic principles of fluid mechanics through the study of mass conservation, momentum balance, and energy conservation applied to fluids in motion.
6. Elasticity – A basic understanding of the mechanics of deformable bodies through a study of the concepts of normal and shear stresses and strains, following a review of the principles of statics.

Module I.RIGID BODY DYNAMICS

Angular Momentum, Kinetic Energy, Moment and Product of Inertia, Principal Moments of Inertia, Parallel and Perpendicular Axis Theorems, Examples, Euler Equations of Motion and the Symmetric Top. 12 Lectures

Module II.LAGRANGIAN AND HAMILTONIAN MECHANICS

Principle of Least Action, Virtual Work, Euler-Lagrange Equations, Cyclic Coordinates, Configuration Space, Examples: Simple and Double Pendulum and Atwood Machine. Conservation Laws. Hamilton Equations of Motion 12 Lectures

Module III. SMALL OSCILLATIONS

Small Oscillations of Conservative Systems. Lagrangian and Lagrange Equations of Motion. The Eigenvalue Equation and the Principal Axis Transformation, Coupled Pendulum, Frequencies of Free Vibration and Normal Coordinates 14 Lectures

Module IV. FLUID MECHANICS AND ELASTICITY

Differential Equation of Motion of Fluid Flow, Continuity Equation, Momentum Equation, Euler, Bernoulli and Navier Stokes Equations, Problems and Examples. Integral Form of Continuity and Momentum Equations.

Hooke"s law of Elasticity, Uniform Strain, Young, Bulk and Shear Modulus, The Strain and Stress Tensors. 14 Lectures

References:

1. Classical Mechanics by N. Rana and P. Joag Tata McGraw Hill
2. Classical Mechanics by John Taylor, University Science Books
3. The Variational Principles of Mechanics by Cornelius Lanzos, Dover Publications
4. Schaums Outline of Theoretical Mechanics by M. Spiegel, McGraw Hill
5. Theory of Elasticity by S. P. Timoshenko and J. N. Goodier 3rd Ed. McGraw Hill
6. A Physical Introduction to Fluid Mechanics by A. Smits, John Wiley & Sons

Course Name: **MATHEMATICAL METHODS**					
Course Code: **MATH 2001**					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	1	0	4	4

Course Outcomes:

1. Construct appropriate mathematical models of physical systems.
2. Recognize the concepts of complex integration, Poles and Residuals in the stability analysis of engineering problems.
3. Generate the complex exponential Fourier series of a function and make out how the complex Fourier coefficients are related to the Fourier cosine and sine coefficients.
4. Interpret the nature of a physical phenomena when the domain is shifted by Fourier Transform e.g. continuous time signals and systems.
5. Develop computational understanding of second order differential equations with analytic coefficients along with Bessel and Legendre differential equations with their corresponding recurrence
6. relations.
7. Master how partial differentials equations can serve as models for physical processes such as vibrations, heat transfer etc.

MODULE I : [12L]

Functions of Complex Variables:

Complex numbers and its geometrical representation.

Functions of a complex variable – Limits, Continuity, and Differentiability.

Analytic Functions, Cauchy- Riemann equations, Necessary and sufficient conditions for analyticity of complex functions (Statement only), Harmonic functions.

Line Integral on complex plane, Cauchy-Goursat theorem, Cauchy's Integral Formula. Taylor's and Laurent's series expansion.

Zeros, Different types of Singularities. Definitions of poles and residues, Residue Theorem, Evaluation of real integrals using residue theorem.

MODULE II : [12L]

Fourier Series , Integrals and Transforms:

Definite Integral , Orthogonality of Trigonometric Functions , Power Series and its convergence .

Periodic Functions , Even and Odd Functions , Dirichlet's Conditions , Euler Formulas for Fourier coefficients , Fourier series representation of a function, e.g. Periodic square wave, Half wave rectifier, Unit step function. Half Range series , Parseval's Identity.

Fourier Integral theorem , Fourier transform , Fourier sine and cosine transform, Linearity, Scaling , Frequency Shifting and Time shifting properties, Convolution Theorem.

Discussion of some physical problems : e.g Forced oscillations.

MODULE III : [12L]

Series Solutions to Ordinary Differential Equations and Special Functions:

Series solution of ODE: Ordinary point , Singular point and
Regular Singular point, series solution when = is an
ordinary point, Frobenius method.

Legendre's Equation , Legendre's polynomials and its graphical representation.

Bessel's equation , Bessel's function of first kind and its graphical representation.

Finite Difference Method and its application to Boundary Value Problem.

MODULE IV : [12L]

Partial Differential Equations:

Introduction to partial differential equations, Formation of partial differential equations, Linear and Nonlinear pde of first order, Lagrange's and Charpit's method of solution.

Second order partial differential equations with constant coefficients , Illustration of wave equation, one dimensional heat equation, Laplace's equation, Boundary value problems and their solution by the method of separation of variables. Solution of Boundary value problems by Laplace and Fourier transforms.

Suggested Books:

1. Complex Variables and Applications ; Brown Churchill ; MC Graw Hill

2. Complex Variable ; Murrey R. Spiegel; Schaum's Outline Series

3. Theory of Functions of a Complex Variable ; Shanti Narayan, P. K. Mittal ; S. Chand

4. Larry C. Andrew, B. K. Shivamoggi ; Integral Transforms for Engineers and Applied Mathematicians ; Macmillan

5. Fourier Analysis with Boundary Value Problem ; Murrey R. Spiegel ; Schaum's Outline Series

6. Mathematical Methods ; Potter, Merle C., Goldberg, Jack. ; PHI Learning

7. Ordinary and Partial Differential Equations ; M. D. Raisinghania ; S. Chand

8. Elements of Partial Differential Equation; Ian Naismith Sneddon ; Dover Publications

9. Advanced Engineering Mathematics ; Kreyszig ; Willey

10. Higher Engineering Mathematics ; B. V. Ramana ; Tata McGraw-Hill

Course Name: **BIOLOGY**					
Course Code: **BIOT2105**					
Contact hrs per week:	L	T	P	Total	Credit Points
	2	0	0	2	2

Course Outcomes:

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

1. Understand the basic structure and function of cells and cellular organelles.
2. Understand the fundamental concepts of DNA, RNA and central dogma of cells.
3. Characterize the different types of proteins, lipids and carbohydrates.
4. Analyze the mechanism of inheritance of characters through generations.
5. Understand and implement the working principles of enzymes and their applications in biological systems and industry.
6. Design and evaluate different environmental engineering projects with respect to background knowledge about bioresources, biosafety and bioremediation.

MODULE-I: BASIC CELL BIOLOGY

Prokaryotic and Eukaryotic cells, Cell theory; Cell structure and function, Cell organelles, Structure and function of DNA and RNA, Central Dogma; Genetic code and protein synthesis.

MODULE-II: BIOCHEMISTRY AND CELLULAR ASPECTS OF LIFE

Biochemistry of carbohydrates, proteins and lipids; Fermentation; Cell cycle; Basics of Mendelian Genetics.

MODULE-III: ENZYMES AND INDUSTRIAL APPLICATIONS

Enzymes – significance, co-factors and co-enzymes, classification of enzymes; models for enzyme action; Restriction enzymes; industrial applications of enzymes.

MODULE-IV: BIODIVERSITY AND BIOENGINEERING INNOVATIONS

Basic concepts of environmental biosafety, bioresources, biodiversity, bioprospecting, bioremediation, biosensors; recent advances in engineering designs inspired by examples in biology.

TEXT BOOKS:

•Wiley Editorial, "Biology for Engineers: As per Latest AICTE Curriculum," Wiley-India, 2018.
•S. ThyagaRajan, N. Selvamurugan, M. P. Rajesh, R. A. Nazeer, Richard W. Thilagaraj, S. Barathi, and M. K. Jaganathan, "Biology for Engineers," Tata McGraw-Hill, New Delhi, 2012.

REFERENCES

•Jeremy M. Berg, John L. Tymoczko and Lubert Stryer, "Biochemistry," W.H. Freeman and Co. Ltd., 6th Ed., 2006.
•Robert Weaver, "Molecular Biology," MCGraw-Hill, 5th Edition, 2012.
•Jon Cooper, "Biosensors A Practical Approach" Bellwether Books**,** 2004.
•Martin Alexander, "Biodegradation and Bioremediation," Academic Press, 1994.
•Kenneth Murphy, "Janeway's Immunobiology," Garland Science; 8th edition, 2011

Course Name: **ENGINEERING MECHANICS**					
Course Code: **MECH 2101**					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After going through the course, the students will be able

1. Understand basic concepts of vector algebra as applied to engineering mechanics.
2. Draw free body diagram of a system under equilibrium.
3. Understand friction phenomenon and calculate friction loss.
4. Interpret dynamics of members/links in a mechanism and understand inertia force with the help of D'Alembert's principle.
5. Know how to calculate the CG location and MI values required for design of structures.
6. Apply the principles of work-energy and impulse-momentum for analysis of dynamic systems.

SL. No	Syllabus	Contacts Hrs.
Module 1	Importance of Mechanics in Engineering ; Definition of Mechanics; Concepts of particles & rigid bodies; Vector and scalar quantities; Vector algebra –definition and notation; Types of vectors – equal , equivalent , free , bound , sliding ; Addition , subtraction of vectors ; Parallelogram law , triangle law , vector polygon ; Scalar multiplication of vectors ; Resolution of vectors in Cartesian co–ordinate system ; Unit vector, unit co–ordinate vectors $(\hat{\imath}, \hat{\jmath}, \hat{k})$; Direction cosines ; Addition/ subtraction of vectors in components form. Dot product , cross product and the application ; Important vector quantities (position vector , displacement vector, velocity vector, acceleration vector, force vector); Force, Moment of a force about a point and about an axis , moment of a couple ; Representation of force and moments in items of $\hat{\imath}, \hat{\jmath}, \hat{k}$. Principle of transmissibility of force (sliding vector); Varignon's theorem for a system of concurrent forces with proof; Resolution of a force by its equivalent force-couple system; Resultant of forces.	1 4 5
Module 2	Type of forces – collinear, concurrent, parallel, concentrated, distributed; Active and reactive forces, different types of reaction forces; Free body concept and diagram; Concept and equilibrium of forces in two dimensions; Equations of equilibrium; Equilibrium of three concurrent forces -- Lami's theorem.	9

Module 3	Concept of friction: Laws of Coulomb's friction; Angle of friction, angle of repose, coefficient of friction -- static and kinetic. Distributed force system; Centre of gravity; Centre of mass & centroid; Centroid of an arc; Centroid of plane areas – triangle, circular sector, quadrilateral and composite area consisting of above figures. Area moment of inertia: Moment of inertia of a plane figure; Polar moment of inertia of a plane figure; Radius of gyration, Parallel axes theorem.	3 7
Module 4	Introduction to dynamics: Kinematics & kinetics; Newton's laws of motion; Law of gravitation and acceleration due to gravity; Rectilinear motion of particles with uniform & non – uniform acceleration. Plane curvilinear motion of particles: Rectangular components (projectile motion), normal and tangential components. Kinetics of particles: D'Alembert's principle and free body diagram; Principle of work & energy; Principle of conservation of energy. Impulse momentum theory: Conservation of linear momentum	3 4 3
	Total	**39 ****

Recommended books:-

1. Engineering Mechanics:- Statics and Dynamics by Meriam & Kreige , Wiley india
2. Engineering Mechanics:- Statics and Dynamics by I.H. Shames, P H I
3. Engineering Mechanics by Timoshenko , Young and Rao , TMH
4. Fundamentals of Engineering Mechanics by Nag & Chanda – Chhaya Prakashani.

Course Name: **FLUID MECHANICS**					
Course Code: **MECH 2102**					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

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

- Examine and use different properties of fluid.
- Apply the fundamental laws to solve problems in fluid statics of incompressible fluids.
- Analyze fluid flow problems with application of mass, momentum and energy conservation equations in engineering systems..
- Develop concept of boundary layer growth and boundary layer separation.
- Evaluate different losses in viscous flow through pipes.
- Perform the dimensional analysis for fluid flow problems.

Sl. No.	Syllabus	Contact Hrs.
Module 1	Definition of fluid and importance of fluid mechanics; Concept of Continuum; Fluid properties- density, specific weight, specific volume, specific gravity. Viscosity: definition, causes of viscosity, Newton's law of viscosity, Ideal and Real fluids; No-slip condition, dimensional formula and units of viscosity, kinematic viscosity; Variation of viscosity with temperature. Newtonian and Non-Newtonian fluids with Rheology diagram; Compressibility and Bulk modulus of elasticity. Difference between compressible and incompressible fluids. Fluid statics: Pascal's Law-statement and proof; Basic Hydrostatic Law and its proof; Variation of pressure with depth in incompressible fluid, piezometric head, pressure head; Unit and scales of pressure measurement. Measurement of fluid pressure: Piezometer, Manometers -Simple and Differential U-tube manometer, Inverted tube manometer, Inclined tube manometer. Characteristics and choice of manometric fluid.	1 4 2 3
Module 2	Hydrostatic thrust on submerged plane and curved surfaces; buoyancy, stability of submerged and floating bodies. Fluid kinematics: Definition; Flow field and description of fluid motion (Eulerian & Lagrangian method), steady and unsteady flow, uniform and non-uniform flow-examples. Stream line, Stream tube, Path line; Equation of streamline and path line. Concept of control volume, Continuity equation in finite (1-D) and differential form in 3-D Cartesian coordinate system.	5 1 3

Module 3	Acceleration of a fluid particle-local acceleration, convective acceleration. Fluid dynamics: Euler's equation of motion; Bernoulli's equation and its significance; Bernoulli's Equation for a real fluid with applications in flow measurement (Venturimeter, Orifice meter, Pitot tube). Application of linear momentum to control volume-linear momer analysis of force exerted by a fluid stream on a solid boundary-bends etc. Boundary layer theory: concept of boundary layer; boundary layer thickness, displacement thickness, momentum thickness, growth of boundary layer, Boundary layer separation.	4 2 4
Module 4	Characteristics of Laminar and Turbulent flow; Reynolds experiment, critical Reynolds number; Laminar flow through pipe- Hagen-Poiseuille equation. Flow through closed conduits: Darcy Weisbach equation; concept of friction factor in a pipe flow, Variation of friction factor with Reynolds Number; Moody's diagram and its use; Minor losses- at sudden expansion, at sudden contraction, at bends, at valves, and fittings etc. Concept of flow potential and flow resistance. Pipes connected in series and parallel. Dimensional analysis and Buckingham Pi theorem.	4 4 2
	Total Classes	39

Text Books:

1. Introduction to Fluid Mechanics and Fluid Machines- Som, Biswas and Chakraborty, TMH, 3e
2. Fluid Mechanics and Machinery-C.S.P Ojha, R. Berndtsson, P.N. Chandramouli, OUP, 1e
3. Fluid Mechanics – Fox, Mcdonald & Pritchard, Wiley, 8e
4. Mechanics of Fluids- B Massey, Taylor & Francis, 8e

Reference books:

1. Fluid Mechanics – Dr. A.K. Jain, Khanna Publishers, 11e

2. Engineering Fluid Mechanics – Graebel. W. P, Taylor & Francis (Yes Dee Publishing Pvt. Ltd), 1st Indian reprint, 2013

Course Name: **HUMAN VALUES AND PROFESSIONAL ETHICS**					
Course Code: **HMTS 2001**					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

The student will

1. be aware of the value system and the importance of following such values at workplace
2. learn to apply ethical theories in the decision making process
3. follow the ethical code of conduct as formulated by institutions and organizations
4. Implement the principles governing work ethics
5. Develop strategies to implement the principles of sustainable model of development
6. Implement ecological ethics wherever relevant and also develop eco-friendly technology

Module I (10 L)

Human society and the Value System
Values: Definition, Importance and application.
Formation of Values: The process of Socialization; Self and the integrated personality; Morality, courage, integrity
Types of Values:
Social Values: Justice, Rule of Law, Democracy, Indian Constitution, Secularism
Aesthetic Values: Perception and appreciation of beauty
Organizational Values: Employee: Employer--- rights, relationships, obligations
Psychological Values: Integrated personality and mental health
Spiritual Values &their role in our everyday life
Value Spectrum for a Good Life, meaning of Good Life
Value Crisis in Contemporary Society
Value crisis at----Individual Level ;Societal Level; Cultural Level
Value Crisis management --- Strategies and Case Studies

Module II (10L)

Ethics and Ethical Values; Principles and theories of ethics
Consequential and non-consequential ethics
Egotism,Utilitarianism, Kant's theory and other non-consequential perspectives
Ethics of care, justice and fairness, rights and duties
Ethics—Standardization; Codification; Acceptance; Application
Types of Ethics--- Ethics of rights and Duties; Ethics of Responsibility; Ethics and Moral judgment; Ethics of care; Ethics of justice and fairness; Work ethics and quality of life at work
Professional Ethics
Ethics in Engineering Profession;
moral issues and dilemmas, moral autonomy(types of inquiry)
Kohlberg's theory, Gilligan'stheory (consensus and controversy)
Code of Professional Ethics Sample Code of ethics like ASME, ASCE. IEEEInstitute of Engineers, Indian Institute of materials management, Institute of Electronics and telecommunication engineers
Violation of Code of Ethics---conflict, causes and consequences

Engineering as social experimentation, engineers as responsible experimenters (computer ethics, weapons development)
Engineers as managers, consulting engineers, engineers as experts, witnesses and advisors, moral leadership
Conflict between business demands and professional ideals
social and ethical responsibilities of technologies.
Whistle Blowing: Facts, contexts, justifications and case studies
Ethics and Industrial Law
Institutionalizing Ethics: Relevance, Application, Digression and Consequences

Module III (10L)

Science, Technology and Engineering
Science, Technology and Engineering as knowledge and profession
----Definition, Nature, Social Function and Practical application of science
Rapid Industrial Growth and its Consequences
Renewable and Non- renewable Resources: Definition and varieties; Energy Crisis
Industry and Industrialization; Man and Machine interaction
Impact of assembly line and automation ;Technology assessment and Impact analysis
Industrial hazards and safety; Safety regulations and safety engineering
Safety responsibilities and rights; Safety and risk, risk benefit analysis and reducing risk
Technology Transfer: Definition and Types ; The Indian Context

Module IV (6L)

Environment and Eco- friendly Technology
Human Development and Environment; Ecological Ethics/Environment ethics
Depletion of Natural Resources: Environmental degradation; Pollution and Pollution Control
Eco-friendly Technology: Implementation, impact and assessment

Sustainable Development: Definition and Concept; Strategies for sustainable development;
Sustainable Development--- The Modern Trends

Appropriate technology movement by Schumacher and later development; Reports of Club of Rome.

Suggested Readings:

1)Tripathi,A.N., Human Values, New Age International, New Delhi,2006
2)Ritzer, G., Classical Sociological Theory, The McGraw Hill Companies, New York,1996.
3)Doshi,S.L., Postmodern Perspectives on Indian Society, Rawat Publications, New Delhi,2008.
4)Bhatnagar, D.K., Sustainable Development, Cyber Tech Publications, New Delhi, 2008.
5)Kurzwell,R., The age of Spiritual Machines, Penguin Books, New Delhi,1999.
6)Weinberg, S.K., Social Problems in Modern Urban Society, Prentice Hall,Inc.,USA, 1970.
7) Giddens, Anthony 2009. Sociology. London: Polity Press (reprint 13th Edition).

Course Name: **ENVIRONMENTAL SCIENCE**					
Course Code: **EVSC 2016**					
Contact hrs per week:	L	T	P	Total	Credit Points
	2	0	0	2	0

Course Outcomes:

The course outcomes of the subject are

1. Understand the natural environment and its relationships with human activities.
2. Characterize and analyze human impacts on the environment.
3. Integrate facts, concepts, and methods from multiple disciplines and apply to environmental problems.
4. Educate engineers who can work in a multi-disciplinary environment to anticipate and address evolving challenges of the 21st century.
5. Understand and implement scientific research strategies, including collection, management, evaluation, and interpretation of environmental data.
6. Design and evaluate strategies, technologies, and methods for sustainable management of environmental systems and for the remediation or restoration of degraded environments.

Module 1

Socio Environmental Impact **6L**

Basic ideas of environment and its component Population growth: exponential and logistic; resources; sustainable development. 3L

Concept of green chemistry, green catalyst, green solvents

Environmental disaster and social issue, environmental impact assessment, environmental audit, environmental laws and protection act of India. 3L

Module 2 **6L**

Air Pollution

Structures of the atmosphere, global temperature models

Green house effect, global warming; acid rain: causes, effects and control. 3L

Lapse rate and atmospheric stability; pollutants and contaminants; smog; depletion of ozone layer; standards and control measures of air pollution. 3L

Module 3 **6L**

Water Pollution

Hydrosphere; pollutants of water: origin and effects; oxygen demanding waste; thermal pollution; pesticides; salts.

Biochemical effects of heavy metals; eutrophication: source, effect and control. 2L

Water quality parameters: DO, BOD, COD.

Water treatment: surface water and waste water. 4L

Module 4 **6L**

Land Pollution

Land pollution: sources and control; solid waste: classification, recovery, recycling, treatment and disposal. 3L

Noise Pollution

Noise: definition and classification; noise frequency, noise pressure, noise intensity, loudness of noise, noise threshold limit value; noise pollution effects and control. 3L

Text/Books

1. GourKrishna Das Mahapatra, Basic Environmental Engineering and Elementary Biology, Vikas Publishing House P. Ltd.
2. A. K. De, "Environmental Chemistry", New Age International.
3. A. K. Das, Environmental Chemistry with Green Chemistry, Books and Allied P. Ltd

References/Books

1. S. C. Santra, Environmental Science, New Central Book Agency P. Ltd
2. D. De, D. De, Fundamentals of Environment & Ecology, S. Chand & Company Ltd.

Course Name: **MACHINE DRAWING-I**					
Course Code: **MECH 2156**					
Contact hrs per week:	L	T	P	Total	Credit Points
	0	0	3	3	1.5

Course Objectives:

After going through the course, the students will be able to

1. Covert a 2-dimensional multi-view projection of an object into a 3-dimensional model.
2. Set all the pre-requisite parameters for generating a drawing of any object using AutoCAD software.
3. Prepare a 2-dimensional drawing of an object using different tools in AutoCAD software.
4. Modify any existing AutoCAD drawing using its various editing tools.
5. Generate an isometric view of any object for better representation of its actual 3-dimensional appearance.
6. Manage assembly work of entire machine or machine part using AutoCAD software.

Module	**Topics**	**Contact Hrs. / No. of sheets**
1A	Conversion of Orthographic Projection (Hand Drawing) a) Conversion of Isometric Views into Multi-View Projection.	1 classes/1 sheet
1B	Conversion of Orthographic Projection (Hand Drawing) b) Conversion of Multi-Views into Isometric Projection.	2 classes/1 sheet
2	A detailed discussion on Drafting software (AutoCAD) Drawing format setting tools, like LIMITS Command, UNITS command, LAYER command, tool for line type setting from GUI, tool for text height-n-width setting etc. Different Drawing tools, like LINE command, PLINE command, MLINE Command, ELLIPSE Command, RECTANGLE Command, POLYGON Command etc. Different transformation and drawing editing tools, like ZOOM Command, SCALE Command, ERRASE Command, TRIM Command, OFFSET Command, MOVE Command, COPY Command, ARRAY Command etc. Conversion of Isometric Views into Multi-View Projection in AutoCAD Conversion of Multi-Views into Isometric Projection in AutoCAD	4 classes
3A	Orthographic Sectional View of a) Shaft Coupling in AutoCAD	1 ½ classes
3B	Nut & Bolt Assembly in AutoCAD	1 ½ classes
4	Assembling of Shaft with antifriction bearing mounted on a Plummer Block in AutoCAD	2 classes

Text Books:

1. Text Book of Machine Drawing, K. C. John, PHI Learning, 1e, 2009

2. Machine Drawing, K. L. Narayana, New Age International, 4e, 2012

3. IS 2079 (Guide for selection of fits), IS-919 (Recommendations for limits and fits in engineering), IS-10719 (To indicate surface texture and finish), IS-8000 (Geometrical tolerance on technical drawing)

4. AutoCAD 2013 for Engineers and Designers, Sham Tickoo, Dreamtech Press, 1e, 2013

Course Name: **WORKSHOP PRACTICE II**					
Course Code: **MECH 2157**					
Contact hrs per week:	L	T	P	Total	Credit Points
	0	0	3	3	1.5

Course Outcomes:

After going through the course, the students will be able to:

CO1: **Understand** various manufacturing processes that are used in a typical workshop, be **aware** of various safety precautions that needs to be observed while working.

CO2: **Understand** the mechanics of material removal in a lathe machine, **Identify** various metal cutting operations that are possible in lathe ,**Select** speed, feed and depth of cut depending on the material to be processed ,**List** and **Sequence** various operations and **Manufacture** and **Inspect** a Job from a given drawing .

CO3: **Define** the key parameters of spur gear, be **Conversant** with the cutting of spur gear in a milling machine, **Calculate** the blank diameter of a spur gear given its module and no of teeth , **Manufacture** and **Inspect** the spur gear.

CO4 : **Differentiate** between the TIG and MIG welding, **Select** TIG and MIG welding parameters , **Operate** the TIG and MIG welding machines , **Perform** a simple job and **Assess** its defects.

CO5 : **Understand** and **Explain** various allowances given to a product drawing , **Prepare and Inspect** a wooden pattern from given a product drawing, **Demonstrate** the purpose and use of core in a mould , **Cast** a component and **Inspect** the component for any casting defects .

CO6 : **Differentiate** between hot working and cold working of metals, **Prepare** a sheet metal component and a forged component from a given drawing, **Calculate** the blank size of sheet metal from a manufacturing drawing, **Appreciate** the various safety measures needs to be taken while forging.

LIST OF JOBS TO BE CARRIED OUT

Sr. No.	Job. No.	Job Description	CO
1.	MECH 2157/01	To prepare a Job involving various operations involving Lathe machine.	1,2
2.	MECH 2157/02	To cut a spur gear in Milling machine.	1,3
3.	MECH 2157/03	To cut a key way in a shaft and spur gear(manufactured in Job no MECH 2157/02), prepare key and assemble onto the shaft.	1,2,3
4.	MECH 2157/04	To prepare a wooden pattern as per drawing given.	1,5
5.	MECH 2157/05	To prepare a sand mould using the pattern manufactured in Job No. MECH 2157/04 and cast the same.	1,5
6.	MECH 2157/06	To prepare a sheet metal fabricated component as per given drawing.	1,6
7.	MECH 2157/07	To prepare a chisel from a hexagonal bar.	1,6
8.	MECH 2157/08	To prepare a sheet metal fabricated component using TIG, MIG and SPOT Welding.	1,4

Reference books:

1. "Elements of Workshop Technology" Vol 1 &2, Hajra Choudhury, Media Promoters & Publishers Pvt. Ltd.
2. "A course in Workshop Technology" Vol 1 & 2, B. S. Raghuwanshi, Dhanpat Rai & Co.

Course Name: **STRENGTH OF MATERIALS**					
Course Code: **MECH 2201**					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	1	0	4	4

Course Objectives:

After going through the course, the students will be able

1: **Define** different types of stresses / strains and **analyze** relationships among them.

2: **Classify** and **analyze** statically determinate and indeterminate problems.

3: **Examine** circular members in torsion and members subject to flexural loadings.

4: **Determine** the principal stresses and orientations of principal planes for structural members.

5: **Assess** the governing differential equation for elastic curve of a beam.

6: **Interpret** the concept of buckling as being a kind of instability and **evaluate** columns subjected to axial loads.

Sl. No.	Syllabus	Contact Hrs.
Module 1	**Stress**: General Concepts, Method of Sections, Definition of Stress, Normal and shear stresses, Definition of strain, Normal and Shear Strains. Stress Analysis of Axially Loaded Bars: Statically Determinate and Indeterminate Problems, Thermal Stresses. Stress-Strain Relationships, Generalized Hooke's Law for isotropic materials, Poisson's ratio, relationships between Young's modulus, shear modulus and bulk modulus. Strain energy in tension, compression.	13
Module 2	**Beam Statics**: axial force, shear force & bending moment diagrams, differential equations of equilibrium for a beam element, symmetric beam bending, strain energy in bending, beams of composite cross section and shear stresses in bending. Transformation of stresses in two-dimensional problems, principal stresses, Maximum & Minimum normal stress maximum shear stresses, Mohr's circle of stress. Thin-walled pressure vessels.	13
Module 3	Beam Deflections: deflections by simple integration, method of superposition, energy methods, Castigliano's theorems. Statically determinate and indeterminate problems on beam deflections.	13

Module 4	Torsion of circular shafts, angular deflection, strain energy in torsion, torsional stress in Solid and Hollow shafts, combined bending and torsion. Columns: Buckling of columns, Critical Euler loads for columns with pinned ends and with other different end restraints, eccentric loading of short struts, Euler's curve, empirical column formulae- (i) straight line (ii) parabolic (iii) Rankine Gordon. Analysis of slender column using Johnson's Formula.	13
	Total Classes	52

Text Books:

1. Elements of Strength of Materials- S.P. Timoshenko & D.H. Young, East West press, 5e, 2011
2. Strength of Materials- D. Nag & A. Chanda, Wiley India, 2e
3. Strength of Materials- R. Subramanian, Oxford University press, 2e, 2010

Reference Books:

1. Engineering Mechanics of Solids- E.P. Popov & T.A. Balan, Pearson Education Asia, 2e, 2010
2. Mechanics of Materials- R.C. Hibbeler, Prentice Hall, 16e, 2013
3. Introduction to Solid Mechanics by I. H. Shames, JM Pitarresi, Prentice Hall, 3e.

Course Name: **FLUID MACHINERY**					
Course Code: **MECH 2202**					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

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

1. Understand the working principle of rotodynamic machines.
2. Classify different types of fluid machines.
3. Identify different losses in fluid machines.
4. Analyze different performance characteristics of various fluid machines.
5. Apply similarity principle in prototype and model design of fluid machines.
6. Describe the phenomenon of cavitation in fluid machines.

Sl. No.	Syllabus	Contact Hrs.
Module 1	Introduction: Definition and application of fluid machines. Classification under different categories (based on principle of operation, direction of energy transfer, type of fluid used). Rotodynamic Machines: Classification- Pump and Turbines. Radial, Axial and Mixed flow type machines. Centrifugal Pump: General pumping system – Suction pipe with strainer and foot valve, delivery pipe. Main components of centrifugal pump and their functions-Impeller eye, impeller blade, Volute or scroll casing, Front and Back shroud. Principle of Energy Transfer, Rotor work, Velocity diagram. Basic equation of energy transfer in Rotodynamic machines- expression for Euler head. Head vs discharge relationship: Ideal head and actual head developed. Shut-off head, manometric head, No swirl condition; effect of outlet blade angle (BCV, FCV, Radial) on head developed. Comparison of radial, axial and mixed flow pump in terms of head developed and discharge. Different losses in a centrifugal pump and efficiencies.	2 2 6
Module 2	Priming of a centrifugal pump. Characteristics curves of centrifugal pump: Main characteristics, Operating characteristics and Muschel curves. System resistance curve with expression for a general pumping system- suction head, delivery head and static head; Matching of pump and system characteristics curves. Operating point and design point. Multi staging of centrifugal pump-Series and parallel operation under different conditions.	4 5
Module 3	Hydraulic Turbines: Classification- Impulse Turbine: Pelton Turbine- Main components and their functions, velocity triangle	4

	and work done. Wheel efficiency, Hydraulic efficiency, Overall efficiency. Reaction turbine: Radial flow reaction turbine-Francis Turbine: main components and their functions; inward and outward radial flow turbine, velocity diagram; Some definitions (Speed ratio, flow ratio, discharge). Net Head across a reaction turbine; Theory and use of different types of draft tube. Axial flow reaction turbine-Propeller and Kaplan turbines, component parts: construction and operation; Difference between Francis and Kaplan Turbine. Characteristics curves of impulse and reaction turbines: Main characteristics, Operating characteristics and Muschel curves.	4 2
Module 4	Positive Displacement Pumps: Reciprocating and Rotary Pumps; Main components of reciprocating pump. Working principle-discharge, work done and power required to drive; slip of reciprocating pump. Variation of velocity and acceleration in the suction and delivery pipes due to acceleration of the piston. Effect of variation of velocity on friction in the suction and delivery pipes; Air vessel. Cavitation in Pumps and Turbine: Causes and effects; NPSH, Thoma's cavitation factor and critical cavitation factor. Methods to avoid cavitation. Principle of similarity in rotodynamic machine and model testing. Specific speed of pump and turbine. Unit quantities in hydraulic machines.	5 2 3
	Total Classes	39

Text Books:

1. Introduction to Fluid Mechanics and Fluid Machines-Som, Biswas and Chakraborty, TMH, 4e
2. Hydraulic Machines – Dr. Jagdish Lal, Metropolitan Book Co. Pvt. Ltd, Reprint 2011.
3. Mechanics of Fluids- B Massey, Taylor & Francis, 8e

Reference Books:

1. Fluid Mechanics and Machinery-C.S.P Ojha, R. Berndtsson, P.N. Chandramouli, OUP, 1e
2. Fluid Mechanics – J.F Douglas, J.M Gasiorek, J.A Swaffield. (Pearson 5e)
3. Fluid Mechanics – Fox, Mcdonald & Pritchard, Wiley, 8e
4. Turbomachinery- Design and theory – Gorla, Taylor & Francis (Yes Dee Publishing Pvt. Ltd), 1st Indian reprint 2011
5. Turbomachines by B.U.Pai; WILEY, 1e, 2013
6. Principle of Turbomachinery- Turton R. K, Springer (Yes Dee Publishing Pvt. Ltd), 1st Indian reprint 2011

Course Name: **ENGINEERING THERMODYNAMICS**					
Course Code: **MECH 2203**					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	1	0	4	4

Course Outcomes:

After going through the course, the students will be able to

1. Analyze a thermodynamic system and calculate work transfer in various quasi-static processes.
2. Understand the difference and correlation between heat transfer and work transfer
3. Read and interpret the values of properties of water/steam from steam table for evaluation of heat transfer and work transfer in processes involving steam
4. Understand and calculate the change of entropy for some specific cases
5. Calculate thermal efficiency of Otto, Diesel and dual combustion cycle
6. Understand the basics of thermal power generation and calculate the efficiencies of Rankine cycles with reheat and regeneration.

Sl. No.	Syllabus	Contact Hrs
Module 1	**Basic concepts of Thermodynamics:** Introduction; Definition of Thermodynamic systems; System boundary, universe; Open, closed and isolated systems; Control mass and control volume; State; Definition of properties: intensive, extensive & specific properties. Thermodynamic equilibrium; Change of state; Thermodynamic processes; Quasi-static processes; Thermodynamic cycles; Zeroth law of Thermodynamics -concept of temperature. **Heat & Work:** Definition and units of Thermodynamic work; Work transfer-displacement work for a simple compressible system, path function, Pdv work in various quasi-static processes(isothermal, isobaric, adiabatic, polytropic, isochoric); Free expansion; Net work done by a system in a cycle. Definition and unit of heat; Heat transfer-a path function; Similarities and dissimilarities between heat and work. **First law of Thermodynamics:** For a closed system executing a cycle; Concept of stored energy; Energy as a property, different forms of stored energy, internal energy, first law for a non-flow process;	5 4 3

Module 2	Definition of enthalpy, C_p, C_v; Energy of an isolated system; Flow energy; First law for an open system-steady flow energy equation; Examples of steady flow devices (nozzle and diffuser, turbine, pump, compressor, heat exchanger, throttling device); PMM-I. **Pure substance**: Definition, properties of pure substance; Phases of pure substance; Phase change processes of pure substances — critical point, triple point; Property (phase) diagrams — P- v, P- T, T- s, h-s diagrams; P v T surface for water; Property tables of pure substances — compressed liquid, saturated, wet and superheated vapour, use of saturated and superheated steam table and Mollier diagram.	4 7
Module 3	**Second law of Thermodynamics:** Qualitative difference between heat and work; Definition of source & sink: cyclic heat engine, heat pump and refrigerator, thermal efficiency of heat engine, C.O.P of heat pump and refrigerator; Kelvin-Plank and Clausius statements of second law; Equivalence of the two statements. PMM-ll Reversible process; Irreversible process; Factors for irreversibility; Carnot cycle and Carnot efficiency; Carnot theorem, corollaries; Thermodynamic temperature scale; Reversible heat engine and heat pump. **Entropy:** Clausius Inequality: Entropy as a property; T-s plot for reversible isothermal, adiabatic, isochoric & isobaric processes. Tds equation and calculation of entropy change of ideal gases for various processes; entropy change of solids; Concept and uses of entropy, Entropy principle.	3 3 5
Module 4	**Air standard Cycles and introduction to I C Engines:** Air standard cycles — Otto cycle, Diesel cycle, Dual combustion cycle; P-v, T-s plots; Efficiency, net work done, mean effective pressure; Principles of 4-stroke S I engine and C I engine; Engine nomenclature. **Reciprocating air compressor:** Compression process, work of compression, Single stage reciprocating compressor, volumetric efficiency, efficiency of a compressor; Multistage compression, advantages, ideal intermediate pressure. **Vapour power Cycle:** Carnot cycle and its practical difficulties; Basic Rankine cycle with steam; Mean temperature of heat addition, steam rate, heat rate; Reheat cycle; Regenerative cycle.	4 5 5
		36

Text Books:

1. Engineering Thermodynamics- 5e, Nag, P.K. – TMH.
2. Fundamentals of Thermodynamics- 6e, Sonntag, Borgnakke & Van Wylen, Wiley India

Reference Books:

1. Thermodynamics- an Engineering approach - 6e, Cengel & Boles, TMH
2. Principles of Engineering Thermodynamics -7e, Moran, Shapiro, Boettner, Bailey. Wiley India

Course Name: **MANUFACTURING PROCESSES**					
Course Code: **MECH 2204**					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After completing the course, students will be able to

1. Form basic idea of different mechanical manufacturing processes (except machining) & related equipment along with type of products manufactured through such processes.
2. Acquire working knowledge of sand casting process.
3. Know about different arc welding processes, resistance welding process, friction welding process.
4. Familiarize with different forming processes like rolling, forging, extrusion & their specific applications.
5. Learn about powder metallurgy process & different plastic moulding processes.
6. Acquire working knowledge of press working process.

Sl. No.	Syllabus	Contact Hrs.
Module 1	**Introduction to casting processes:** Engineering materials (metals & plastics); classification of manufacturing processes. Casting: Definition; Ferrous & non ferrous casting; Example of cast products. Types of casting & their application: (1) Sand casting, (2) Shell moulding, (3) Expendable mould, (4) Investment casting, (5) Die casting, (6) Centrifugal casting, (7) Sodium silicate-CO_2 moulding. Sand casting: pattern, types of pattern, materials, allowances, mould making procedure; definition & meaning of different terms, cope & drag, gating system and riser design. Properties of moulding sand: moulding sand composition; effect of grain size, clay & water content on moulding sand properties, sand testing. Core: Definition & use; Core making with oven/no baking, core prints & chaplets. Defects in sand casting & remedies. Process & utility of die casting & centrifugal casting.	10
Module 2	**Welding process:** Different metal welding processes; types of joints. Gas welding: oxy-acetylene flame; gas welding equipment; welding process. Electric arc welding: principle of arc formation; arc welding equipment- AC & DC machine; electrodes. Manual metal arc welding procedure: edge preparation, current & voltage setting, electrode movement; down hand, horizontal & overhead welding. TIG & MIG welding: process & application. Resistance welding- spot welding & butt/seam welding. Causes & remedy of welding defects,NDT methods.	8
Module 3	**Forming process:** Elastic & plastic deformation of perfect crystal; effect of mechanical working on	10

	mechanical properties; hot & cold working; recrystalization process. **Forging:** Definition; hot & cold forging; application. Forging methods: smith forging, drop forging, press forging & machine forging. Design features of forging dies; forging defects. **Rolling:** definition; hot & cold rolling; rolled products- sections & flats, Rolling load & torque. Rolling stand: 2 Hi, 3Hi, 4Hi & cluster mill. **Extrusion:** process & product; hot & cold extrusion; forward & backward extrusion; impact extrusion. **Wire drawing:** process & products; drawing dies, drawing machine.	
Module 4	**Press work, Powder metallurgy & Plastic processing:** **Press work:** definition of process & different operations like shearing, blanking, piercing, notching, drawing (cupping), coining & embossing. Press tools (die & punch); effect of tool clearance; simple, compound & combination die. Basic components of a press; electro mechanical & hydraulic press. **Powder metallurgy:** Definition & products; metal powder making processes. Processing methods: blending, compacting, sintering, secondary operations (heat treatment, coating). **Definitions of polymer;** thermo-plastics & thermo-sets; popular plastics & their use. Processes: extrusion; injection moulding; blow moulding; thermo-forming (vacuum & pressure).	8
	Total Class	**36**

Text Books:

1. Manufacturing technology, Foundry, Forming & Welding-P.N Rao. Vol. 1, 3e, 2012
2. Manufacturing Science-A Ghosh & A Mallick, 2e, 2010
3. Manufacturing Engineering & Technology-S Kalpakjian; Pub:Addison Wesley. 5e, 2013
4. Fundamentals of Metal forming processes by B. L. Juneja, New age International publishers, 2e, 2010

Reference Books:

1. Materials & processes in manufacturing-E.P Degarmo, Black & Kohser, Pub: Wiley, 10e
2. Processes & materials of manufacturing-R.A Lindberg, 2e, 1978

Course Name: **KINEMATICS OF MACHINES**					
Course Code: **MECH 2205**					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

On completion of this course student will be able to-

1. Specify a mechanism on the basis of its technical parameters.
2. Analyze velocity of different components in a mechanism.
3. Analyze acceleration of different components in a mechanism.
4. Synthesize principle dimensions (link length, angular position etc) of a Four Bar mechanism.
5. Construct different power transmission layout using gears.
6. Design layouts of a cam drive for specified follower motion.

Module	Syllabus	Contact Hrs.
1	Introduction to mechanisms, Difference between Machine and Mechanism; Kinematic link, Types of links, Kinematic pair, Types of constrained motions, Types of Kinematic pairs, Kinematic chain, Types of joints, Mechanism, Machine, Degree of freedom (Mobility), Kutzbach criterion, Grubler's criterion. Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions, Double slider crank chain and its inversions.	8
2A	**Velocity Analysis of mechanisms (mechanisms up to 6 links).** Velocity analysis by instantaneous center of rotation method (Graphical approach) Velocity analysis by relative velocity method (Graphical approach)	5
2B	**Acceleration analysis of Mechanism** Acceleration Images, Klein's construction, Coriolis acceleration. Analytical expression of velocity & acceleration.	4
3A	**Synthesis** Introduction, Analytical derivation of four bar mechanism: Displacement function, velocity function and acceleration function. Analytical and Graphical process of synthesis (basic discussion) Analytical synthesis of mechanism: Function generation	3
3B	**Gear and Gear trains :** Types of Gears, Gear terminologies, Simple, compound, Epicyclic gear train; Speed-torque analysis of geartrains. gear train; Speed-torque analysis of geartrains.	5

4A	**Cam Mechanisms:** Cam and its Classifications. Followers and its Classification. Motion analysis and plotting of displacement-time, velocity-time, acceleration- time, jerk-time graphs for SHM motion, uniform velocity motion, Constant acceleration motion and Cycloid motions of cams with knife-edge, roller and flat face follower (along with concept of offset follower). Pressure angle and method to control pressure angle Layout of cam profiles.	7
4B	**Lower Pair Mechanisms:** **Straight line generating Mechanisms:** Exact Straight Line Generating Mechanisms – Peaucellier's and Hart's Approximate Straight Line Generating Mechanisms – Watt's, Grasshopper and Tchebicheff's. **Offset slider crank mechanisms-** Pantograph. Hook joint- single and double **Steering gear mechanisms –** Ackerman, Davis	4
	Total Classes	**36**

Text Books:

1. Theory of Machines – S S Rattan, Tata McGraw Hill, 4e, 2014
2. Theory of Machines – R. S. Khurmi and J. K. Gupta, S. Chand Technical, 14e, 2005

Reference Books:

1. Theory of Machines and Mechanisms – Uicker, Pennock and Shigley, Oxford University Press, 3e, 2009
2. Kinematics and Dynamics of Machinery – R. L. Norton, McGraw Hill Education, 1e, 2009
3. The Theory of Machines through Solved Problems – J. S. Rao, New Age International Publication, 1e, 2012
4. Mechanism and Machine Theory – Ashok G. Ambekar, PHI Learning, 1e, 2007
5. Theory of Mechanisms & Machines (3rd edition) By Ghosh and Mallik; East West Press, 3e, 2006

Course Name: **APPLIED MECHANICS LAB**					
Course Code: **MECH 2251**					
Contact hrs per week:	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcomes:

After completing the course students will be able to:

1. Examine material behavior under different loading conditions experimentally and relate with theoretical knowledge gained.
2. Demonstrate experimentally the load-deformation behavior of a material under tensile and torsional loadings.
3. Utilize a strain gauge for measurement of strain and subsequently the modulus of elasticity.
4. Evaluate hardness using different hardness test method and coefficient of friction between different materials.
5. Explain the method deployed in determining the stiffness of leaf and helical spring.
6. Identify metal cracks and examine metallographic structure.

List of Experiments:

1. Tensile test of mild steel.
2. Impact Test – Charpy and Izod.
3. Drawability test of sheet metal by Cupping
4. Fatigue test of a typical sample.
5. Torsion test of mild steel.
6. Deflection of cantilever beam using a strain gauge.
7. Hardness Test (Brinell hardness, Rockwell hardness and Vicker's hardness).
8. Determination of coefficient of friction.
9. Determination of stiffness of leaf spring.
10. Determination of stiffness of close coiled helical spring.
11. Identification of surface cracks by Dye Penetration Test of given sample.
12. Identification of surface and sub-surface cracks by Magnetic particle inspection (MPI) Test.
13. Sample preparation and metallographic observation of ferrous, non-ferrous metals and alloys.

Reference Books:

1. Nag, D., Chanda, A. (2018) Strength of Materials, Second Edition, Wiley India Pvt. Ltd., New Delhi, India.
2. Timoshenko, S.P., Young, D.H. (2011) Elements of Strength of Materials, Fifth Edition, Rekha Printers Pvt. Ltd., Affiliated by East West Press Pvt. Ltd., New Delhi, India.
3. Hibbeler, R.C. (2018) Mechanics of Materials, Ninth Edition (S.I. units), Pearson India Education Services Pvt. Ltd., Noida, India.
4. Bhandari, V.B. (2015) Design of Machine Elements, Third Edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi, India.

Course Name: **FLUID MECHANICS & HYDRAULIC MACHINES LAB**					
Course Code: **MECH 2252**					
Contact hrs per week:	L	T	P	Total	Credit Points
	0	0	3	3	1.5

Course Outcomes:

At the end of the course, a student will be able to	
1	Apply the laws of fluid mechanics to solve of engineering problems.
2	Demonstrate some fundamental characteristics of flowing fluid.
3	Examine different flow measurement devices used in fluid flow systems.
4	Analyze different losses occurred in pipe flow.
5	Investigate various performance characteristics of centrifugal pump.
6	Understand the operation and performance of hydraulic turbines.

List of Experiments:

1. Characteristics of Laminar & Turbulent flow.
2. Verification of Bernoulli's Theorem.
3. Determination of Coefficient of Discharge of Flow Measuring Devices.
4. Pipe friction characteristics in different flow regimes for flow through pipes.
5. Calibration of V-Notch & Rectangular Weir.
6. Determination of airflow velocity by a Pitot Static Tube.
7. Performance test of a Centrifugal Pump.
8. Performance test of a Pelton Turbine.
9. Performance test of a Francis Turbine.

Reference Books:

1. 'Fluid Mechanics with Laboratory Manual' by B. Majumdar, PHI Publication.
2. 'Fluid Mechanics' by Frank M White, McGraw-Hill Publication.
3. 'Mechanics of Fluids' by B. Massey, CRC Press Publication.
4. 'Fluid Mechanics (Including Hydraulic Machines)' by A. K. Jain, Khanna Publication.

Course Name: **MACHINE DRAWING-II**					
Course Code: **MECH 2256**					
Contact hrs per week:	L	T	P	Total	Credit Points
	0	0	3	3	1.5

Course Outcomes:

On completion of this course students will be able to

1. Read and generate drawing with proper dimension, geometrical tolerance, surface roughness and other manufacturing symbols.
2. Create 3-D model of any machine part parametrically in simplest possible way using a CAD software.
3. Execute advanced modeling job of a very complicated part using a CAD software.
4. Assemble 3-D parts of a whole machine with a CAD software in fully constrained way.
5. Generate detailed drafting parametrically along with sectional view with detailed dimensioning using a CAD software.
6. Create any machine modeling using a CAD software staring from part modeling to automated drafting along with BOM.

Module	Topics	Contact Hrs. / No. of sheets
1	• **Geometric dimensioning and tolerancing (GD&T):** ➢ An introduction about GD&T ➢ Discussion on analytical methodology to calculate Dimensional Tolerances on the basis of required fitment and basic dimensions. ➢ To know how to select any Geometrical Tolerance on the basis positional requirements of different parts in an assembly. ➢ Different types of surface roughness symbols and manufacturing symbols and their implementations. • **A brief discussion on CAD/CAM/CAE and their respective software.**	9
2	• **3D modeling tools of a CAD software named *PTC Creo-Parametric*:** ➢ Discussion on tools used in 'Sketching Module' of PTC Creo. ➢ Different Sketch based tools under 'Part Module' like, Extrude, Revolve, Sweep, Variable Section Sweep, Blend, and Swept Blend. ➢ Various Feature based tools under Part Module like, Round, Chamfer, Pattern, Hole, Copy Geometry, Boolean Operations (Trim, Merge and Intersect), Thicken and Solidify.	12
3	• **Assembly of parts with PTC Creo Parametric Software:** ➢ Discussion on Top-Down assembly methodology ➢ Creation of assembled part using Bottom-Up methodology ➢ Exploding the components of an assembled part. • **Automated Drafting using PTC Creo Parametric** ➢ Setting of different drafting parameters. ➢ Creation of different projections, auxiliary projection, sectional view, detailed view. ➢ Dimensioning, writing annotations, putting tolerance symbols, surface finish symbols and manufacturing symbols.	9
4	Building up parts, assembly model and manufacturing drawing of following machine part assemblies in accordance with few predefined design constraints. ➢ A screw jack assembly. ➢ A shaft coupling assembly.	6

Recommended Book:

1. PTC Creo Parametric 3.0- for engineers and Designers by Prof. Sham Tickoo, Dreamtech Press

Course Name: **MECHANICAL MEASUREMENT AND INSTRUMENTATION**					
Course Code: **MECH 2211**					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

At the end of the course, a student will be able to	
1	Understand various measuring techniques.
2	Implement the concept of interchangeability, fits and tolerance in engineering drawings and manufacturing.
3	Understand the structure and characteristics of measuring instruments.
4	Define and understand working principle of transducers.
5	Apply the knowledge of surface finish and its measurement for design of engineering components.
6	Select and operate measuring instruments such as LVDT, SEM, Strain Gauge, Piezoelectric load cell, Pneumatic gauge, Thermocouple, Optical Pyrometer as necessitated by the engineering application.

Module No.	**Syllabus**	**Contact hrs.**
1	Introduction: Definition and importance of Metrology & Measurement; Methods of measurements – direct, indirect, comparison, substitution, transposition, deflection and null measurement; Errors in measurement – absolute, relative, parallax, alignment, loading, dynamic and calibration error; Units of measurements – SI base and derived units, SI prefixes of units.	**3**
	Linear Metrology: Vernier scale; use of Vernier calliper, Vernier height and depth gauge, micrometer; slip gauge, surface plate.	**1**
	Angular Metrology: Use of protractor, Vernier bevel protractor, angle gauges, sine bar and slip gauges.	**2**
	Measurements of: (i) Level using spirit-level; (ii) Flatness using interferrometry (Newton's rings) and dial indicator; Parallelism, cylindricity and concentricity using dial indicator. Alignment & testing methods. Gear tooth measurement.	**4**
2	Interchangeability of components; concept of limits, tolerances and fits; Hole basis and shaft basis system of fits; Go and No Go limit gauges; plug, ring, snap, thread, radius and feeler gauges.	**5**
	Definition, use and essential features of Comparators; working principle and application of (i) dial gauge, (ii) Cook optical comparator, (iii) back pressure Bourdon gauge pneumatic comparator, (iv) In-process gauging (v) optical comparator-profile projector.	**5**

3	Measuring Instruments: Functional elements of an instrument – sensing, conversion & manipulation, data transmission and presentation element; Characteristics – accuracy, precision, repeatability, sensitivity, reproducibility, linearity, threshold, response; Transducers – definition, primary and secondary, active and passive. Tolerance analysis in manufacturing and assembly.	**5**
	Measurement of Surface Finish: Definition; Terminologies – geometrical surface, effective surface, surface roughness, roughness (primary texture), waviness (secondary texture), form, lay, sampling length; Numerical evaluation of surface roughness: peak-to-valley height (Rmax), centre line average (CLA, Ra), average depth (Rm), smoothness value (G); Principle of operation of a Talysurf.	**4**
4	Principle of operation of a few measuring instruments: displacement by LVDT; SEM, force by strain – gauge load cell and piezoelectric load cell; pressure by Bourdon – tube gauge; temperature by liquid-in-glass thermometer, thermocouples, optical pyrometer.	**10**
	Total:	**39**

Text Books:

1. N. V. Raghavendra & L. Krishnamurthy, Engineering Metrology & Measurement, Oxford University Press
2. R. Rajendra, Principles of Engineering Metrology, Jaico Pub. House. 2e
3. Bewoor and Kulkarni, Metrology & Measurement, TMH. 1e

Reference books:

1. E.O. Doebelin and D.N. Manik, Measurement Systems– Application and Design, Tata McGraw Hill. 5e
2. Beckwith, Lienhard and Marangoni, Mechanical Measurements, Pearson. 6e
3. R.K. Jain, Metrology, Khanna Publication, New Delhi. 20e

Course Name: **MECHANICAL MEASUREMENT AND INSTRUMENTATION LAB**					
Course Code: **MECH 2261**					
Contact hrs per week:	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcomes:

At the end of the course, a student will be able to	
1	Measure linear dimensions using Vernier Caliper, Outside Micrometer. Vernier Height Gauge & Depth Micrometer.
2	Measure internal dimensions using Inside Tubuler Micrometer and Telescopic Gauge.
3	Measure precision angles using Sine Bar, Vernier Bevel Protractor and Angle Gauge.
4	Measure linear and angular dimensions of precision components and profiles using Profile Projector.
5	Measure parallelism, cylindricity and concentricity of components using dial indicator.
6	Measure surface finish.

Taking measurements using following instruments:

1. Measurement of linear dimensions of a rectangular block by Vernier Caliper and Outside Micrometer.
2. Measurement of the diameter of a hole by Inside Tubuler Micrometer and Telescopic Gauge.
3. Linear measurement using Vernier Height Gauge & Depth Micrometer.
4. Precision Angular measurement using Sine Bar.
5. Angular measurement using Vernier Bevel Protractor and Angle Gauge.
6. Measurement of thread profile of a bolt/ file by Profile Projector.
7. Measurement using Thread gauge, Radius gauge, Angle gauge and Feeler gauge.
8. Measurement of parallelism, cylindricity and concentricity of components using dial indicator.
9. Measurement of surface finish
10. Measurement of air velocity across an air duct using anemometer.

N.B. A minimum of six experiments must be performed in the semester.

Text Books:

1. N. V. Raghavendra & L. Krishnamurthy, Engineering Metrology & Measurement, Oxford University Press
2. R. Rajendra, Principles of Engineering Metrology, Jaico Pub. House. 2e
3. Bewoor and Kulkarni, Metrology & Measurement, TMH. 1e