MECHANICAL ENGINEERING

B.TECH. PROGRAMME

JULY - 2020

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 Practical				**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 1252	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 Practical				**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 Practical				**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	2
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.	**Paper Code**	**Paper Name**	**Sl.No.**	**Paper 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.	**Paper 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
MECH 3224: Industrial Engineering

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

Honours Papers:

Sl. No.	Semester	Paper Code	Paper Name	Contact hours/week				Credit Points
				L	T	P	Total	
01	1st	ECEN 1011	Basic Electronics	3	0	0	3	3
02	1st	ECEN 1061	Basic Electronics Lab	0	0	2	2	1
03	2nd	HMTS 1011	Communication for Professionals	3	0	0	3	3
04	2nd	HMTS 1061	Professional Communication Lab	0	0	2	2	1
05	4th	MECH 2211	Mechanical Measurement and Instrumentation	3	0	0	3	3
06	4th	MECH 2261	Mechanical Measurement and Instrumentation Lab	0	0	2	2	1
07	6th	MECH 3211	IC Engine	3	0	0	3	3
08	6th	MECH 3261	IC Engine Lab	0	0	2	2	1
09	7th	MECH 4111	Automation in Manufacturing	3	0	0	3	3
10	7th	MECH 4161	Automation in Manufacturing Lab	0	0	2	2	1
			Total	**15**	**0**	**10**	**25**	**20**

Swayam/MOOCs courses recommended to the students of ME Dept.

Sl. No.	Paper Code	Paper Name	Credit Points	Corresponding Online Course	Offered by	Platform
1	ECEN1011	Basic Electronics	3	Fundamentals of Semiconductor Devices	IISc Bangalore	NPTEL
2	ECEN 1061	Basic Electronics Lab	1			
3	HMTS1011	Communication for Professionals	3	Effective Business Communication	IIM Bangalore	Swayam
4	HMTS1061	Professional Communication Lab	1	Developing Soft Skills and Personality	IIT Kanpur	Swayam
5	MECH2211	Mechanical Measurement and Instrumentation	3	Engineering Metrology	IIT Kanpur	Swayam
6	MECH2261	Mechanical Measurement and Instrumentation Lab	1			
7	MECH3211	IC Engines	3	IC Engines and Gas Turbines	IIT Guwahati	NPTEL
8	MECH3261	IC Engines Lab	1			
9	MECH4111	Automation in Manufacturing	3	Manufacturing Automation	IIT Kanpur	NPTEL
10	MECH4161	Automation in Manufacturing Lab	1			

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 Hours 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 Hours 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 Hours 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 Hours 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 Hours 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 Hours 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	**L**	**T**	**P**	**Total**	**Credit Points**
per week	**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 1252					
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 Hours 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 Hours 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)

Module 8: 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 9: 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 Hours 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 communication for 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 English to form derivatives
- 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 Hours 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 Hours 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 Hours 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 Hours 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 Hours 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;	1
	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);	4
	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.	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.	3

	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.	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 & HYDRAULICS					
Course Code: MECH 2102					
Contact Hours 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 fluid kinematics and dynamics principles.
- Develop concept of boundary layer growth and boundary layer separation.
- Examine different flow parameters for viscous flow through pipe and evaluate different losses in pipe flow.
- 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 (Venturi meter, Orifice meter, Pitot tube). Application of linear momentum to control volume-linear momentum equati force exerted by a fluid stream on a solid boundary- thrust on pipe 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 Hours 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 Hours 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 Hours 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 Hours 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 Hours 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 Hours 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

- Classify different types of fluid machines and list their components.
- Apply the working principle of rotodynamic machines for evaluating different flow parameters.
- Identify losses in fluid machines and relate different efficiencies.
- Analyze performance characteristics of various fluid machines.
- Examine different components and working principle of positive displacement machine.
- Describe different processes and phenomena involving operation of 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. Principle of similarity in rotodynamic machine and model testing.	4 5

Module 3	Hydraulic Turbines: Classification- Impulse Turbine: Pelton Turbine- Main components and their functions, velocity triangle 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 4 2
Module 4	Positive Displacement Machine: Reciprocating Pump- Main components; 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 Pump and Turbine: Causes and effects; NPSH, Thoma's cavitation factor and critical cavitation factor. Methods to avoid cavitation. 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 Hours 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	3
	Reversible process; Irreversible process; Factors for irreversibility; Carnot cycle and Carnot efficiency; Carnot theorem, corollaries; Thermodynamic temperature scale; Reversible heat engine and heat pump.	3
	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.	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.	4
	Reciprocating air compressor: Compression process, work of compression, Single stage reciprocating compressor, volumetric efficiency, efficiency of a compressor; Multistage compression, advantages, ideal intermediate pressure.	5
	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.	5
		48

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 Hours 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.	10
Module 3	**Forming process:** Elastic & plastic deformation of perfect crystal; effect of mechanical working on mechanical properties; hot & cold working; recrystalization process. **Forging:** Definition; hot & cold forging; application. Forging methods: smith forging, drop forging, press forging & machine forging.	10

	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).	9
	Total Class	**39**

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 Hours 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.	9
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.	5
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.	6

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	**39**

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 Hours 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 a mild steel specimen.
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 a mild steel specimen.
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 a leaf spring.
10. Determination of stiffness of a 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 Hours 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	
CO 1	Identify different flow patterns and regimes.
CO 2	Evaluate Coefficient of Discharge of Flow Measuring Devices.
CO 3	Understand the determination of airflow velocity by a Pitot Static Tube.
CO 4	Analyze the validity of the Bernoulli's equation for steady flow of water in a tapered duct.
CO 5	Demonstrate practical understanding of friction losses in internal pipe flow.
CO 6	Evaluate the overall efficiencies of Pelton turbine, Francis Turbine and Centrifugal pump.

List of Experiments / Jobs to be carried out during the semester

1. Characteristics of Laminar & Turbulent flow.
2. Verification of Bernoulli's Equation.
3. Determination of Coefficient of Discharge of Flow Measuring Devices in pipe flow.
4. Pipe friction characteristics in different flow regimes for flow through pipes.
5. Determination of Coefficient of Discharge 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 Hours 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 Hours 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 –	**5**

	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.	
	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 Hours 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

Course Name: MACHINE DESIGN-I					
Course Code: MECH 3101					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

On completion of this course students will be able to

COs	Description
CO1	Select suitable material for the object to be designed, as per the requirement of strength and other physical properties in accordance with the given loading and boundary conditions.
CO2	Identify relevant 'Mode of Failure' and 'Theory of Failure' when solving a problem regarding design of machine components under different types of loading like tensile or bending or torsion or various combinations of loadings and with various boundary conditions.
CO3	Estimate stresses in any object or machine component with dimensional discontinuity subjected to different static loadings and boundary conditions considering the stress concentration factors.
CO4	Predict life of a machine component with or without dimensional discontinuity subjected to various dynamic loadings constrained with different boundary conditions.
CO5	Prepare a detailed specifications and arrangements for fasteners like screw, nut-n-bolt, specification for welding and specification of power screw by analyzing the machine component subjected to various loading and boundary conditions.
CO6	Evaluate and select different dimensions of solid and hollow shaft, coil and leaf spring, shaft couplings and various belts for a belt drive for given power rating, loadings and boundary conditions.

Module	Course Contents	CO	Contact Hours
1A	• Importance of study of machine design • A discussion on various mechanical properties of engineering materials related to machine design. • Identification of various materials by their codes, respective compositions and applications. • Selection of materials for machine component design. • An overview about 'Preferred Number Series'	1	5
1B	• Different modes of failure and their selection methodology related to a given problem. • Theories of failures: maximum normal stress theory, maximum shear stress theory, Distortion energy theory and their role in design of machine components. • Determination of stresses in machine component applied with single or combined loading and subjected to boundary conditions.	2	7
2A	• Stress concentration: causes and remedies; stress concentration factors of a component with different dimensional discontinuity and subjected to various loading and boundary conditions.	3	4
2B	• Types of dynamic loading, endurance stress and S-N diagram.	4	7

	• Designing of machine element for infinite or finite life subject to a given reversed loading and boundary condition. • Cumulative fatigue failure under reversed loadings. • 'Soderberg', 'Goodman' and 'Modified Goodman' diagrams for different types of fluctuating loads. • Designing of machine element for infinite or finite life subject to a given fluctuating load and boundary condition.		
3	• Different standards and specifications of various threaded fasteners like screw, nut and bolts. • Design of threaded fasteners under concentric or eccentric loading in pressure vessels and structures. • Design of welded joints under concentric as well as eccentric loading. • Design of power screw.	5	7
4	• Design of solid and hollow shafts under transverse and torsional loads. • Design of Helical spring: stress and deflection equations, stiffness, curvature effect: Wahl's factor, springs in parallel and series. • Multi-leaf springs: load-stress and load-deflection equations, Nipping. • Shaft coupling: rigid, pin-bush and geared; alignment of coupling. • Design of Belt Drive: Power transmission by flat and V-belt drives, selection of belts by manufacturer's catalogues.	6	9
		Total Classes	**39**

Text Books:

1. Design of Machine Elements - V. B. Bhandari, TMH.
2. Fundamentals of Machine Design - P.C. Gope, PHI.

Reference Books:

1. Mechanical Engineering Design – Shigley and Mischke, TMH.
2. Theory and Problems of Machine Design – Hall, Holowenko and Laughlin, TMH.
3. Design of Machine Elements – M.F. Spotts, Prentice Hall.
4. Machine Design – P. Kannaiah, Scitech Publications.

Course Name: HEAT TRANSFER					
Course Code: MECH 3102					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	4	**0**	**0**	**4**	**4**

Course Outcomes:

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

CO1	Recognize the basic laws of heat transfer, and implement the concepts to account for the heat transfer in thermal analyses of engineering systems.
CO2	Evaluate heat transfer rates involving one-dimensional steady-state heat conduction in simple geometries
CO3	Examine heat transfer rates for extended bodies and heat transfer in transient conduction. Define and analyze radiation heat transfer between black surfaces, as well as radiation heat exchange between gray bodies.
CO4	Examine heat transfer by convection by evaluating heat transfer coefficients for forced convection inside ducts and over external surfaces.
CO5	Evaluate heat transfer rates for (i) free convection on a vertical flat plate and (ii) laminar film condensation.
CO6	Understand boiling heat transfer phenomenon and analyze heat exchanger performance by using the methods of LMTD and ε-NTU.

Sl. No.	Syllabus	Contact Hrs
Module 1	Fundamentals: Modes of heat transfer: Physical origins and rate equations; Relationship to Thermodynamics; Analysis of heat transfer problems-methodology; Relevance of heat transfer.	1
	Introduction to Conduction: The conduction rate equation (Fourier's law); Thermal conductivity, isotropic, homogeneous medium, effect of temperature on thermal conductivity of solids, liquids and gases; Thermal diffusivity.	2
	The heat diffusion equation in Cartesian, Cylindrical and Spherical coordinates and its reduction to specific cases.	2
	One-dimensional, steady-state conduction without heat generation: Plane Wall — temperature distribution, thermal resistance, electrical analogy, composite wall, thermal contact resistance.	3
	Radial Systems— the Cylinder and the Sphere, critical thickness of insulation; Overall heat transfer coefficient.	2
	One-dimensional, steady-state conduction with heat generation: Plane wall and radial systems.	2
Module 2	Heat Transfer from Extended Surfaces: General conduction-convection analysis, types of fin, heat flow analysis through fin of uniform cross section (infinitely long, insulated tip, fixed rate of heat loss at the tip and tip with fixed temperature), efficiency and effectiveness of fin	3
	Transient Conduction: Lumped capacitance method, thermal time constant, validity of lumped parameter approach, Biot number, Fourier number	2

	Radiation: Physical mechanism of thermal radiation, spectral radiation intensity, spectral emissive power and total emissive power; Blackbody radiation: definition of black body, radiation laws, emissivity, absorptivity, reflectivity, transmissivity, Kirchoff's identity; Gray body.	3
	Radiation exchange between black bodies, radiation shape factors and various relationships; Heat exchange between non-black bodies, concept of opaque, gray and diffuse surface, irradiation, radiosity, radiation heat exchange among surfaces forming enclosure.	3
Module 3	Forced Convection: Principles of convection; Newton's law of cooling and significance of heat transfer coefficient.	1
	Dimensional analysis applied to forced convection; Dimensionless numbers and their physical significance; Empirical correlations	1
	Derivation of continuity, momentum and energy equations in 2-D	3
	The velocity and thermal boundary layer and its significance; Local and average convection coefficients; Momentum and energy equations of laminar boundary layer on a flat plate; Similarity methods.	3
	General solution of von Kármán integral momentum and energy equation of boundary layer; Relation between fluid friction and heat transfer; Introduction to turbulent boundary layer heat transfer.	4
	Forced Convection (Continued): Heat transfer in laminar tube flow; Bulk temperature; Empirical relations for pipe and tube flow.	2
Module 4	Natural Convection: Mechanism of free convection; Velocity and thermal boundary layers.	2
	Free convection heat transfer on a vertical flat plate; Empirical relations for free convection.	2
	Introduction to Boiling Heat Transfer: General aspects, Boiling regimes, Bubble shape, size, growth and collapse, Critical diameter; Factors affecting nucleate boiling.	1
	Condensation Heat Transfer: General aspects; laminar film condensation.	
	Heat Exchangers: Uses and types of heat exchangers; Parallel and counter-flow types.	1
	Introduction to LMTD method; correction factors; Fouling factor.	1
	ϵ-NTU method for heat exchangers	2
		2
		48

Text Books:

1. Introduction to Heat Transfer- S.K. Som, PHI, 2e
2. Heat & Mass Transfer, P.K. Nag, TMH, 3e

Reference Books:

1. Fundamentals of Heat and Mass Transfer-Incropera, DeWitt, Bergmam, & Lavine, Wiley India
2. Heat and Mass Transfer: A Practical Approach- Yunus A. Cengel, McGraw-Hill, 2007
3. Heat Transfer-J P Holman & Souvik Bhattacharyya, TMH
4. NPTEL lecture series on heat transfer

Course Name: ENGINEERING MATERIALS					
Course Code: MECH 3103					
Contact Hours 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	
CO 1	Classify different materials like metals, polymers, ceramics, composites and advanced materials and analyze different crystal structure of materials
CO 2	Identify different types of defects in the material structure and construct the phase diagram of multi-phase system of alloy.
CO 3	Analyze the Iron –Iron Carbide equilibrium diagram and discuss the composition, properties and applications of ferrous and nonferrous alloy.
CO 4	Explain mechanical, thermal, electrical and magnetic properties of material and implement the concept in mechanical components design.
CO 5	Understand different heat treatment processes for ferrous material.
CO 6	Discuss the properties, applications and making processes of different polymers, ceramics, composites and nanomaterials.

Sl. No.	Syllabus	Contact Hrs.
Module 1	**Introduction:** Material Science –its importance in engineering: Classification of Materials -metals, polymers and elastomers (visco-elastic materials), ceramics, composites; Advanced materials –semiconductors, smart materials, nano-materials; Brief concept of atomic structure, Atomic bonding in solids—bonding forces and energies; Ionic/covalent/metallic bonding. **Crystal structure**: Fundamental concepts; unit cells; seven crystal systems; single crystal, polycrystalline and non-crystalline materials; Metallic crystal structures—FCC, BCC, & HCP structures, atomic packing factor; Isotropy & Anisotropy. **Imperfections and defects in Metals:** Point defects due to vacancy & impurities, alloys, solid solutions; linear defects, interfacial defects, grain boundaries, grain growth, grain structure, slip, plastic deformation of polycrystalline material, twining, recovery, recrystallization and grain growth. **Phase Diagrams:** Definition and basic concepts; solubility limit; phase Equilibrium, one component phase diagram, binary phase diagram, interpretation of phase diagrams.	**2** **2** **3** **3**
Module 2	**Iron-carbon system:** Allotropy of iron, iron-iron carbide phase diagram, Properties and uses. **Classification of Metals and Alloys- compositions, properties and uses:** ***Ferrous alloys:*** Plain carbon steel, properties, classification –low carbon steels, medium carbon steels, high carbon steels, stainless steels, alloy steels, tool and die steel, cast iron and its types.	**3** **2**

	Non-ferrous alloys: Copper and Copper alloys, Aluminum alloys; Zinc Alloys; Nickel alloys; Lead and Tin alloys.	**2**
Module 3	**Properties of Materials:** ***Mechanical Properties:*** Elastic properties of materials-tensile and compressive stress and strain, stress-strain behavior, modulus of elasticity(Young's modulus), yield strength, tensile strength, plastic deformation, true stress and strain, Ductility; Resilience; Toughness, Hardness, correlation between hardness and tensile strength; Strain hardening; Fatigue; Effect of temperature on tensile strength and impact properties, creep. ***Physical, Thermal, Electrical and Magnetic Properties of materials:*** **Heat Treatment:** Definition and purposes, Heat treatment processes of steels— Hardening, structural change during heating and cooling, factors affecting hardening; Tempering; Austempering; Normalizing; Annealing— full annealing, spheroidising annealing, stress relieving, recrystallization annealing; Precipitation or Age Hardening of non-ferrous alloys, Martempering. T-T-T diagram Heat treatment cycles for a tool steel.	**4** **1** **6**
Module 4	**Polymers & Elastomers:** Processing of polymers-polymer molecular structures, Thermoplastics & Thermosets; characteristics of polymers - low specific gravity, optical, electrical & thermal property, decorative color, easy formability, low corrosion etc. Uses of polymers and elastomers. **Ceramic Materials:** Common ceramic materials and their characteristic; Processing of ceramics -sintering and vitrification process; Properties and applications. **Composite Materials:** Definition; processing of composite materials; Polymers matrix, Metal matrix and ceramic matrix composites and their applications **Nanomaterials:** Brief introduction of nanomaterials, applications, Processing, classification. **Corrosion: Degradation and prevention of Engineering Materials:** Definition; Types of corrosion -uniform, pitting, crevice, galvanic, stress corrosion cracking and erosion, Corrosion Control - material selection, environment control, proper design. **Materials selection methodology:** Selection of material based on required properties, availability and cost of material, environmental issues.	**2** **2** **2** **2** **2** **1**
	Total Classes	**39**

Text Books:

1. Materials Science and Engineering by W. D. Callister and adapted by R. Balasubraniam, Wiley India, 9e, 2010.
2. Engineering Materials and Metallurgy by R. Srinivasan, Tata McGraw Hill, 2e.
3. Materials Science and Engineering by V. Raghavan, Prentice Hall India, 5e.

Reference books:

4. Engineering Materials Properties & Selection by Budinski & Budinski, Prentice Hall India, 9e.
5. A Textbook of Material Science and Engineering by R. K. Rajput, S. K. Kataria & Sons, 4e, 2013.
6. Mechanical Metallurgy by George E Dieter, McGraw Hill, 3e.

New Inclusion:

- Dislocation is included separately in module 1 with new topics recovery, recrystallization and grain growth
- A new topic "Nano material" is included in module 4.

Course Name : MACHINING & MACHINE TOOLS					
Course Code: MECH 3104					
Contact Hours 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	
CO 1	Acquire knowledge on basic principle and purpose of machining, familiarization with tool geometry and to designate a single point cutting tool.
CO 2	Analyze mechanism of machining, mechanics of machining.
CO 3	Identify sources and effects of Heat generation in machining and control of cutting temperature.
CO 4	Detect tool failure mechanisms, assess tool life and select an appropriate cutting tool material, assessing machinability.
CO 5	Identify purpose, general constructional features and kinematic structures of different machine tools, selection of grinding wheels and application
CO 6	Carry out the use of different power drives, gear layout, gear box etc., control of speed and feed of machine tools, estimation of machining time, NC & CNC system

Module	Syllabus	Contact Hrs.
1	**Ia. Introduction:** Machining: Basic principle, purpose, definition and requirements.	1
	Ib. Geometry of cutting tools: 1. Geometry of single point turning tools in ASA and ORS systems. Significance of rake and clearance angles. Conversion of tool angles from one system to another by graphical method. 2. Geometry of drills and milling cutters.	4
	Ic. Mechanism of machining: 1. Chip formation mechanism, yielding and brittle fracture, chip reduction coefficient, cutting ratio, shear angle and cutting strain. 2. Built-up edge formation, cause, type and effects, orthogonal cutting and oblique cutting. 3. Machining chips: types and conditions, chip formation in drilling and milling.	4
2	**IIa. Mechanics of machining:** 1. Purposes of determination of cutting forces, cutting force components in orthogonal cutting and Merchant's circle diagram. 2. Determination of cutting forces, analytical and experimental methods. 3. Dynamometers, construction and working principles of strain gauge type and piezoelectric crystal type turning, drilling dynamometers.	3
	IIb. Cutting temperature: 1. Heat generators, sources and cutting zone temperature, causes and effects on job and cutting tools, role of variation of the machining parameters on cutting temperature.	1

	2. Control of cutting temperature and application of cutting fluids and other techniques (purpose, essential properties, selection and methods of application). **IIc. Cutting tool-failure, life and materials:** 1. Methods of failure of cutting tool, geometry and assessment of tool wear. 2. Tool life, definition, assessment and measurement, Taylor's tool life equation and it's use. 3. Cutting tool materials, essential properties, characteristics and applications of HSS, carbide (uncoated/coated), ceramic, diamond and CBN tools; carbide tool inserts & tool holders. **IId. Machinability and Machining economics:** Machinability: definition, assessment, improvement and evaluation of optimum cutting velocity and tool life.	4 2
3	**IIIa. Machine tools – Introduction:** 1. Purpose of use , definition and general features of machine tools. 2. Generatrix and Directrix and tool – work motions in different operations of conventional machine tools. **IIIb. Machine tool classification, General constructional features and functions of machine tools:** 1. Broad classification of machine tools. 2. Major components and their functions for lathe; shaping, planning and slotting machines ; drilling and milling machines; capstan and turret lathe. 3. Machining operations and application of the common machine tools and their way of specification. **IIIc. Kinematic structure of machine tools:** 1. Types of kinematic structures and diagrammatic representation. 2. Kinematic structure of centre lathe, shaping and gear hobbing machine.	2 4 5
4	**IVa. Control of speed and feed of machine tools :** 1. Need of wide ranges of speeds and feeds for machine tool drive. 2. Design of speed gear box, speed layout, ray diagrams, gear layout, gears and spindle. 3. Control (selection and change) of feed in centre lathes. **IVb. Grinding:** 1. Modes and mechanisms of chip formation, selection of grinding wheels and application. 2. Grinding forces, surface roughness and wheel life. **IVc. Machining time :** 1. Estimation of time required for various operations like turning, drilling, shaping and milling. **IVd. Computer numerical control machine tools :** 1. NC and CNC system; purpose, principle, advantages, limitations and application in machine tools.	4 1 2 2
Total Classes		**39**

Text Books:

1. Machining and Machine Tools- A.B. Chattopadhyay, Wiley India (P) Ltd., New Delhi.
2. Principles of Metal Cutting- G. Kuppuswamy, University Press, Hyderabad.
3. Metal Cutting Principles and Practices- M.C. Shaw, Oxford University Press.

Reference Books:

1. Metal Cutting Theory and Practice- Stephenson & Agapion, Taylor and Francis, NY.
2. Principles of Machine Tools- G.C. Sen and A. Bhattacharyya, New Cantral Book Agency (P) Ltd., Kolkata.
3. Machine Tool Design- Acharkan, Vol. I, II, III and IV, Mir Publication, Moscow.

Course Name : DYNAMICS OF MACHINES					
Course Code: MECH 3105					
Contact Hours 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	
CO 1	**Analyze** the dynamic forces, torque in mechanisms and its application to **design** flywheel.
CO 2	**Understand** the gyroscopic effects and **analyze** stability of motion of different system based on the effects.
CO 3	**Examine** an unbalanced system and **solve** the problem for balancing the same graphically and analytically.
CO 4	**Analyze** a free and forced single degree vibrating system with and without damping.
CO 5	**Apply** the knowledge of vibration in case of longitudinal, transverse and torsional vibrating systems
CO 6	**Understand** basic idea of vibration of multi-degree of freedom system

Module	Syllabus	Contact Hrs.
1A	**Dynamic analysis of Mechanism:** Inertia force and inertia torque in Mechanism; Dynamic Equivalent System; correction couple (torque); Turning moment diagram and flywheel design.	5
1B	**Gyroscope:** Gyroscopic Torque; Gyroscopic effects on Aero-plane; Gyroscopic Effects on Naval Ship; Stability of an Automobile; Stability of Two-wheel Vehicles.	5
2	**Balancing**: Static balancing and dynamic balancing of rotating masses - graphical and analytical methods; Balancing of reciprocating mass - primary and secondary balancing; Balancing of Locomotive; Effects of partial balancing in Locomotives (Swaying couple; Hammer blow); Balancing of inline Engine; Balancing of V- Engine.	9
3A	**Free Un-damped Vibration:** Determination of Equation of motion and solution function of a linear and rotary vibratory motion by Equilibrium method, Energy method (Rayleigh's maximum energy principle), Natural Frequency of the free un-damped linear and rotary vibration. Effect of inertia in longitudinal vibration and natural frequency.	3
3B	**Linear Free Damped Vibration:** Equation of motion and solution function for free damped vibration. Understanding the damping factor or ratio. A detailed discussion about under damped motion, critically damped motion and over damped motion. Logarithmic decrement.	3

3C	**Forced Damped Vibration:** Equation of motion and solution function for forced damped vibration. Understanding the physical significance of the solution. Steady state condition and amplitude. Dynamic Magnification Factor and phenomenon of resonance. Vibration Isolation and Transmissibility. Effect of unbalance and support motion.	4
4A	**Transverse vibration of Shaft:** Vibration with single concentrated load, uniformly distributed load and with several loads (Dunkerley's Method and Energy Method), Whirling of shaft and calculation of critical speed.	3
4B	**Torsional vibration:** Free Torsional vibration, Inertia effect of mass of shaft, Multifilar system, Torsionally equivalent shaft, Free Torsional vibration of geared system.	3
4C	**Multi degree of freedom system:** Natural vibration, Forced harmonic vibration, vibration absorber.	3
4D	**Vibration Measurements**	1
	Total Classes	**39**

Text Books:

1. Theory of Machines – S S Rattan, Tata McGraw Hill, 4e, 2014.
2. Theory of Mechanisms & Machines (3^{rd} edition) – Ghosh and Mallik; East West Press, 3e, 2006.
3. Kinematics and Dynamics of Machinery – R. L. Norton, McGraw Hill Education, 1e, 2009.
4. Theory of Vibration - Thomson and Dahleh, 5e, Pearson, 1998

Reference Books:

1. Theory of Machines and Mechanisms – Uicker, Pennock and Shigley, Oxford University Press, 3e, 2009.
2. The Theory of Machines through Solved Problems – J. S. Rao, New Age International Publication, 1e, 2012.
3. Mechanism and Machine Theory – Ashok G. Ambekar, PHI Learning, 1e, 2007.
4. Theory of Machines – R. S. Khurmi and J. K. Gupta, S. Chand Technical, 14e, 2005.

Course Name : FLUID POWER CONTROL					
Course Code: MECH 3131					
Contact Hours 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	
CO 1	Describe the term fluid power, its advantages, the basic components and working fluid used in fluid power systems.
CO 2	Explain different types of pumps, actuators, valves and other components used in hydraulic and pneumatic circuits.
CO 3	Relate the fundamental laws of fluid mechanics with fluid power and control systems.
CO 4	Draw and analyse various fluid power circuits.
CO 5	Formulate the performance parameters of different components used in fluid power systems.
CO 6	Justify the use of different components in pneumatic system and electrical devices to control fluid power circuits.

Module	Syllabus	Contact Hrs.
1	**Fluid power:** Definition and terminology; Applications and advantages of fluid power; Components of a hydraulic and pneumatic system. Advantages and disadvantages of hydraulic system compared to pneumatic system. Functions and desired properties of working fluid in hydraulic system; advantages of mineral oil over water; factors influencing the selection of a fluid. **Hydraulic Pumps:** Positive displacement pumps-classification; constructional features, working principle, volumetric displacement and theoretical flow rate of external gear pump, vane pump, axial piston pump and radial piston pump. Pump performances: volumetric efficiency, mechanical efficiency, overall efficiency. Factors influencing pump selection.	2 2 5
2	Multiplication of force:- Pascal's law; analysis of simple hydraulic jack. Application of Pascal's Law: hand operated hydraulic jack. Energy and power in hydraulic system; Application of continuity equation and Bernoulli's equation in hydraulic system. **Hydraulic Actuators:** definition and classification. (i) Hydraulic Cylinders: Constructional features of single acting and double acting hydraulic cylinders; force, velocity and power from a cylinder; mounting of cylinders, cushioning of cylinder; Cylinder loadings through mechanical linkages. (ii) Hydraulic Motors: classification; limited rotation hydraulic motors-analysis of torque capacity; torque, power and flow rate in a hydraulic motor. Hydraulic motor performances: Motor efficiencies.	3 4 3

3	**Hydraulic Valves:** (i) Direction control valves – operation and graphical symbol of check valves, shuttle valves, two way, three way and four way valves; different modes of activation of direction control valves; (ii) Pressure Control valves- operation and graphical symbols of pressure relief valve, pressure reducing valve, unloading valve and sequence valve (iii) Flow control valves - needle valve, non pressure compensated and pressure compensated valves. ANSI symbols of different hydraulic components. **Analysis of hydraulic circuits for :** i) Single acting cylinder control. ii) Double acting cylinder control. iii) Regenerative cylinder circuit. iv) Pump unloading circuit. v) Double pump hydraulic system. vi) Cylinder synchronization circuits.	6 4
4	**Analysis of hydraulic circuits for :** vii) Speed control of hydraulic cylinder: Meter-In and Meter-Out circuit. viii) Speed control of a hydraulic motor. ix) Automatic sequencing of two cylinders. x) Fail safe circuits - Protection from inadvertent cylinder extension and overload. **Pneumatic system:** Basic system requirements; Selection of pipeline for pneumatic system, compressed air distribution system in a plant; constructional details and operation of a reciprocating compressor; working principle and use of filter, pressure regulator and lubricator; ANSI symbols of different pneumatic components; drawing pneumatic circuits for different operations. Use of electrical devices for controlling fluid power circuits; function of electrical devices like push-button switches, limit switches, pressure switches, solenoids, relays and timers and their symbols; study of following circuits using electrical control devices : i) Control of a solenoid actuated cylinder using single limit switch. ii) Reciprocation of a cylinder using pressure or limit switches.	2 5 3
	Total Classes	**39**

Text Books:

1. Fluid Power with Applications- A. Esposito, 7e; Pearson.
2. Pneumatic Systems: Principles and Maintenance- S.R. Majumdar, Tata McGraw Hill.

Reference Books:

1. Introduction to Hydraulics and Pneumatics- Ilango and Soundararajan, 2e; PHI.
2. Fluid Power, Generation, Transmission and Control- Jagadeesha. T and Gowda T, 1e; Wiley Publication.
3. Fluid Power: Theory and Applications- James A. Sullivan, 3e; PHI.

Course Name : REFRIGERATION & AIR CONDITIONING					
Course Code: MECH 3132					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

CO1	Differentiate between cooling and Refrigeration, Calculate refrigeration capacity, understand the nomenclature of various refrigerants, List various important properties of refrigerants and their impact on environment.
CO2	Understand how standard vapour compression cycle works, its various key components, their functions, Analyse different thermodynamic cycles , Calcualte COP of the SVCRs, Identify the limitations of single stage vapour compression refrigeration cycle and Understand the utility of Multi stage, multi evaporator system.
CO3	Understand Air Refrigeration system, its advantages and limitations, and its applications, Air craft refrigeration system.
CO4	Understand how different types (Li – Bromide , Aqua-Ammonia, Three fluids system) of Vapour absorption cycle operates, its advantages and disadvantages over VCRs, Calculate actual COP and theoretical max. COP.
CO5	Understand the different types of compressor, condensers, expansion devices and evaporators used in various refrigeration systems, Calculate the Heat Rejection Rate , Critical charge and its importance on system performance .
CO6	Understand various properties of moist air, Read Psychrometric chart and collect data based on various psychrometric processes, Estimate the heating and cooling load calculations, Design ducts based on field requirement, Estimate ventilation load

Module	Syllabus	Contact Hrs.
1	**Introduction:** Concepts of Refrigeration and Air-conditioning, Unit of refrigeration, Refrigerants-Desirable Properties, Nomenclature. **Simple Vapour Compression Refrigeration System (Simple VCRS):** Vapour compression cycle on $p-h$ and $T-s$ diagrams, Cycles with subcooling, superheating and their effects; Effect of changes in evaporator pressure and condenser pressure on the performance of a simple VCRS. Multi-stage and multiple evaporator system, Cascade system, COP comparison.	2 4 4

2	**Air Refrigeration System (ARS):** Bell-Coleman refrigerator. COP determination, actual air refrigeration cycle, Air craft Refrigeration system, Boot – strap air cooling system. **Vapour Absorption Refrigeration System (VARS):** Advantages of VARS over VCRS, Working principle of simple VARS, practical VARS, Refrigerant-absorbent combinations, Lithium bromide-water System, Aqua-ammonia systems. Limitations of VARS, Maximum COP of VARS, Three fluid absorption System.	4 3 2
3	**Equipment and Control:** Major Refrigeration Equipment - Compressors: rotary & centrifugal. Condensers: types used in refrigeration systems; Evaporators: expansion devices: capillary tubes and thermostatic expansion valves.	9
4	Basic definitions and principles related to Psychometry ; Psychometric Charts & Their Uses; Heating, Cooling, Heating & Humidification and Cooling & Dehumidification processes. Adiabatic Saturation, Cooling Coils, By-pass Factor. Sensible Heat Factors. Heat Load estimation: Simple cases of Cooling and Dehumidification. Ventilation: Definition & Requirements, Natural & Mechanical Ventilation, Ventilation Load Calculation, Air Handling unit. Duct Sizing & Duct Design.	4 3 4
	Total Classes	**39**

Text Books:

1. Refrigeration and Air Conditioning- C.P. Arora, TMH, 3e.
2. Refrigeration and Air Conditioning- W.F. Stoecker & J.W. Jones, McGraw Hill.

Reference Books:

1. Refrigeration and Air Conditioning- R.C. Arora, PHI.
2. Basic Refrigeration and Air Conditioning- P.N. Ananthanarayanan, TMH, 3e.
3. Refrigeration and Air Conditioning- S.C. Arora and S. Domkundwar, Dhanpat Rai Publication.

Course Name : ELECTRICAL MACHINES					
Course Code: MECH 3133					
Contact Hours per week:	L	T	P	Total	Credit points
	3	0	0	3	3

Course Outcomes:

At the end of this course students will be able to

CO1: Acquire the knowledge of the constructional details and operating principle of DC generator and analyze the performance under various operating conditions to solve complex electrical engineering problems.
CO2:- Acquire the knowledge of the operating principle of DC motor and analyze the performance under various operating conditions to solve complex electrical engineering problems.
CO3: Identify and analyze the problems related to performance analysis of single phase transformer reaching substantiated conclusion.
CO4 Identify, formulate and solve the numerical problems related to three phase induction motor.
CO5: Acquire the knowledge of synchronous generator to identify and analyze the problems related to performance analysis.
CO6: Understand the knowledge of synchronous motor to solve complex engineering problems related to various applications.

Module I:-

Construction of DC machine. Different methods of excitation of DC machine. [1]

DC Generators:- EMF equation. Concept of armature reaction. Voltage build-up of shunt Generator. Characteristics of DC Generator. [3]

D.C. Motors:- Principle of operation. Back EMF. Torque equation. Characteristics of DC motors. Speed control of DC motor. Starting of DC shunt motor. Different methods of braking. [5]

Losses and Efficiency of D.C Machine . Application of D.C Machine [2]

Module II:-

Single phase Transformers:- Construction of Transformer. Operating principle of 1-ph transformer. Emf Equation, Equivalent circuit and Phasor diagram of ideal and practical transformer. Losses and efficiency- Open & short circuit tests. Voltage regulation. Parallel operation. [7]

ModuleIII :-

Three phase Induction Motor:-Construction. Production of rotating magnetic field. Working principle. Slip, frequency of rotor current, stator and rotor emf. Equivalent circuit and phasor diagram. Torque speed characteristic. Different methods of speed control. Methods of improving the starting torque. Different methods of braking of induction motor. Application of three phase Induction Motor. [7]

Module IV:-

Alternator:- Construction. Excitation Systems. E.M.F equation. Pitch factor and Distribution factor. Armature reaction- Lagging, Leading, Unity p.f load. Equivalent circuit and phasor diagrams. Voltage regulation- Open circuit and short circuit test. Use of salient pole and cylindrical rotor alternator. [5]

Synchronous Motor:- Principle of operation. Phasor diagram. Effect of varying field current- v curve, synchronous condenser. Starting of synchronous motor. Hunting. Application of synchronous motor. [4]

Special Machine:- Stepper Motor, Servo Motors (A.C and D.C), Universal motor. [2]

Text Books :	Reference Books :
1.Electrical Machinery by Dr. P.S. Bimbhra. 2.Electrical Machines by S. K. Bhattacharya 3. Electrical Machines by Ashfaq Hussain	1.Theory & Performance Of Electrical Machines By J.B.Gupta 2.Electrical Machines By Abhijit Chakarabarti And Sudipta Debnath.

Course Name : DATA STRUCTURE & RDBMS					
Course Code: MECH 3134					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

1. Understand and remember the basics of data structures and how time complexity analysis is applicable to different types of algorithms.
2. Apply different types of data structures in algorithms and understand how the data structures can be useful in those algorithms.
3. Analyze the behavior of different data structures in algorithms. (For example, given an algorithm that uses a particular data structure, how to calculate its space and time complexity.
4. Evaluate solutions of a problem with different data structures and thereby understand how to select suitable data structures for a solution. (For example, what are the different ways to find the second largest number from a list of integers and which solution is the best.)
5. Formulate, using relational algebra and SQL, solutions to a broad range of query and data update problems.
6. Demonstrate an understanding of normalization theory and apply such knowledge to the normalization of a database.

Module I: (11L)

Linear Data structures: Singly Linked List- Insertion at beginning, at end and any position of the List. Deletion by value, by position: beginning, end and any position of the List Stack and Queue: Both array and Linked Representation, Circular queue using array only. Application of stack: Infix to postfix conversion, Evaluation of postfix expression.

Module II: (8L)

Non-Linear Data Structures:

Trees: Binary Trees: Array and Linked representation, Binary tree Traversal Techniques, reconstruction of binary tree using traversal sequence. Binary Search Trees - Insertion and Deletion algorithms.

Sorting Algorithms: Bubble sort, Insertion sort, Selection sort, Quick sort and their comparison. **Searching Algorithms**: Linear search, Binary search and their comparison.

Database Concept

Module III: (10L)

Introduction to Database Concepts, File Processing System and Database Management System, DBMS Architecture and Data Independence. Data Model: Basic Concepts, Entity-Relationship Diagram, Keys, Cardinality, Weak Entity Set. Introduction to SQL: Operators like select, project, rename, Cartesian product, join, union, intersect, minus, DDL, DML.

Module IV: (10L)

Relational Database Design: Functional Dependencies, Normalization: Different anomalies in database designing 1NF, 2NF, 3NF and BCNF. Introduction to Transaction Processing Concepts: ACID properties, Serializability

Text Books:

Data Structures:

I) Title: Data Structures. Author: Seymour Lipschutz. Publication: Tata McGraw-Hill (India)

II) Title: Data Structures and Program Design in C. Author: Kruse Robert L., Robert Kruse, Cl Tondo. Publication: Pearson Education India.

Database Concept:

I) Title: Fundamentals of Database Systems Author: Elmasri Ramez and Navathe Shamkant Publication: Pearson.

II) Title: Database System Concepts Author: A. Silberschatz, H.F Korth, S.Sudarshan Publication: McGraw Hill Education (India) Private Limited

Reference Books:

Data Sturucture:

I) Title: Data Structures using C. Author: Tanenbaum A. S, Langsam Y., Augenstein M. J. Publication: Pearson.

II) Title: The Art of Computer Programming Author: Donald E. Knuth Publication: Addison-Wesley Professional

Database Concept:

I) Title: Introduction to Database Management Vol. I, II, III, Author: Date C. J. Publication: Addison Wesley.

II) Title: Principles of Database Systems Author: Ullman JD. Publication: Galgottia Publication Subject Name: RAILWAY & AIRPORT ENGINEERING

Course Name : INDIAN CONSTITUTION AND CIVIL SOCIETY					
Course Code: INCO 3016					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	2	**-**	**-**	**2**	**0**

Course Outcomes:

The learner will be able to-

- Analyse the historical, political and philosophical context behind the Indian Constitution-making process
- Appreciate the important principles characterizing the Indian Constitution and institute comparisons with other constitutions
- Understand the contemporaneity and application of the Indian Constitution in present times
- Critique the contexts for constitutional amendments in consonance with changing times and society
- Establish the relationship between the Indian Constitution and civil society at the collective as well as the individual levels
- Consciously exercise the rights and the duties emanating from the Indian Constitution to one's own life and work

Module 1- 6L
Introduction to the Constitution of India-Historical Background
Making of Indian Constitution -the process of framing the constitution, the constituent assembly
Module II-6L
Salient Features of the Indian constitution
Comparison with the constitutions of other countries
Module III-6L
Relevance of the Constitution of India
Constitution and Governance
Constitution and Judiciary
Constitution and Parliament-Constitutional amendments
Module IV-6L
Constitution and Society- democracy, secularism, justice
Constitution and the individual citizen- Fundamental Rights, Directive Principles of state policy and Fundamental Duties

Reference Books

C.M.Elliot, (ed.), Civil Society and Democracy, OUP, Oxford, 20012..
David Held et.al (ed),The Idea of the Modern State, Open Univ. Press, Bristol, 1993
Neera Chandoke, State and Civil Society, Sage, Delhi, 19953

Course Name : APPLIED THERMODYNAMICS & HEAT TRANSFER LAB					
Course Code: MECH 3152					
Contact Hours 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	
CO 1	Describe a combined separating and throttling calorimeter and assess the dryness fraction of a steam sample by using the mentioned calorimeter.
CO 2	Estimate the thermal conductivity of (i) a cylindrical metallic rod and (ii) insulating powder using appropriate principles.
CO 3	Describe a shell and tube heat exchanger and formulate log-mean temperature difference and effectiveness of the heat exchanger.
CO 4	Calculate the convective heat transfer coefficient for forced convection over a cylindrical fin and plot the spatial variation of temperature along the fin.
CO 5	Examine natural convective heat transfer coefficient in (i) a heated vertical cylinder and (ii) a stationary pool of water.
CO 6	Learn the basic terminologies related to thermal radiation and calculate the emissivity of a gray body.

List of Experiments:

1. Determination of dryness fraction of steam by a combined separating and throttling calorimeter.
2. Determination of thermal conductivity of a metal rod.
3. Determination of thermal conductivity of an insulating powder.
4. Study of a shell and tube heat exchanger for determination of LMTD and calculation of effectiveness.
5. Determination of local heat transfer coefficient (h) for forced convection over a cylindrical fin and temperature plotting.
6. Determination of emissivity of a grey body.
7. Determination of the Natural Heat Transfer Co-efficient in a heated vertical cylinder.
8. Determination of Convective Heat Transfer Co-efficient with the use of Transient Heat Conduction.

Course Name : DYNAMICS OF MACHINES LAB					
Course Code: MECH 3155					
Contact Hours 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	
CO 1	**Understand** and **apply** the concept of free, forced and damped vibration.
CO 2	**Understand** and **apply** the concept of linear and torsional vibration.
CO 3	**Understand** different Governor mechanism, **evaluate** and **analyze** the dynamic study.
CO 4	**Understand, evaluate** and **analyze** the dynamic study of Gyroscope.
CO 5	**Understand, analyze** and **apply** the concepts of static and dynamic mass balancing.
CO 6	**Understand, evaluate** and **analyze** the cam and follower mechanism

List of Experiments:

1. Studying and designing different mechanisms for performing specific tasks in a machine tool and for common engineering applications.
    I. Four bar mechanism
    II. Slider crank mechanism
    III. Whitworth quick return mechanism
    IV. Crank slotted lever mechanism
2. Experiments on working of governor, operation and analysis.
    I. Watt governor
    II. Porter governor
    III. Proell governor
    IV. Hartnell governor
3. Experiments on working of gyroscope, operation and analysis.
4. Drawing a cam.
5. Studying operation of cams and its analysis.
6. Static and dynamic balancing of rotating masses.
7. Balancing of reciprocating masses.
8. Studying vibratory systems of single and more than one degree of freedom in linear and rotary systems.

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

Course Name : FLUID POWER CONTROL LAB					
Course Code: MECH 3181					
Contact Hours 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	
CO 1	Identify the basic components of fluid power control systems.
CO 2	Apply the knowledge of engineering fundamentals to understand the working principle of different components used in fluid power control circuits.
CO 3	Prepare different circuits with relevant components for actuator control and demonstrate the same.
CO 4	Calculate various useful parameters from the experimental readings with some knowledge on related errors in the experimental readings/setup/procedure/instruments.
CO 5	Relate pressure, flow rate from one set of units to another for computing performance analysis parameters.
CO 6	Justify the use of different fluid power control circuits for desired outcome.

List of Experiments:

1. Study of a hydraulic trainer system.
2. Study of a pneumatic trainer system.
3. Controlling the speed of a pneumatic cylinder using a flow control valve.
4. Controlling the speed of a hydraulic cylinder using a flow control valve.
5. Prepare an ‘AND’ logic circuit using pneumatic components.
6. Prepare an ‘OR’ logic circuit using pneumatic components.
7. Operation and study of the function of a pressure reducing valve in a hydraulic circuit.
8. Preparation and operation of a hydraulic circuit for sequencing two hydraulic cylinders using a sequence valve.

Course Name : REFRIGERATION AND AIRCONDITIONING LAB					
Course Code: MECH 3182					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**1.5**

Course Outcomes:

CO1	Determination of cooling load from psychometric chart.
CO2	Demonstrate the VARS and calculate the COP.
CO3	Demonstrate the VCRS and calculate the theoretical and experimental COP.
CO4	Understand the different components of air condition test rig and perform the theoretical and experimental COP.
CO5	Analyze the domestic refrigeration and calculate the COP and heat rejection rate.
CO6	Understand the thermoelectric cooling and heating system.

List of Experiments:

1. Study of a cut model of VCRS and determination of COP of a VCR system.
2. Study of a cut model of VARS and determination of COP of a VAR system.
3. Study of a room (window type) Air Conditioner and determination of COP.
4. Determine the heat rejection rate by the condenser of window air conditioner.
5. Performance test of an Air Conditioning Unit: Determination of COP and plotting of the cooling – dehumidification process on a psychometric chart.
6. Performance test of an Air Conditioning Unit: Determination of COP and plotting of the heating – humidification process on a psychometric chart.
7. Performance test of thermoelectric refrigeration system used as cooler.
8. Performance test of thermoelectric system used as Heater.

Course Name : ELECTRICAL MACHINES LAB					
Course Code: MECH 3183					
Contact Hours per week:	L	T	P	Total	Credit points
	0	0	3	3	1.5

Course Outcomes:

At the end of this course students will be able to

1) **Understand** the different characteristics of various electrical machines to **analyze** the performance of the different machines.
2) **Determine** the equivalent circuit parameter and phasor diagram and efficiency of machines by performing the open circuit & short circuit test.
3) **Perform** the different speed control method of DC shunt motor.
4) **Analyze** the performance of 3 phase induction motor by performing speed –torque characteristics of 3 phase induction motor.

List of Experiments:

1. To study the open circuit and short circuit tests of a single phase Transformer.
2. To study the speed control of a D.C shunt Motor.
3. To study the saturation characteristics of a D.C shunt Generator.
4. Speed control of D.C shunt Motor by ward-Leonard method.
5. To study the Speed-Torque characteristics of an Slip-ring Induction Motor.
6. To study the external load characteristics of a D.C Shunt Generator.
7. To study the open and short circuit characteristics of an Alternator.

Course Name : RDBMS LABORATORY					
Course Code: MECH 3184					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**1.5**

Course Outcomes:

1. To give a good formal foundation on the relational model of data.
2. To present SQL and procedural interfaces to SQL comprehensively
3. To give an introduction to systematic database design approaches covering conceptual design, logical design and an overview of physical design.
4. To present the concepts and techniques relating to query processing by SQL engines.
5. To present the concepts and techniques relating to ODBC and its implementations.
6. To introduce the concepts of transactions and transaction processing.

Experiments on Database on RDBMS Platform (Oracle):

DDL Commands: Creating Tables along with constraints like: Primary Key, Foreign Key, unique, Not Null, Check. Altering Table Structure like adding and modifying constraints, adding and modifying column data types, etc.

DML: Inserting rows, Updating rows, Deleting rows.

SQL Query: Cartesian Product, All types of Join, Union, Intersect, Minus, Single Row functions, multiple row functions using GROUP BY clause, ORDER BY Clause, Nested Sub-Queries, Views

Introduction to PL/SQL: Programming Language Constructs in PL SQL like variable declaration, Conditional Statements, different types of loop structures, functions, etc. Programming using Stored Procedures, Triggers.

Books:

DBMS Laboratory

Title: SQL, PL/SQL: The Programming Language Of Oracle (With CD-ROM) (English) 4th Revised Edition
Author: Ivan Bayross
Publisher: BPB Publications

Course Name : ECONOMICS FOR ENGINEERS					
Course Code: HMTS 3201					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

The student will be able to-

1. Evaluate a project and estimate the total cost of the project.
2. Apply financial analytical methodologies to prepare a report regarding the financial performance of an organization.
3. Participate actively in an organization's capital budgeting process.
4. Provide vital inputs regarding the pricing of a product.
5. Apply the knowledge of the interplay of various economic variables and indicators in workplace.
6. Provide insight about different accounting concepts and apply broader concepts like costs, revenues, assets, liabilities, capital, profit, investment and interest.

Module 1:

Market: Meaning of Market, Types of Market, Perfect Competition, Monopoly, Monopolistic and Oligopoly market.

The basic concept of economics – needs, wants, utility.

National Income-GDP, GNP. Demand & Supply, Law of demand, Role of demand and supply in price determination, Price Elasticity.

Inflation: meaning, reasons, etc. **(6L)**

Module 2:

Business: Types of business, Proprietorship, Partnership, Joint-stock company, and cooperative society – their characteristics.

Banking: role of commercial banks; credit and its importance in industrial functioning. Role of central bank: Reserve Bank of India.

International Business or Trade Environment. **(4L)**

Module 3:

Financial Accounting-Journals. Ledgers, Trial Balance, Profit & Loss Account, Balance Sheet.

Financial Statement Analysis (Ratio and Cash Flow analysis). **(8L)**

Cost Accounting- Terminology, Fixed, Variable and Semi-variable costs.

Break Even Analysis. Cost Sheet. Budgeting and Variance Analysis.

Marginal Cost based decisions. **(6L)**

Module 4:

Time Value of Money: Present and Future Value, Annuity, Perpetuity.

Equity and Debt, Cost of Capital. **(4L)**

Capital Budgeting: Methods of project appraisal - average rate of return - payback period - discounted cash flow method: net present value, benefit cost ratio, internal rate of return.

Depreciation and its types, Replacement Analysis, Sensitivity Analysis. **(8L)**

Suggested Readings:

1. R**.** Narayanswami, *Financial Accounting- A Managerial Perspective.* Prentice-Hall of India Private Limited. New Delhi
2. Horne, James C Van, *Fundamentals of Financial Management*. Prentice-Hall of India Private Limited, New Delhi
3. H. L. Ahuja., *Modern Economic Theory*. S. Chand. New Delhi.
4. Newman, Donald G., Eschenbach, Ted G., and Lavelle, Jerome P. *Engineering Economic Analysis.* New York: Oxford University Press. 2012.

Course Name: MACHINE DESIGN-II					
Course Code: MECH 3201					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

On completion of this course students will be able to

COs	Description
CO1	Explain the method of force analysis and determination of design-parameters of Spur and Helical gears
CO2	Illustrate the method of Bevel and Worm wheel design along with the force analysis in torque transmission.
CO3	Apply the technical knowledge in the process of pressure vessel design with pressure loading only.
CO4	Work on the process of designing and/or selection of Clutch and Brake for a drive system.
CO5	Evaluate design-parameters of rolling contact bearing for proper selection of it under a given loading and boundary condition.
CO6	Determine design-parameters of sliding contact bearing for proper selection of it under a given loading and boundary condition.

Module	Course Contents	CO	Contact Hours
1A	**Gear Design- Introduction:** Design objectives of Gears, Classification of Gears and their Technical Terminologies, Different tooth profile of Gears, Interference and Undercutting, Backlash of Gear, Gear materials, Laws of gearing.	1	2
1B	**Design of Spur Gear:** Strength design, static and dynamic considerations in strength design, Lewis formula, Lewis form factor, Beam strength, Buckingham equation for dynamic tooth load; Endurance strength and wear strength; Designing a pinion based on above considerations.	1	4
2A	**Design of Helical Gear:** Helical Gear: Helix angle, minimum face width, virtual number of teeth; Strength design, Buckingham formulae for checking dynamic load and wear load.	1	2
2B	**Design of Bevel Gear:** Terminologies, formative number of teeth; Lewis equation, dynamic load, endurance strength and wear strength checking.	2	4
2C	**Design of Worm- worm wheel:** Terminologies and their inter-relation; Preferred combination of various parameters; Efficiency; Materials.	2	2

3A	**Design of Pressure vessels**– thin cylinder, thick cylinder, Lame's equation, Clavarino's equation, Bernie's equation, Autofrettage– compound cylinders, End Covers, Opening in pressure vessel – area compensation method, Fired and unfired vessels – category, Industrial Code.	3	6
3B	**Design of Clutch and Brakes: Clutches:** Function, types; Friction clutches – torque capacity based on uniform pressure and uniform wear theory for disc and cone clutch; Centrifugal clutch; Friction materials; Considerations for heat dissipation. **Brakes:** Function, types; pivoted block brake (single and double block brakes), internal expanding shoe brake, self-energizing and self-locking; Pivoted block brake; Band brake-simple and differential; Energy equation for braking time calculation; Magnetic and hydraulic thruster operated fail-safe brakes; Brake lining materials; Thermal considerations during braking.	4	7
4A	**Rolling contact bearings:** Bearing types, nature of load; Static and dynamic load capacity, Stribeck equation ,Load - Life relation; Bearing selection from manufacturers' catalogues; Methods of lubrication; Bearing mounting on journal and bearing block.	5	6
4B	**Design of Sliding contact bearings:** Bearing types and materials; Stribeck Curve, Petroff equation, Hydrodynamic lubrication theory - pressure development; Tower experiment, Reynolds equation, Finite bearings – Raimondi-Boyd charts, Design factors/variables, Heat generation & dissipation; Hydrostatic bearing; Plummer block.	6	6
		Total Classes	**39**

Text Books:

1. Design of Machine Elements- V. B. Bhandari, TMH.
2. Fundamentals of Machine Design- P.C. Gope, PHI.

Reference Books:

1. Mechanical Engineering Design- Shigley and Mischke, TMH.
2. Theory and Problems of Machine Design- Hall, Holowenko and Laughlin, TMH.
3. Design of Machine Elements- M.F. Spotts, Prentice Hall.
4. Machine Design- P. Kannaiah, Scitech Publications.

Course Name: FINITE ELEMENT METHOD					
Course Code: MECH 3231					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

On completion of this course students will be able to

COs	Description
CO1	Understand the transformation of the solution methodology of Governing Equation of any physical phenomenon from its analytical approach to a numerical approach like method of Finite Element Analysis (FEA).
CO2	Justify the expressions of Shape Functions of different 1D elements like (BAR, BEAM and FRAME) used for solving any physical problem numerically with 1D topological consideration through energy method like PSTP and Rayleigh-Ritz method.
CO3	Implement 1D elements like BAR element, BEAM element and FRAME element correctly in accordance with the Boundary conditions and Loading conditions of a particular problem to solve numerically using FEA method.
CO4	Justify 'Plane Stress' approach and 'Plane Strain' approach to solve any physical problem numerically using FEA method with 2-Dimensional elements like 'TRIA' and 'QUAD' for 2-Dimensional topological consideration.
CO5	Use 'Normalized Co-ordinate System' in place of 'User Co-ordinate System' in solving a physical problem numerically using FEA method with 2-Dimensional topological consideration using 2-Dimensional elements.
CO6	Justify the method of operation or steps of operation of any FEA software like MSC Software, ANSYS etc using computer as working or solving media.

Module	Course Contents	CO	Contact Hours
1A	**Introduction:** Historical background, FEM application on design problems, Concept of governing Equations for continuum, Solution of Governing Equation using Domain residual method, Galarkin Weighted Residual method.	1	6
1B	Concept of Shape Function and Element stiffness matrix, Principle of Stationary Total Potential (PSTP) (Ritz Method), Implementation of PSTP to find Element Stiffness Matrix of BAR Element and BEAM Element	2	6
2	FEA formulation and understanding of Boundary Condition terms and Force Terms, Shape function and Stiffness Matrix of Quadratic BAR Element and BEAM element, Concept of FRAME Elements. Assembly of elements and Technique of Stiffness Matrix Globalization, Solving 2-Dimensional Truss Problems.	3	8
3	Dimensionality of a Problem, Overview about different Two Dimensional elements and their geometrical approximation, Discussion about three node Triangular element, Concept Constant Strain Triangle (CST), Discussion about four node Quadrilateral Element.	4	9

4A	Discussion on Isoparametric formulation, Concept of normalized or natural coordinate system, Method of transformation from real coordinate to normalize or natural coordinate. Determination of shape function of triangular element and quadrilateral element in natural coordinate system.	5	6
4B	Discussion on Preprocessing, Solution and Post processing methods followed by and FEA Software in solving a physical problem using Finite Element Method.	6	4
		Total Classes	**39**

Text Books:

1. Introduction to Finite Elements in Engineering by T.R. Chandrupatla and A.D. Belegundu, Prentice Hall of India.
2. A Text Book of Finite Element Analysis by P Seshu, PHI Learning Pvt. Limited.
3. Concepts and Applications of Finite Element Analysis by R.D. Cook, D.S. Malkus and M.E. PleshaPrentice Hall-India, NewDelhi.

Reference Books:

1. Finite Element Analysis by C.S. Krishnamoorthy, TMH.
2. Finite Element Procedures by K-J. Bathe, Prentice Hall.
3. The Finite Element Method: Its Basis and Fundamentals by O.C. Zienkiewicz, R.L. Taylor, J.Z. Zhu, Elsevier.
4. An Introduction to the Finite Element Method by J.N. Reddy, McGraw-Hill.

Course name: MECHATRONICS & CONTROL SYSTEMS					
Course Code: MECH 3232					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Point**
	3	**0**	**0**	**3**	**3**

Course outcomes:

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

CO1: Acquire knowledge on different kinds of drives or actuators.

CO2: Learn about different types of sensors.

CO3: Study about the signals, signal processing and communication systems.

CO4: Learn about control system and close loop controllers

CO5: Acquire knowledge on the architecture and programming of microcontroller

CO6: Learn the Programmable Logic Controller (PLC) system and programming

Module	Syllabus	Contact hr.
1	Introduction to Mechatronics **Mechanical Drives:** Introduction, Different mechanisms, transmission system, recirculating ball screws, Linear motion bearings, harmonic drives. **Pneumatic and Hydraulic Drives & actuators:** Elements of pneumatic and hydraulic drives comparison between them, pneumatic and hydraulic circuits, symbolic representations of such circuits indicating different valves, actuators, etc. **Electrical Drives & actuators:** Servo motors, Brushless DC motors, Induction motor, Variable Frequency Drive, Stepper motor, Limit switches and Relays.	**10**
2	**Sensors and transducers:** Displacement-linear & angular, velocity, acceleration, pressure, force, temperature, proximity etc. **Signal:** Signals, types of signals, Signal conditioning, Data acquisition system, Communication system, Interfaces, I/O systems, Signal generators.	**9**
3	**Control system**: Introduction, Types of control system, system modeling, transfer function, time domain analysis, frequency domain analysis, Stability, Close loop controllers.	**10**
4	**Microcontroller:** Introduction, Architecture, Instruction set, Programming in Assembly and C language. Interfacing & microcontroller based systems. **PLC:** Introduction to Programmable Logic Controller (PLC), PLC ladder logic programming,	**10**

Text Books:

1. Mechatronics- W. Bolton, Pearson Education
2. Mechatronics- Tilak Thakur, Oxford University Press
3. Mechatronics- N.P. Mahalik, Tata McGraw Hill Publication
4. Mechatronics- M.D. Singh and J.G. Joshi, Prentice Hall of India Pvt. Ltd.

Reference Books:

1. The 8051 microcontroller and embedded systems using assembly and C - Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay, Pearson Education
2. Microcontrollers: principles and applications- Ajit Pal, PHI
3. Mechatronics- HMT Ltd., Tata McGraw Hill Publication.

Course Name : ADVANCED FLUID MECHANICS					
Course Code: MECH 3233					
Contact Hours 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	
CO 1	Understand the fundamental principles for solving kinematics of fluid flow.
CO 2	Analyze standard bench mark problems like Couette flow, Poiseuille flow.
CO 3	Apply the fundamental laws to solve problems of compressible fluid flow in engineering systems.
CO 4	Relate different flow parameters for boundary layer flow over flat plate.
CO 5	Evaluate the effects of drag and lift force on submerged bodies.
CO 6	Explain various phenomena for ideal fluid flow.

Module	Syllabus	Contact Hrs.
1	**Kinematics of Fluid Flow:** Deformation of fluid particle- Translation, Rate of linear and angular deformation and rotation of a fluid particle; Irrotational and Rotational flow; Stream function and Velocity Potential function; equipotential line; relation between velocity potential and stream function. Circulation and vorticity; Vortex flow: forced and free vortex flow, equation of motion for free and forced vortex flow. Equation of free vortex flow and pressure head at different level in case of closed cylindrical vessel with rotation.	5 5
2	**Viscous Laminar Flow of Incompressible Fluid:** Flow between parallel surfaces: Couette flow and plane Poiseuille flow. Boundary layer flow: momentum integral equation; boundary layer thickness, shear stress, drag force and drag coefficient in terms of Reynolds number for flow over flat plate. Boundary conditions for different velocity profiles.	5 5
3	**Compressible Flow:** Compressible Flow: steady flow energy equation; speed of propagation of a small disturbance through a compressible fluid, sonic velocity, Mach number, Mach cone and Mach wave; isentropic flow, stagnation and sonic properties of a compressible flow, isentropic pressure, temperature and density ratios; compressibility correction factor in the measurement of air speed; area – velocity relationship for compressible flow through a variable area duct, mass flow rate through a duct, maximum mass flow rate through a duct, critical condition and choking; flow through convergent-divergent nozzle.	9

4	**Flow of fluid around submerged bodies:** basic concept and expression of drag and lift; Pressure drag, friction drag, streamlined body, bluff body; drag on a sphere - terminal velocity of a body. **Ideal Fluid Flow:** Important cases of potential flow- uniform flow, source flow, sink flow, free vortex flow, super imposed flow (source and sink pair, doublet, flow past a half body, source and sink pair in a uniform flow, doublet in uniform flow)	4 6
Total Classes		**39**

Text Books:

1. Introduction to Fluid Mechanics and Fluid Machines- Som, Biswas and Chakraborty, TMH, 3e.
2. Advanced Engineering Fluid Mechanics - K. Murlidhar & G. Biswas, Narosa Publication, 2e.

Reference books:

1. Fluid Mechanics- Kundu, Cohen & Dowling, Academic Press (Elsevier), 5e.
2. Engineering Fluid Mechanics- Graebel. W. P, Taylor & Francis (Yes Dee Publishing Pvt. Ltd), 1st Indian reprint, 2013.
3. Fundamental Mechanics of Fluid- I.G. Currie, 3e, Marcel Dekker, Inc./McGraw-Hill.

Course Name : TOTAL QUALITY MANAGEMENT (TQM)					
Course Code: MECH 3236					
Contact Hours 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	
CO 1	Explain the concepts of Total Quality Management and Total Quality Education , Report Quality Cost measure, Customer Satisfaction Index (UNDERSTANDING)
CO 2	Identify the problems in Quality Improvement Process , Use various QC tools, appreciate the benefits of implementing 5-S Techniques (REMEBERING)
CO 3	Apply various Quality Function Deployment (QFD) Techniques(APPLYING)
CO 4	Analyze Statistical Process Control(SPC) data to improve processes, Design experiments for arriving at optimal solutions (ANALYZE)
CO 5	Appreciate the incorporation of ISO System standard and its benefits , Address isues relating to closure of NCR'S (EVALUATE)
CO 6	Propose how business leaders might plan and execute quality management in an organization , struggles to gain and sustain competitive advantage in today's global business arena (CREATE)

Module	Syllabus	Contact Hrs.
1	**Introduction:** Definition of quality ; Quality control vs. Quality Assurance ; TQM- Components of TQM; TQM vs. TPM; Quality Gurus ; Quality Planning and Quality costs; Collection and reporting of quality cost information; Leadership role in TQM; Role of senior management in TQM; Implementation and Barriers to TQM ; Customer Satisfaction- Customer perception of quality-customer complaints-customer feedback- customer retention; Employee involvement.	9
2	**QMS (ISO 9000):** Evolution of QMS- ISO 9000 series of standards- Quality manual – ISO 9001 requirements ; Different clauses of ISO 9001 system and their applicability in various business processes ; Registration of ISO 9001 : 2000 ; ISO 9001: 2000 Certification ; Steps involved in ISO 9001 : 2000 Certification ; benefits/ limitations of ISO 9001 :2000 ; Internal Audits and Implementation of ISO 9001 :2000. **EMS (ISO 14000):** Concepts of ISO 14001 ; Requirements of ISO 14001 ; Benefits of ISO 14001	11
3	Continuous process improvement; PLAN-DO-CHECK-ACT (PDCA); 7 QC tools and their use for quality improvement; Quality Function Deployment; QFD team ; Benefits of QFD; QFD Process KAIZEN; 5 – S Principle; Concept of quality circles.	9

4	Statistical process control : Basic statistical concepts ; control charts for variables; Group control charts ; Control charts for attributes; Acceptance Sampling - OC Curve ; Process capability; Sampling Plans ; Six Sigma and its applications; Design of experiments and Taguchi Methodology	10
	Total Classes	**39**

Text Books:

1. Total Quality Management – J.D. Juran , MHE.
2. Total Quality Management - Besterfield, Pearson Education.
3. Statistical Quality Control –M. Mahajan, Dhanpat Rai & Co.(Pvt.) Ltd.

Reference Books:

1. Total Quality Management – Arasu & Paul , Scitech.
2. Total Quality Management – Poornima M Charanteemath , Pearson Education .

Course Name : TURBO MACHINERY					
Course Code: MECH 3237					
Contact Hours 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. Describe the knowledge on pumps, turbines and compressors.
2. Understand the basic working principle of different types of turbo machines.
3. Solve problems using velocity triangles in turbomachinery stages.
4. Analyze the hydrodynamic forces acting on vanes and their performance evaluation.
5. Select an appropriate class of turbo machine for a particular application.
6. Compare different types of turbo machines.

Module No.	Syllabus	Contact Hrs.
1	**Introduction**: Definition, Classification and Application of turbo machines. Incompressible and compressible flow turbomachines. Radial, Axial and Mixed flow type machines. Comparison of turbo machines with positive displacement machines; Similarity and model study in turbo machines; dimensional analysis of incompressible flow turbomachines; unit and specific quantities, non-dimensional parameters and their significance; effect of Reynolds number, specific speed. Installation losses of turbo machines.	2 7
2	**Pump:** Classification and applications, Main components and their function and power transmission system in pump; Velocity diagram; Multi stage of pump; slip factor; Minimum speed of pump to deliver liquid; overall design considerations of pump; similarity relations and specific speed, **selection of pump**; cavitation and NPSH, horizontal inclined and vertical pump, bore hole pump/ deep well pump / submersible pump. Axial thrust in pump.	10
3	**Hydraulic Turbines:** Classification and applications; Main components and their functions; degree of reaction; design aspects of Pelton wheel, Francis and Kaplan turbines; Run away speed of turbine, model and selection of turbine: models and their testing, similarity considerations, relation between the characteristic data of a turbine and that of its model; Comparison between hydraulic turbine and steam turbine; governing of water turbine; water conveyance system and surge tank.	10
4	**Compressible flow machines:** Introduction: comparison among fans, blowers & compressors; classification and applications; set up and operating characteristic ices of fans, blowers & compressors. **Centrifugal Compressor:** Introduction, elements of centrifugal compressor, Work done and pressure rise, inlet duct impeller, pre-whirl vanes, Diffuser design, Choking, Overall pressure ratio developed; losses in centrifugal compressor. **Axial flow compressor**: Axial compressor characteristics, compressor staging, flow through stages, velocity triangles, pressure ratio developed per stage – work done factor.	10
Total Classes		**39**

Text Books:

1. Introduction to Fluid Mechanics and Fluid Machines – Som, Biswas and Chakraborty, TMH, 3e.
2. Hydraulic Machines – Dr. Jagdish Lal, Metropolitan Book Co. Pvt. Ltd, Reprint 2011.
3. Mechanics of Fluids – B Messy, Taylor & Francis, 8e.
4. Turbines, Compressors & Fans – S.M. Yahya, Mc Graw Hill, 4e.

Reference Books:

1. Fluid Mechanics and Machinery– C.S.P Ojha, R. Berndtsson, P. N. Chandramouli, OUP, 1e.
2. Turbomachinery: Designed and theory– Gorla, Taylor & Francis (Yes Dee Publishing Pvt. Ltd), 1stIndian reprint 2011.
3. Incompressible Flow Turbomachines– Rowal, Elsevier (Yes Dee Publishing Pvt. Ltd), 1stIndian reprint 2011.
4. Principle of Turbomachinery– Turton R. K, Springer (Yes Dee Publishing Pvt. Ltd), 1stIndian reprint 2011.
5. Turbomachines– B. U. Pai; WILEY, 1e, 2013.

Course Name : AERODYNAMICS					
Course Code: MECH 3238					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

After completion of the course, students will be able to:	
CO1	Describe the fundamental laws of aerodynamics.
CO2	Relate the fundamental laws to solve problems in aerodynamic applications.
CO3	Solve standard bench mark problems like vortex flow, Stokes theory, etc.
CO4	Analyze the effect of drag and lift force on aerofoils.
CO5	Estimate the compressibility effects on swept wings.
CO6	Design various aerodynamic structures like turbo machinery blades, vehicles, buildings, etc.

Module No.	**Syllabus**	**Contact Hrs.**
Module 1	Introduction: definition, historical development, classification & practical objectives, some fundamental aerodynamic variables, Aerodynamic forces & moments, centre of pressure, dimensional analysis and flow similarity, Mach number regimes, Kinematics of gas flow: equation of motion, circulation, Stokes theory, stream function and velocity potential.	9
Module 2	Vortex motion: vortex tube, vortex sheet, Biot-Savart law, Kelvin's theorem, vortex theorems of Helmboltz, Combination of basic flow patterns: lift on a rotating cylinder, Magnus effect, Joukowski's transformation.	10
Module 3	Lift on an aerofoil: aerodynamic forces on a lifting surface; nomenclature and shape of aerofoils; lift and drag coefficients of aerofoils; circulation theory of lift; effect of wave on lift. Thin aerofoil theory and its application; finite span effects; induced drag. Drag on an aerofoil: effect of viscosity, skin friction and forms drag; flow separation and stalling; boundary layer control and its effect.	10
Module 4	Effects of compressibility: shock waves on wings and bodies; effect of sweep on two-dimensional wings. Application of the knowledge of aerodynamics in the design of turbo-machine blades, streamlining vehicle structures, reducing wind-load on buildings and structures etc.	10
Total		**39**

Text Books:

1. Fundamentals of Aerodynamics, John D. Anderson, Jr., Mc-Graw Hill, 3e.
2. Foundations of Aerodynamics: Bases of Aerodynamics Design, Arnold M. Kuethe and Chuen-Yen Chow, Wiley India Pvt. Ltd.

Reference books:

1. Theoretical Aerodynamics, L. M. Milne-Thomson, Dover Pub.

Course Name : TOOL ENGINEERING					
Course Code: MECH 3239					
Contact Hours 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	
CO 1	Understand basic tool design and manufacturing concepts, materials used for manufacturing various tools.
CO 2	Learn design features of various types of tools used in manufacturing industry.
CO 3	Learn tool manufacturing methods for various types of HSS tools used in industry.
CO 4	Familiarize with Production of carbide tools and Press tools.
CO 5	Design Jigs and fixtures for various work holding and machining situations.
CO 6	Design and manufacture of Inspection Gauges.

Module No.	Syllabus	Contact Hrs.
Module 1	**Introduction:** Concept of Tool Design and Manufacturing, its importance in Manufacturing Industry. Fundamentals of Cutting and Forming tools. **Tool Materials**: Work hardening Tool Steels, Shock Resisting Tool Steels, Cold-Work Tool Steels, Hot-Work Tool Steels, High Speed Tool Steels, Non-ferrous Tool Materials- Cemented Carbide, Coated Carbide, Non-Metallic Tool Materials- Ceramic, Cubic Boron Nitride (CBN), Polycrystalline Diamond (PCD).	**4** **6**
Module 2	**Manufacturing tools:** Geometrical features of various tools-Drills, Milling Cutters: Profile sharpened Milling Cutters, Form relieved Milling Cutters, Inserted blade Cutters, Gear tooth Milling Cutters, Gear Hobs, Press tools.	**10**
Module 3	**Tool Manufacturing:** Blank Preparation, Machining locating datum surfaces, Manufacturing body of cutting tool, Making of cutting edge, Sharpening and lapping. (HSS tools) Production of carbide tools. Punch and Die Manufacture, Tracer and Duplicating Mills for cavity applications, EDM for cavity applications.	**5** **4** **1**
Module 4	**Jigs & Fixtures:** **Drill Jigs:** Introduction: Purpose, Accuracy; Types of Drill Jigs, Drill Bushings, and Methods of construction. **Fixtures:** Introduction: Purpose, Accuracy; Types of fixtures, Milling, Boring, Lathe and Grinding fixtures. **Inspection Gauges:** Introduction: Purpose, types; Fixed gauges, Gauge tolerances, Material selection, Methods of construction.	 **3** **3** **3**
	Total	**39**

Text Books:

1. Tool Design, C. Donaldson and V. C. Goold, TMH Publication.

Reference Books:

1. Fundamentals of Tool Design, Jeff Lantrip, John G. Nee, and David Alkire Smith, Society of Manufacturing Engineers.

Course Name : COMPUTATIONAL FLUID DYNAMICS					
Course Code: MECH 3221					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

At the end of the course, a student will be able to	
CO 1	Describe the fundamental conservation laws of fluid mechanics.
CO 2	Express the transport equations in general form.
CO 3	Construct the methodologies for converting Partial Differential Equations (PDE) to discretised algebraic forms using Finite Volume Method (FVM).
CO 4	Analyze various CFD solution algorithms for steady and unsteady flows.
CO 5	Compare the results obtained from direct analytical solution and FVM using Tri-Diagonal Matrix Algorithm (TDMA).
CO 6	Formulate CFD problems using CFD software and examine the validity of such scheme.

Module No.	Syllabus	Contact Hrs.
Module 1	Introduction, Control Mass, Control Volume, Description of fluid motion: Eulerian & Lagrangian methods.	**1**
	Substantial, Temporal and Convective derivatives. Equations of state.	**1**
	Conservation laws for fluid motion (a) mass (b) momentum and (c) energy Navier-Stokes equations for Newtonian fluid.	**3**
	General transport equations.	**1**
	Time averaged Navier-Stokes equations for Turbulent flow, Turbulence models (brief idea).	**1**
		2
Module 2	Concept of initial and boundary value problems.	**1**
	Different differencing schemes (Upwind, Central, QUICK) and their applicability.	**2**
	Finite volume method for steady state: (a) Diffusion (b) Convection-Diffusion problems.	**4**
	Diffusion and Convection-Diffusion problem solving.	**2**
Module 3	CFD solution algorithms for Pressure-Velocity coupling: Staggered grid, SIMPLE & PISO algorithm.	**4**
	Solution of discretized algebraic equations using TDMA.	**2**
	Introduction to CFD software *: Basic architecture (Pre-processing, Processing, and Post-processing).	**1**
	Grid/Mesh generation: Types of grid/mesh elements (Quad, Tri, Tetrahedron, Hexahedron, etc.)	**1**
	Structured and Unstructured grid.	**2**
Module 4	*Multi-block grid structure.	**2**
	Grid interface.	**1**
	Inputs for boundary conditions & solution methods.	**1**
	Selection of materials & properties.	**1**
	Multiphase domain.	**3**
	Grid independency.	**1**
	Post-processing: Plotting graphs, contours, vectors, and data export.	**2**
	Total	**39**

*** CFD software related topics may be covered in conjunction with ANSYS FLUENT (Dept. licensed version)**

Text Books:

1. Computational Fluid Dynamics: The finite volume approach, H. K. Versteeg & W. Malalasekara, Pearson Pub.
2. Computational Fluid Dynamics: the basics with applications, Jr. John D. Anderson, McGraw Hill.

Reference Books:

1. Numerical Heat Transfer and Fluid Flow, Suhas V Patankar, Taylor & Francis
2. Computational Fluid Dynamics, John Wendt, Springer-Verlag Berlin Heidelberg

Course Name : ADVANCED WELDING TECHNOLOGY					
Course Code: MECH 3222					
Contact Hours 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	
CO 1	Compare the processes of common welding technology
CO 2	Evaluate process parameters in different welding processes.
CO 3	Understand critical and precise welding processes and their setups.
CO 4	Analyze the metallurgical properties after welding and select post welding heat treatments, if required.
CO 5	Explain the weldability of different material and implement the knowledge of welding fixture and automation in different welding process.
CO 6	Identify the welding defects, its causes and remedial measures.

Module No.	Syllabus	Contact Hrs.
Module 1	a. Introduction: Review of various welding processes. Sequence of welding in long T-weld joints. b. Process Descriptions and Parametric influences: On fusion welding, arc welding-SMAW, GMAW, GTAW, FCAW, Submerged Arc Welding, c. Resistance welding processes.	2 6 1
Module 2	a. Critical and Precision Welding Processes: PAW, LBW, EBW, USW b. Solid state welding, pressure welding, friction welding, diffusion welding, Friction Stir Welding, Under Water Welding. c. Welding of Plastics, Ceramics and Composites.	4 4 2
Module 3	a. Welding Metallurgy: Heat Affected Zone (HAZ), Effects of different process parameters on the characteristics of weldment, Post welding heat treatment. Pre-heating before welding. b. Weldability of plain carbon steels, stainless steel, cast iron, aluminum and its alloys.	5 5
Module 4	a. Welding fixtures, welding automation and robot welding. b. Welding Defects: Types, causes and remedial measures. c. Testing of welded joints-Destructive and non-destructive tests. d. Safe Practices in Welding.	3 3 3 1
	Total	**39**

Text books:

1. A Text Book of Welding Technology, O.P.Khanna , Dhanpat Rai
2. Welding Engineering and Technology, R.S. Parmar , Khanna Publishers
3. Welding Technology, R. Little, McGraw Hill

Reference books:

1. Essentials of Welding, Raymond J. Sacks, McGraw-Hill Higher Education
2. Welding Principles and Practice, Raymond J. Sacks and Edward R. Bohnart, McGraw-Hill

Justification of change:

7. **"Arc Welding:** Different types of equipment, power sources, arc characteristics, electrode selection."

This portion from module II is omitted as it will be covered in module I.

8. "Testing of welded joints by visual inspection, Dye Penetration (DP) test, ultrasonic and radiography." This portion from module IV is replaced by ' Welding Defects: Types, causes and remedial measures. / Testing of welded joints-Destructive and non-destructive tests.'

9. Topics are broken in to sub-topics and identified by sub-topic number.

10. Few rearrangements are done to keep number of lectures similar in every module. So, that good distribution of questions can be made from each module.

Course Name: NEW PRODUCT DEVELOPMENT					
Course Code: MECH 3223					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

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

CO1	Identify market opportunity for new products and initiate necessary actions for developing the product.
CO2	Forecast technology requirement, assess market demand and customer needs and work out project cost and ROI of a product.
CO3	Prepare detailed product architecture and product costing.
CO4	Conduct brainstorming and generate ideas.
CO5	Set final product specification taking into account its manufacturability, assembly and maintenance.
CO6	Create prototype of a product, validate its performance and carry out failure analysis.

Module	Syllabus	Contact Hrs.
1	**Introduction:** Need for the new product development; Product development Process: understand opportunity, develop concept, implement concept of Reverse engineering & redesign methodology; Development Vs design; Product development team; Product development planning; Legal and ethical issues in product development; case studies.	**10**
2	**What to Develop:** 'S' curves and technical forecasting; Market demand assessment; Customer needs and satisfaction; Product function and FAST (function analysis system technique) method. Volume and profit breakdown; Estimating project facility cost and ROI.	**10**
3	**Product Architecture:** Integral and modular architecture; types of modularity; Modular design: Clustering method and functional method; Generating concepts/ value engineering: brain storming, direct search, morphological analysis; Product costing; case studies.	**10**
4	**Design Process:** Bench marking process steps; Setting product specifications; Design for manufacture, assembly and disassembly; maintenance, quality and usability; Prototype making and validation; Causes of new product failure; Case studies.	**9**
	Total Classes	**39**

Text Books:

1. Product Design: Technique in Reverse Engineering and New product Development- K.Otto and K.Wood, Pearson Education, 17th Impression.
2. Product Development- Anil Mital et al, Elsevier, 2008.
3. New Product development- M.A. Annacchino, Elsevier, 2003.

Reference Book:

1. Engineering Design by George E. Dieter, McGraw Hill, International Editions, 3rd Ed.

Course Name: INDUSTRIAL ENGINEERING					
Course Code: MECH 3224					
Contact Hours 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	
CO 1	Interpret the theoretical knowledge about the various tools and techniques of Industrial Engineering (UNDERSTAND)
CO 2	Develop work procedures about various safety standards to be followed In carrying out different types of equipments or systems (CREATE)
CO 3	Implement the Inventory Management Principles & Techniques (APPLY)
CO 4	Make judgments based on the criteria and standards through Quality Control Practices and Testing Methods (EVALUATE)
CO 5	Identify to prepare production planning and the control procedures with the knowledge of industrial legislation (REMEMBERING)
CO 6	Determining how the productivity improvement tools relate to one another for an overall structure or purpose through differentiating, organizing and attributing (ANALYZE)

Module	Syllabus	Contact Hrs
1	**Introduction to Industrial Engineering :** Evolution of modern concepts in IE -Functions of IE, Field of application of IE, Product Development and Research-Design Functions-Objectives of Design-Manufacturing vs. Purchase-Economic aspects-CVP Analysis-Simple Problems, Development of designs-prototype, production and testing-Human factors in design-Value Engineering,	**07**
2	**Location Selection and Plant Layout:** Nature of Location Decision, Importance of Plant Location, Dynamic Nature of Plant Location, Choice of site for selection, Comparison of Location, Principles of Plant Layout and Types, Factors affecting Layout, methods, Factors governing flow pattern, travel chart, analytical tool of plant layout, layout of manufacturing shop floor, repair shop, service sectors and process plant , Quantitative methods of Plant Layout: CRAFT and CORELAP, Relationship Diagrams	**10**
3	**Production Planning & Control :** Importance of Planning, Types of Production Systems and their Characteristics, Functions & Objectives of Production Planning & Control-Routing, Scheduling, Dispatching and Expediting-Gantt Charts, Inventory Control, Inventory models-determination of EOQ and	**10**

	reorder levels-simple problems-selective Inventory control techniques, introduction to line of balance, assembly line balancing ,and progress control	
4	**Productivity and Work Study :** Definition of Productivity, application and advantages of Productivity improvement tools, reasons for increase and decreases in Productivity, Areas of application of work study in Industry, Method Study: objectives and procedure for methods analysis, recording techniques, operations process chart, man-machine chart, multiple activity chart, travel chart, and two handed process chart, string diagram, Therbligs, micro-motion study: principles of motion economy, Work measurement : objectives, work measurement techniques-time study, work sampling, pre-determined motion time standards(PMTS)Determination of time standards ,observed time, basic time, normal rating, rating factors, allowances, and standard time. ergonomics-wages and incentives, primary wage system, wage incentive plans	**12**
Total		**39**

Reference Book:

1. Modern Production/Operations Management (Wiley Series in Production)/Operations Management by Elwood S. Buffa and Rakesh K. Sarin | 2 September 1987.
2. Production System , Planning , Analysis and Control by J L Riggs, 3rd Edition Wiley.
3. Production and Operation Management by R Panneerselvam , PHI publishers
4. Industrial Engineering and Production Management by Martland Telsang , S Chand and Company.

Course Name : MACHINING AND MACHINE TOOLS LAB					
Course Code: MECH 3256					
Contact Hours 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	
CO 1	Design speed structure, construct Ray Diagram of an all-gear headstock Lathe and Analyze Apron Mechanism of a Centre Lathe.
CO 2	Quick-return mechanism & stroke length adjustment of a Shaping Machine, Analyze speed and feed system of a Milling Machine.
CO 3	Understand special features of radial drilling machine and making multiple holes in a plate using radial drilling machine.
CO 4	Measure cutting forces in turning operation in a Lathe and Analyze mechanism of chip formation in turning operation.
CO 5	Learn basic principle of tool-wear and evaluate tool life, Understand a surface grinding machine and produce smooth surface on a flat object.
CO 6	Produce a Helical gear.

Expt No	List of Experiments	Contact Hrs.
1	**Machine Tool:** Study of speed structure & construction of Ray Diagram of an all-geared headstock Lathe.	3
2	**Machine Tool:** Study of Apron Mechanism of a Centre / Engine Lathe.	3
3	**Machine Tool:** Study of Quick-return mechanism and stroke length adjustment of a Shaping Machine.	3
4	**Machine Tool:** Study of spindle rotation and table feed system of a Milling Machine.	3
5	**Machine Tool:** Study of special features of radial drilling machine and drilling multiple holes in a plate using radial drilling machine.	3
6	**Machining:** Measurement of cutting forces in straight turning at different feeds and speeds.	3
7	**Machining:** Study of chip formation (type, color and thickness) in turning mild steel and evaluation of role of variation of cutting speed and feed on chip reduction coefficient / cutting ratio and shear angle.	3
8	**Machining:** Measurement of tool-wear and evaluation of tool life in turning mild steel by HSS.	3
9	**Machining:** Study of surface grinding machine and producing smooth surface on a flat object.	3
10	**Machining:** Production of a Helical gear from a cast or forged disc.	3

Course Name: FINITE ELEMENT METHOD LAB					
Course Code: MECH 3281					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**2**	**2**	**1**

Course Outcomes:

On completion of this course students will be able to

COs	Description
CO1	Implement as well as understand different international codes like ASME codes, AGMA codes, ISO codes etc. when they will be encountering with industrial drawings in their professional life.
CO2	Convert the physical model of any structural problem into a FEA model in a FEA software like MSC Patran/Nastran or ANSYS by adopting relevant structural element and by implementing proper boundary condition as well as loading.
CO3	Prepare FEA model of any thermal problem by using proper thermal element and implementing boundary condition as well as loading conditions accurately in a FEA software like MSC Patran/Nastran or ANSYS.
CO4	Take active part in design activity regarding designing of shaft or equivalent machine components where ASME codes are used extensively in detail and also FEA software is used for design calculations and validations.
CO5	Engage themselves fruitfully in the process of any power driving system design like designing of Gear Drive and/or Pulley Drive and/or Cam Drive etc. where AGMA and ASME codes are used as well as FEA Software are used.
CO6	Understand design process of a Thermo-Mechanical system like designing of pressure vessel etc. where ASME as well as TEMA codes are used along with FEA software for the design validation.

Module	Course Contents	CO	Contact Hours
1	A detailed discussion on different design standards like AGMA (American Design Manufacturing Association) standard for Gear design, ASME (American Society for Mechanical Engineers) for Pressure Vessel Design, ISO (International Standardization Organization). .	1	6
2	A Detailed discussion on methodology of solving a structural problem using FEA software MSC Patran and Nastran or equivalent software.	2	6
3	A Detailed discussion on methodology of solving a thermal problem using FEA software MSC Patran and Nastran or equivalent software.	3	6
4	**Design of shaft and bearing assembly:** ➢ Identification of loads and boundary conditions for a shaft which is to be designed and to be assembled between to roller bearings. ➢ Design of shaft and selection of bearings as per identified load and boundary conditions. Designing of shaft will be done complying ASME and ISO standards. ➢ 3-Dimensional modeling of shaft, bearing and assembly of shaft and bearing in a 3-D modeling software named PTC Creo Parametric or equivalent software.	4	6

	➢ Numerical validation of the design using a FEA software like MSC Nastran or equivalent software.		
5	**Design of a simple spur gear assembly:** ➢ Identification of required input data from the problem definition. ➢ Calculations for module and other constructional parameters of the spur gear following AGMA standard. ➢ Parametric modeling of the gears and their assembly using a 3D modeling software named PTC Creo Parametric or equivalent software. ➢ Numerical validation of the design using a FEA software like MSC Nastran or equivalent software.	5	6
6	**Design of a pressure vessel:** ➢ Identification of required input data from the problem definition. ➢ Calculation of plate thickness for autofritage condition following ASME code. ➢ Parametric modeling of pressure vessel using a 3D modeling software named PTC Creo Parametric or equivalent software. ➢ Numerical validation of the design using FEA software like MSC Nastran or equivalent software.	6	6
		Total Classes	**36**

Recommended Books:

I. Mechanical Component Design- Robert C Juvinall and Kurt M Marshek. Published by Wiley Publication, 5th Edition 2012.
II. Mechanical Design of Machine Elements and- Jack A Collins, Henry Busby and George Staab. Published by _Wiley Publication', 2nd Edition, 2010.
III. ISO Codes: All parts of ISO 6336.
IV. AGMA Codes: AGMA 901/908/913/917/918/923/933, ANSI/AGMA- 2004 and ANSI/AGMA- 2012.
V. ASME Codes: BPVC Section I- Rules for Construction of Power Boilers and BPVC Section IV- Rules for Construction of Heating Boilers.
VI. Finite Element Analysis with PATRAN / MSC NASTRAN, by Pramote Dechaumphai, Sedthawat Sucharitpwatskul, Publisher- Narosa.
VII. Finite Element Analysis with ANSYS Workbench 2019 R2, by Sham Tickoo, Publisher-BPB Publications

Course Name: MECHATRONICS & CONTROL SYSTEMS LAB					
Course Code: MECH 3282					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**2**	**2**	**1**

Course Outcomes:

On completion of this course students will be able to

CO1	Study the physical principles of different analogue and digital sensors and **to** measure load, linear displacement and angular displacement using sensors
CO2	Operate and control of Servomotor / Stepper motor
CO3	Acquire knowledge to control the speed of Induction motor using Variable Frequency Drive
CO4	Operate pneumatic and hydraulic circuits using limit switches.
CO5	Study the basic concepts and programming of Programmable Logic Controller.
CO6	Use the basic concepts in programming of Microcontroller.

Experiment/Study	Topics	Contact hrs.
1	**Sensor:** i. Strain gauge, ii. Pressure Dependent Resistor (PDR), iii. Light Dependent Resistor (LDR), iv. Linearly Variable Differential Transformer (LVDT), v. Proximity sensors (Ultrasonic, InfraRed (IR), Inductive).	**8**
2	**Servomotor:** i. Working principle ii. Characteristics, iii. Linear position control, iv. Angular position control **v.** Angular Velocity control.	**2**
3	**Stepper motor** i. Working principle ii. Characteristics, iii. Linear position control, iv. Angular position control v. Angular Velocity control.	**2**
4	**3 phase Induction motor** i. Working principle ii. Characteristics iii. Speed control by controlling supply frequency using Variable Frequency Drive (VFD).	**2**
5	**Pneumatic & Hydraulic control system** i. Fluid circuit components ii. Electrical circuit components iii. Control of Pneumatic & Hydraulic systems.	**2**
6	**Programmable Logic Controller (PLC)** i. PLC introduction ii. PLC programming and simulation iii. Control of Mechatronics system using PLC.	**4**
7	**Microcontroller:** i. Microcontroller introduction ii. Microcontroller programming and simulation iii. Control of Mechatronics system using Microcontroller.	**6**
	Total	**26**

Course Name: ADVANCED FLUID MECHANICS LAB					
Course Code: MECH 3283					
Contact Hours 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	
CO 1	Identify the components used in different fluid flow systems.
CO 2	Apply the knowledge of engineering fundamentals to understand the viscous drag in creep flow, separation in pipe fittings, and characteristics of free surface flow.
CO 3	Investigate the effect of design, and off-design conditions on centrifugal pumps.
CO 4	Calibrate and measure different flow parameters in wind tunnel.
CO 5	Investigate and estimate errors in experiment.
CO 6	Perform effectively as an individual, and as a member of a team in a laboratory.

List of Experiments / Jobs to be carried out during the semester

1. Verification of Stokes' Law.
2. Study of minor losses in pipe fittings.
3. Determination of cavitation parameters of a centrifugal pump.
4. Performance test of centrifugal pumps in parallel operation.
5. Performance test of centrifugal pumps in series operation.
6. Study of characteristics of hydraulic jump.
7. Calibration of a suction type, open circuit, subsonic wind tunnel.
8. Pressure distribution on a cambered airfoil at different Angle of Attack (AoA).
9. Surface flow visualization and drag force calculation through surface pressure distribution on a cylinder at different Reynolds number.
10. Experimental error analysis.

Course Name: SEMINAR & TERM THESIS					
Course Code: MECH 3293					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**4**	**4**	**2**

Course Outcomes:

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

CO1	Independently learn a novel topic of his own interest not covered in curriculum
CO2	Analyze a given topic in order to prepare a logical sequence of information to be collected and then properly collated/reported.
CO3	Acquire the skills required to source relevant information and data (from books/magazines/journals/internet etc) on topics not formally studied in regular course curricula
CO4	Develop the skills to present the topic in audio-visual format in front of an audience and keep them engaged
CO5	Apply the knowledge of science, engineering and general reasoning in defending the queries raised during or after the presentation
CO6	Enhance knowledge and develop capabilities of independent thinking to discuss, compare, debate, judge and criticize subjects/topics presented by others.

- Each student has to propose at least three topics, preferably related to mechanical engineering, to the concerned class teacher on which he/ she wants to present the seminar within 7 days of start of the seminar class. The topics should not be a part of the subjects already taught in the class. The class teacher will select the final topic from the proposed topics.

- The student will submit a report on the accepted topic within 14 days of finalization of the topic.

- Each student will be allotted a particular date as per routine for making a presentation on the topic for 20 minutes followed by a question session for 10 minutes.

- The presentation will be through power point having not more than 30 slides. The presentation will be open to all class mates and departmental teachers.

- The presentation should have an opening slide clearly mentioning the topic and the speaker, a slide that lists the contents of the presentation, a slide for introduction/ abstract, several slides for elaborating the topic, a slide with conclusion and a slide with list of references.

- The text in the slides should be in short sentences and bullet marked (the text in the report should not be reproduced in the slides). The student has to verbally elaborate the content of the slide and not just read it out.

- The graphs, sketches, pictures, tables etc used in the slide should be easily readable/ legible with proper labels and units.

- The report should contain the following and be prepared as per the guidelines given below.
  1. Main matter of the report should not be less than 10 typed pages (font size 12 for main body of the report). Each page should be numbered.
  2. A cover page containing HIT logo, name of the topic, 'SEMINAR and Term Thesis – MECH 3292', session 20xx – 20xx, name of the student with class roll number and name of the concerned faculty.
  3. An acknowledgement page with name, roll number and signature of the student.
  4. Certificate of disclaimer
  5. List of contents
  6. List of figures
  7. List of tables
  8. An abstract and a broad overview.
  9. Introduction
  10. Types of the product/ system/ process prevalent in industry
  11. Application in various fields with examples
  12. Input parameters/ variables that are necessary for product/ system/ process configuration as applicable
  13. Input materials for manufacture of the product as applicable
  14. Manufacturing steps and the machinery used as applicable
  15. Any other relevant material.
  16. Conclusion
  17. Bibliography
  18. Every figure should have a caption and should be numbered and referred to in the text.
  19. Every graph should be legible, have a description, unit of the axes and should be numbered and referred to in the text.
  20. The report should be presented in a Channel File.
  21. The report should NOT be a collection of print out of the presentation slides.

- Students should consult with the designated faculty for a better understanding of the deliverable and content of the report.

- All students, including those who are not making the presentation, have to be present during the presentation and actively participate in the question answer session.

Course Name : IC ENGINE					
Course Code: MECH 3211					
Contact Hours 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 to:

- **Demonstrate** knowledge of the operating characteristics of common IC engines and the ability to perform a thermodynamic analysis of Otto, Diesel, and Dual cycle models (**L-3**).
- **Explain** and quantify the differences in work outputs between theoretical cycles and actual cycles in operation (**L-2**).
- **Distinguish** between the combustion processes in SI and CI engines and the characteristics of common liquid and gaseous fuels (**L-3**).
- **Execute** combustion analysis of fuels in the basic cycles as well as quantitative analysis of the air-fuel ratio in a simple carburetor (**L-3**).
- **Describe** the various performance testing procedures and **recognize** IHP, BHP, FHP and efficiency parameters (**L-2**).
- **Examine** an ideal gas turbine cycle and calculate thermal efficiency and work output (**L-4**).

Module	Syllabus	Contact Hrs.
1	**Heat engines:** Working principle of 2-stroke and 4- stroke IC engines. Basic engine components and nomenclature; First law analysis of engine cycle; Nomenclature of various engine parameters.	2
	Analysis of air standard cycles: Otto cycles, Diesel cycles and dual combustion cycles; comparison; Other cycles: Carnot, Stirling, Erricsson, Lenoir, Atkinson, Brayton cycles; numerical problems.	3
	Analysis of fuel- air cycles: significance; effects of variable specific heat, composition of gases, dissociation, number of moles; numerical problems; Analysis of actual cycles with respect to factors of time loss, heat loss and exhaust blowdown.	5
2	**Fuels**: Gaseous and liquid fuels; Desirable characteristics of I.C. engine fuels; Rating of S.I. and C.I. engine fuels; HCV and LCV of the fuels	3
	Fuel- air mixing in S.I. engines: Volumetric efficiency, concept of supercharging, working principle of a simple carburetor; Analysis of simple carburetor; Numerical problems.	4
	Combustion of fuels in I.C. engines: Stages of combustion in SI and CI engines; flame front propagation; factors influencing combustion; knocking / detonation and their preventions.	3

3	Mechanical injection systems in C I engines: Principles of different injection systems; Fuel feed pump, injection pumps; Fuel injector and nozzles; Quantity of fuel and size of nozzle orifice; Numerical problems; Basic principles of MPFI in SI engines. Ignition in S I engine: Requirement of an ignition system; Battery ignition system with different components; ignition timing and spark advance; Reference to other ignition systems. Lubrication system in I.C. engines: Losses and requirement of lubrication; Different systems; Properties of lubricating oil.	4 3 2
4	Cooling system in I.C. engines: Temperature distribution and heat transfer; Principles of liquid cooled and air cooled Performance and testing of I.C. engines: Engine power; Engine efficiencies; Engine performance characteristics. Measurement of speed, torque, fuel consumption, determination of IHP, BHP and FHP, sfc, different efficiencies; plot of efficiency vs. speed curves, numerical problems Engine emissions and their control: Different exhaust and non-exhaust emission, relation with equivalence ratio; Emission control methods Introduction to Gas Turbine: Open cycle/ closed cycle gas turbine; Analysis of simple ideal gas turbine cycle; real gas turbine cycles with isentropic efficiencies, numerical problems	2 4 2 2
	Total Classes	**39**

Text Books:

1. Internal Combustion Engines- V. Ganesan, Tata McGraw-Hill Companies.
2. A course in Internal Combustion Engines - M.L. Mathur and R.P. Sharma, Dhanpat Rai & Sons.
3. Fundamentals of Internal Combustion Engines- H.N. Gupta, PHI Learning Private Ltd.

Reference Books:

1. Fundamentals of IC Engines by Paul W Gill, Oxford & IBH-Pubs Company-New Delhi.
2. Gas Turbines- V. Ganesan, Tata McGraw-Hill Companies.
3. Internal Combustion Engine and Air Polution -Edward Frederic Obert.
4. Internal Combustion Engines; Applied thermo sciences- Colin R Farguson, Allan T, Kirkpatrick, Willey Publication, 3e.
5. Internal Combustion Engine Fundamentals -John B Heywood, Mc-Graw Hills.

Course Name : IC ENGINE LAB					
Course Code: MECH 3261					
Contact Hours 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	
CO 1	**Describe** the working principles of 2/4-stroke SI/CI engines through models (**L2**).
CO 2	**Define** and **calculate** the calorific value of a fuel by Bomb calorimeter (**L1**).
CO 3	**Explain** the implication of opening and closing of valves on engine performance through the valve timing diagram (**L2**).
CO 4	**Analyze** the performance ($IHP, BHP, FHP, bsfc, \eta_{vol}, etc.$) of CI/SI Engines through various experiments using various dynamometer arrangements (**L4**).
CO 5	**Analyze** flue gas composition by the ORSAT apparatus (**L4**).
CO 6	**List** the different components of the MPFI (multipoint fuel injection) system through a model (**L1**).

Sl. No.	List of Experiments	Contact Hrs.
Expt 1	Familiarization with different components of an I C Engine.	3
Expt 2	Determination of calorific value of a fuel by Bomb calorimeter.	3
Expt 3	Study of valve timing diagram of a Petrol Engine.	3
Expt 4	Performance Test of a C I Engine using electric dynamometer.	3
Expt 5	Performance Test of a multi-cylinder S I Engine by Morse Test.	3
Expt 6	Flue gas analysis by ORSAT apparatus.	3
Expt 7	Use of catalytic converter and its effect on flue gas of a CI Engine (Analysis to be done by ORSAT apparatus).	3
Expt 8	Study of MPFI (multipoint fuel injection system). (Demonstration only)	3
	Viva-voce	

N B: At least 6 experiments are to be performed.