Mechanical Engineering

B.TECH. PROGRAMME

June - 2017

Part-I

Course Structure

1st Year 1st Semester Syllabus:

Theory							
Sl. No	Paper Code	Paper Name	Contact Hrs per Week				Credit Point
			L	T	P	Total	
1	HMTS1101	Business English	2	0	0	2	2
2	PHYS1001	Physics I	3	1	0	4	4
3	MATH1101	Mathematics I	3	1	0	4	4
4	ECEN1001	Basic Electronics Engineering	3	1	0	4	4
5	MECH1101	Engineering Mechanics	3	1	0	4	4
		Total Theory	**14**	**4**	**0**	**18**	**18**

Laboratory/Practical							
Sl. No	Paper Code	Paper Name	Contact Hrs per Week				Credit Point
			L	T	P	Total	
1	PHYS1011	Physics I Lab	0	0	3	3	2
2	ECEN1011	Basic Electronics Engineering Lab	0	0	3	3	2
3	MECH1011	Workshop Practice	1	0	3	4	3
4	HMTS 1111	Language Practice Lab (level I)	0	0	2	2	1
		Total Laboratory	**1**	**0**	**11**	**12**	**8**

Sessional							
Sl. No	Paper Code	Paper Name	Contact Hrs per Week				Credit Point
			L	T	P	Total	
1	HMTS1121	Co- Curricular Activities	0	0	2	2	1
		Total Sessional	**0**	**0**	**2**	**2**	**1**
Total of Semester			**15**	**4**	**13**	**32**	**27**

1st Year 2nd Semester Syllabus:

Theory							
Sl. No	**Paper Code**	**Paper Name**	**Contact Hrs per Week**				**Credit Point**
			L	**T**	**P**	**Total**	
1	CSEN1201	Introduction to Computing	3	1	0	4	4
2	CHEM1001	Chemistry I	3	1	0	4	4
3	MATH1201	Mathematics II	3	1	0	4	4
4	ELEC1001	Basic Electrical Engineering	3	1	0	4	4
5	MECH1201	Engineering Thermodynamics and Fluid Mechanics	3	1	0	4	4
		Total Theory	**15**	**5**	**0**	**20**	**20**

Laboratory/Practical							
Sl. No	**Paper Code**	**Paper Name**	**Contact Hrs per Week**				**Credit Point**
			L	**T**	**P**	**Total**	
1	CSEN1211	Introduction to Computing Lab	0	0	3	3	2
2	CHEM1011	Chemistry I Lab	0	0	3	3	2
3	ELEC1011	Basic Electrical Engineering Lab	0	0	3	3	2
4	MECH1012	Engineering Drawing	1	0	3	4	3
		Total Laboratory	**1**	**0**	**12**	**13**	**9**
Total Semester			**16**	**5**	**12**	**33**	**29**

2nd Year 1st Semester Syllabus:

Theory							
Sl. No.	**Code**	**Paper**	**Contact Hours/Week**				**Credit Points**
			L	**T**	**P**	**Total**	
1	**PHYS 2001**	Physics - II	3	1	0	4	4
2	**MECH 2101**	Applied Thermodynamics	3	0	0	3	3
3	**MECH 2102**	Strength of Materials	3	0	0	3	3
4	**MECH 2103**	Fluid Mechanics	3	0	0	3	3
5	**MECH 2104**	Engineering Materials	3	0	0	3	3
6	**MECH 2105**	Metrology & Measurement	3	0	0	3	3
7	**HMTS 2002**	Indian Culture and Heritage	2	0	0	2	1
Total Theory			**20**	**1**	**0**	**21**	**20**
Laboratory/Practical							
6	**HMTS 2011**	Language Practice Lab (level II)	0	0	3	3	2
7	**MECH 2111**	Machine Drawing - I	0	0	3	3	2
8	**MECH 2112**	Applied Mechanics Lab	0	0	3	3	2
9	**MECH 2113**	Workshop Practice - II	0	0	3	3	2
Total Practical			**0**	**0**	**12**	**12**	**8**
Total of Semester			**20**	**1**	**12**	**33**	**28**

2nd Year 2nd Semester Syllabus:

Theory							
Sl. No.	**Code**	**Paper**	**Contact Hours/Week**				**Credit Points**
			L	**T**	**P**	**Total**	
1	**MATH 2002**	Numerical and Statistical Methods	3	0	0	3	3
2	**MATH2001**	Mathematical Methods	3	1	0	4	4
3	**MECH 2201**	Fluid Machinery	3	0	0	3	3
4	**MECH 2202**	Kinematics of Machines	3	0	0	3	3
5	**MECH 2203**	Primary Manufacturing Processes	3	0	0	3	3
6	**HMTS2001**	Human Values & Professional Ethics	2	0	0	2	2
7	**CHEM 2001**	Basic Environmental Engineering & Ecology	3	0	0	3	3
Total Theory			**20**	**1**	**0**	**21**	**21**
Laboratory/Practical							
8	**MECH 2211**	Machine Drawing - II	0	0	3	3	2
9	**MECH 2212**	Metrology & Measurement Lab	0	0	2	2	1
10	**MECH 2213**	Manufacturing Technology Lab	0	0	3	3	2
11	**MECH 2214**	Material Testing Lab	0	0	2	2	1
12	**MATH 2012**	Numerical and Statistical Methods Lab	0	0	2	2	1
Total Practical			**0**	**0**	**12**	**12**	**7**
Total of Semester			**20**	**1**	**12**	**33**	**28**

3rd Year 1st Semester Syllabus:

Theory							
Sl. No.	**Code**	**Paper**	**Contact Hours/Week**				**Credit Points**
			L	**T**	**P**	**Total**	
1	**HMTS 3101**	Economics for Engineers	3	0	0	3	3
2	**MECH 3101**	Dynamics of Machines	3	0	0	3	3
3	**MECH 3102**	Heat Transfer	3	1	0	4	4
4	**MECH 3103**	Design of Mechanical Systems-I	3	1	0	4	4
5	**MECH 313X**	Professional Elective - I	3	0	0	3	3
6	**MECH 314X**	Professional Elective - II	3	0	0	3	3
Total Theory			**20**	**0**	**0**	**20**	**20**
Laboratory/ Practical							
7	**MECH 3111**	Fluid Mechanics & Hydraulic Machines Lab	0	0	3	3	2
8	**MECH 3112**	Design Practice - I	0	0	3	3	2
9	**MECH 313Y**	Professional Elective - I Lab	0	0	3	3	2
Total Practical			**0**	**0**	**9**	**9**	**6**
Sessional							
Sl. No	**Paper Code**	**Paper Name**	**Contact Hrs per Week**				**Credit Point**
			L	**T**	**P**	**Total**	
10	**MECH 3121**	Seminar-I	0	0	3	3	2
		Total Sessional	**0**	**0**	**3**	**3**	**2**
Total of Semester			**20**	**0**	**12**	**32**	**28**

List of Professional Elective I:

1. MECH 3131 : Fluid Power Control
2. MECH 3132 : Refrigeration & Air Conditioning
3. MECH 3133 : Electrical Machines

List of Professional Elective I Lab:

1. MECH 3136 : Fluid Power Control Lab
2. MECH 3137 : Refrigeration & Air Conditioning Lab
3. MECH 3138 : Electrical Machines Lab

List of Professional Elective – II

1. **MECH 3141 :** Total Quality Management (TQM)
2. **MECH 3142 :** Finite Element Method
3. **MECH 3143 :** Turbo Machinery
4. **MECH 3144** : New Product Development
5. **MECH 3145** : Tool Engineering
6. **MECH 3146** : Industrial Robotics

3rd Year 2nd Semester Syllabus:

Theory							
Sl. No.	**Code**	**Paper**	**Contact Hours/Week**				**Credit Points**
			L	**T**	**P**	**Total**	
1	**HMTS 3201**	Principles of Management	2	0	0	2	2
2	**MECH 3201**	IC Engines	3	0	0	3	3
3	**MECH 3202**	Machining Principle & Machine Tools	3	0	0	3	3
4	**CSEN 3206**	Data Structure & RDBMS	3	0	0	3	3
5	**MECH 325X**	Professional Elective - III	3	0	0	3	3
6	**MECH 326X**	Professional Elective - IV	3	0	0	3	3
Total Theory			**17**	**0**	**0**	**17**	**17**
Laboratory/ Practical							
7	**MECH 3211**	Dynamics of Machines Lab	0	0	3	3	2
8	**MECH 3212**	Applied Thermodynamics & Heat Transfer Lab	0	0	3	3	2
9	**CSEN 3216**	RDBMS Laboratory	0	0	3	3	2
10	**MECH 325Y**	Professional Elective – III Lab	0	0	3	3	2
Total Practical			**0**	**0**	**12**	**12**	**8**
Sessional							
Sl. No	**Paper Code**	**Paper Name**	**Contact Hrs per Week**				**Credit Point**
			L	**T**	**P**	**Total**	
1	**MECH 3221**	Seminar-II	0	0	3	3	2
2	**HMTS 3221**	Personality Development	1	0	0	1	1
		Total Sessional	**1**	**0**	**3**	**4**	**3**
Total of Semester			**18**	**0**	**15**	**33**	**28**

List of Professional Elective – III:

1. **MECH 3251 :** Design of Mechanical Systems-II
2. **MECH 3252 :** Mechatronics
3. **MECH 3253 :** Advanced Fluid Mechanics

List of Professional Elective – III Lab:

1. **MECH 3256 :** Design Practice - II Lab
2. **MECH 3257 :** Mechatronics Laboratory
3. **MECH 3258 :** Advanced Fluid Mechanics Lab

List of Prof. Elective- IV

1. MECH 3261 : Maintenance Engineering
2. MECH 3262 : Renewable Energy Systems
3. MECH 3263 : Materials Handling
4. MECH 3264 : CAD/CAM
5. MECH 3265 : Operations Management

4th Year 1st Semester Curriculum:

Theory							
Sl. No.	**Code**	**Paper**	**Contact Hrs/Week**				**Credit Points**
			L	**T**	**P**	**Total**	
1	**MECH 4101**	Power Plant Engineering	3	0	0	3	3
2	**MECH 4102**	Advanced Manufacturing Technology	3	1	0	4	4
3	**MECH 4103**	Operations Research	3	0	0	3	3
4	**MECH 414X**	Professional Elective - V	3	0	0	3	3
5	****** 418Y**	Free Elective- I	3	0	0	3	3
Total Theory			**16**	**0**	**0**	**16**	**16**
Laboratory/ Practical							
6	**MECH 4111**	IC Engine Lab	0	0	3	3	2
7	**MECH 4112**	Machining & Machine Tools Lab	0	0	3	3	2
Total Practical			**0**	**0**	**6**	**6**	**4**

Sessional							
Sl. No	**Paper Code**	**Paper Name**	**Contact Hrs/Week**				**Credit Points**
			L	**T**	**P**	**Total**	
8	**HMTS 4121**	Professional Development	0	0	3	3	2
9	**MECH 4131**	Industrial Training Evaluation					2
10	**MECH 4191**	Project I	0	0	6	6	4
		Total Sessional	**0**	**0**	**9**	**9**	**8**
Total of Semester			**16**	**0**	**15**	**31**	**28**

List of Prof. Elective- V

1. **MECH 4141:** Advanced Welding Technology
2. **MECH 4142:** Computational Methods in Engineering
3. **MECH 4143:** Quantity Production Method
4. **MECH 4144:** Computational Fluid Dynamics
5. **MECH 4145:** Supply Chain Management and Logistics

List of Free Elective I:

1. **AEIE 4181 :** Instrumentation & Telemetry
2. **CHEN 4182:** Project Management
3. **CIVL 4181 :** Building Materials

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

1. **MECH 4181:** Quantitative Decision Making
2. **MECH 4182:** Quality Control & Management
3. **MECH 4183:** Ecology and Environmental Engineering

4th Year 2nd Semester Curriculum:

Theory							
Sl. No.	**Code**	**Paper**	**Contact Hours/Week**				**Credit Points**
			L	**T**	**P**	**Total**	
1	**HMTS 4202**	Project Management	2	0	0	2	2
2	****** 428X**	Free Elective- II	3	0	0	3	3
Total Theory			**5**	**0**	**0**	**5**	**5**
Laboratory/ Practical							
3	**MECH 4211**	Advanced Manufacturing Lab	0	0	3	3	2
Total Practical			**0**	**0**	**3**	**3**	**2**
Sessional							
4	**MECH 4221**	Design of an Industrial Product	0	0	4	4	2
5	**MECH 4231**	Comprehensive Viva Voce					3
6	**MECH 4291**	Project II	0	0	12	12	8
Total Sessional			0	0	**16**	**16**	**13**
Total of Semester			**5**	**0**	**19**	**24**	**20**

List of Free Elective II:

1. **AEIE 4281 :** Sensor Technology
2. **CIVL 4282 :** Principles of Surveying
3. **CIVL 4283 :** Project Planning and Management
4. **HMTS 4281:** Introduction to Industrial Sociology
5. **HMTS 4283:** Elementary Spanish for Beginners

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

1. **MECH 4281:** Mechanical Handling of Materials
2. **MECH 4282:** Aerodynamics
3. **MECH 4283**: Modern Manufacturing Technology

Distribution of course credit

SL. NO.	*CATEGORY*	*PROP. CREDIT RANGE*	*ME.COURSE CREDIT*
1.	*HU/SS/MGMT*	*19*	*19*
2.	*Basic Sciences*	*30-36*	*35*
3.	*Engg. Sciences*	*30-40*	*37*
4.	*Professional Core*	*60-80*	*79*
5.	*Professional Elective*	*12-20*	*19*
6.	*Free Elective*	*6*	*6*
7.	*Seminar & Ind. Training*	*6*	*6*
8.	*Project & Grand Viva*	*15*	*15*
	Suggested Total	*216*	*216*

Semester Wise Credit Point and contact hours

Semester	*Credit*	*Contact hour*
1 st semester	*27*	*32*
2nd semester	*29*	*33*
3rd semester	*28*	*33*
4th semester	*28*	*33*
5th semester	*28*	*32*
6th semester	*28*	*33*
7th semester	*28*	*31*
8th semester	*20*	*24*
TOTAL	*216*	*251*

Part-II

Detailed Syllabus

1st Year 1st Semester Syllabus:

Course Name : BUSINESS ENGLISH					
Course Code: HMTS 1101					
Contact hrs per week:	L	T	P	Total	Credit points
	2	0	0	2	2

Module I – [5L]
Communication Skill
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 II-[12L]
Business Communication- Scope & Importance
Writing Formal Business Letters
Writing Reports
Organizational Communication: Agenda & minutes of a meeting, notice, memo, circular
Project Proposal
Technical Report Writing
Organizing e-mail messages
E-mail etiquette
Tips for e-mail effectiveness

Module III-[10L]
Language through Literature
Modes of literary & non-literary expression
Introduction to Fiction, (An Astrologer's Day by R.K. Narayan and Monkey's Paw by W.W. Jacobs), Drama (The Two Executioners by Fernando Arrabal) or (Lithuania by Rupert Brooke) & Poetry (Night of the Scorpion by Nissim Ezekiel and Palanquin Bearers by Sarojini Naidu)

Module IV-[3L]
Grammar in usage (nouns, verbs, adjectives, adverbs, tense, prepositions, voice change) -to be dealt with the help of the given texts.

References

1. Armand Matterlart and Michele Matterlart, Theories of Communication: A Short Introduction, Sage Publications Ltd., 1998.

2. Chan, Janis Fisher, and Diane Lutovich. Professional Writing Skills. San Anselmo, CA: Advanced Communication Designs, 1997.

3. Geffner, Andrew P. Business English. Hauppauge, New York: Barron's Educational Series, 1998.

4. Good, Edward C. Mightier Than the Sword. Charlottesville: Word Stone Publications, 1989.

5. Edward P.Bailey, Writing and Speaking at Work: A Practical Guide for Business Communication, Prentice-Hall, 7th edn, 2004.

6. Kitty O. Locker, Business and Administrative Communication, McGraw-Hill/ Irwin, 7th edn, 2004.

7. Lillian Chaney and Jeanette Martin, Intercultural Business Communication, Prentice Hall, 4th edn, 2005.

8. Yudkin, Marcia. Persuading on Course Name. Lansing, IL: Infinity Publishing, 2001.

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

Module I: [22 L]

Optics

1. Interference :

The principle of superposition of waves, Superposition of waves: Two beam superposition, Multiple-beam superposition, coherent and incoherent superposition. Two source interference pattern (Young's double slit), Intensity distribution. Interference in thin films, wedge shaped films and Newton's rings, applications of interference. Newton's rings: Determination of wavelength of light, refractive index of liquid.

2. Diffraction:

Diffraction of light waves at some simple obstacles. Fraunhoffer diffraction through double slit and diffraction grating, grating spectra, resolving power of grating.

3. Polarisation & Fibre Optics:

Elementary features of polarization of light waves.Production and analysis of linearly, elliptic and Circularly polarized light, polaroids and application of polarizations. fibre optics - principle of operation, numerical aperture, acceptance angle

4. Laser:

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.

Module II: [8L]

Waves & Oscillation:

Superposition of two linear SHMs (with same frequency), Lissajous' figures. Damped vibration – differential equation and its solution, Critical damping, Logarithmic decrement, Analogy with electric circuits. Forced vibration – differential equation and solution, Amplitude and Velocity resonance, Sharpness of resonance and Quality factor. Progressive wave- Wave equation and its differential form, Difference between elastic (mechanical) and electromagnetic waves.

Module III: [9L]

Quantum Mechanics:

Need for Quantum physics-Historical overviews, Particle aspects of radiation-Black body radiation, Compton scattering, pair production, Origin of X-ray spectrum. Wave aspect of particles- matter wave, de Broglie Hypothesis, Heisenberg Uncertainty principles- Statement, Interpretation and application.

Module IV: [6L]

Introduction of Crystallography:
Space Lattice**,** Unit Cell, Lattice Parameters, Crystal Systems, Bravais Lattices, Miller Indices and its applications, Crystal Planes and Directions, Inter Planar Spacing of Orthogonal Crystal Systems, Atomic Radius, Co-ordination Number and Packing Factor of SC, BCC, FCC. Bragg's law and its applications.

Text Books:
1. Atomic Physics Vol 1 – S.N. Ghoshal
2. Optics – Ajoy Ghak
3. Waves & Oscillation – N.K. Bajaj
4. Quantum Physics of Atoms , Molecules, Solids, Nuclei and particles – Eisberg and Resnick

Reference Books:
1. Introduction to Special Relativity – Robert Resnick
2. Prespective on Modern Physics - Arthur Beiser
3. Optics – Jenkins and White
4. University Press – Sears & Zemansky
5. Introduction to modern Physics – Mani and Meheta
6. Optics – Brijlal and Subrahmanyam

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

Module 1 [10L]

Matrix:

Matrices and their basic attributes, Determinant of a square matrix, Minors and Cofactors, Laplace's method of expansion of a determinant, Product of two determinants, Adjoint of a determinant, Jacobi's theorem on adjoint determinant. Singular and non-singular matrices, Adjoint of a matrix, Inverse of a non-singular matrix and its properties, Orthogonal matrix and its properties, Special Complex Matrices: Hermitian, Unitary, Normal(definition only), Rank of a matrix and its determination using elementary row and column operations, Solution of simultaneous linear equations by :Cramer's Rule and Matrix inversion method, Consistency and inconsistency of a system of homogeneous and inhomogeneous linear simultaneous equations, Characteristic Equation and computation of eigenvalues and eigenvectors of a square matrix (of order 2 or 3), Cayley-Hamilton theorem and its applications (with special reference to higher power of matrices, e.g. Idempotent and Nilpotent matrices)

Module 2 [10 L]

Mean Value Theorems & Expansion of Functions:

Rolle's theorem: its geometrical interpretation and its application, Concavity and Convexity of curves, Mean Value theorems – Lagrange & Cauchy and their application, Taylor's theorem with Lagrange's and Cauchy's form of remainders and its application, Expansions of functions by Taylor's and Maclaurin's theorem, Maclaurin's infinite series expansion of the functions: $\sin x, \cos x, e^x, \log(1+x), (a+x)^n$, n being an integer or a fraction (assuming that the remainder $R_n \to 0$ as $n \to \infty$ in each case).

Infinite Series:

Preliminary ideas of sequence, Infinite series and their convergence/divergence, Infinite series of positive terms, Tests for convergence: Comparison test, Cauchy's Root test, D' Alembert's Ratio test(statements and related problems on these tests), Raabe's test, Proof of e being irrational, Alternating series, Leibnitz's Test (statement, definition) illustrated by simple examples, Absolute convergence and Conditional convergence,

Module 3 [10 L]

Successive differentiation:

Higher order derivatives of a function of single variable, Leibnitz's theorem (statement only and its application, problems of the type of recurrence relations in derivatives of different orders and also to find $(y_n)_0$).

Calculus of Functions of Several Variables:

Recapitulation of some basic ideas of limit and continuity of functions of single variable, 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, Chain rules, Differentiation of implicit functions, Total differentials and their related problems, Jacobians up to three variables and related problems, Maxima, minima and saddle points of functions and related problems.

Module-4 [10 L]

Multiple Integration and Vector Calculus:

Concept of line integrals, Double and triple integrals. 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, Green's theorem, Gauss Divergence Theorem and Stoke's theorem (Statements and applications).

Reduction formula:

Reduction formulae both for indefinite and definite integrals of types:

$\int \sin^n x, \int \cos^n x, \int \sin^m x \cos^n x, \int \cos^m x \sin nx, \int \frac{dx}{(x^2+a^2)^n}, m, n$ are positive integers.

References

1. Advanced Engineering Mathematics: Erwin Kreyszig by Wiley India.
2. Engineering Mathematics: B.S. Grewal (S. Chand & Co.).
3. Higher Engineering Mathematics: John Bird (Elsevier).
4. Advanced Engineering Mathematics: Wiley and Barrett (Tata McGraw-Hill).
5. Calculus: M. J. Strauss, G. L. Bradley and K. L. Smith (Pearson Education).
6. Engineering Mathematics: S. S. Sastry (PHI).
7. Advanced Engineering Mathematics: M.C. Potter, J.L. Goldberg and E.F. Abonfadel (OUP),Indian Edition.
8. Linear Algebra(Schaum's outline series): Seymour Lipschutz, Marc Lipson (McGraw Hill Education).
9. Vector Analysis(Schaum's outline series): M.R. Spiegel, Seymour Lipschutz, Dennis Spellman (McGraw Hill Education).
10. Introduction to Real Analysis: S.K.Mapa (Sarat Book Distributors).

Course Name : Basic Electronics Engineering					
Course Code: ECEN 1001					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

Module I [10 L]

Semiconductors:

Crystalline material, Energy band theory, Fermi levels; Conductors, Semiconductors and Insulators: electrical properties, band diagrams. Semiconductors: intrinsic and extrinsic, energy band diagram, electrical conduction phenomenon, P-type and N-type semiconductors, drift and diffusion carriers.

Diodes and Diode Circuits:

Formation of P-N junction, energy band diagram, built-in-potential forward and reverse biased P-N junction, formation of depletion zone, V-I characteristics, Zener Diode and its Application, Zener and Avalanche breakdown.
Simple diode circuits, load line, piecewise linear model; Rectifier circuits: half wave, full wave, PIV, DC voltage and current, ripple factor, efficiency, idea of regulation.

Module II [10 L]

Bipolar Junction Transistors:

Formation of PNP / NPN junctions, energy band diagram; transistor mechanism and principle of transistors, CE, CB, CC configuration, transistor characteristics: cut-off, active and saturation modes of operation, transistor action, input & output characteristics, load line & amplifier operation and current amplification factors for CB and CE modes. Biasing and Bias stability: calculation of stability factor.

Module III [9 L]

Field Effect Transistors:

Junction field effect transistor (JEET): Principle of operation, JFET parameters, eqv. Circuit, JFET biasing, self bias, design of bias circuits, load line, amplifier characteristics.

MOSFETs:
Construction & principle of operation of p- & n-channel enhancement & depletion mode MOSFETs, drain & transfer characteristics, threshold voltage & its control.

Cathode Ray Osilloscope:
Construction and working principle of CRO, Lissajous pattern.

Module IV [9 L]

Feed Back Amplifier:

Concept-block diagram, properties, positive and negative feedback, loop gain, open loop gain, feedback factors; topologies of feedback amplifier; effect of feedback on gain, condition of oscillation, Barkhausen criteria.

Operational Amplifier:

Introduction to integrated circuits, operational amplifier and its terminal properties; Application of operational amplifier; Concept of op-amp saturation, inverting and non-inverting mode of operation, Adders, Subtractors, Voltage follower, Integrator, Differentiator, Basic Comparator Circuit.

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 : ENGINEERING MECHANICS					
Course Code: MECH 1101					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

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

- Understand basic concepts of vector algebra as applied to engineering mechanics.
- Analyze free body diagram of a system under equilibrium.
- Understand friction phenomenon and calculate friction work loss.
- Interpret dynamics of members/ links in a mechanism and understand inertia force with the help of D' Alembert's principle.
- Know how to calculate the CG from the view point of mechanical stability.
- Calculate MI values required for engineering design calculations.
- Apply the principles of work - energy and impulse- momentum for analysis of dynamic systems.

Module-I [10L]
Importance of Mechanics in Engineering ; Definition of Mechanics; Concepts of particles & rigid bodies;

Vector and scalar quantities; Vector algebra –definition and notation; Types of vectors – equal , equivalent , free , bound , sliding ; Addition , subtraction of vectors ; Parallelogram law , triangle law , vector polygon ; Scalar multiplication of vectors ; Resolution of vectors in Cartesian co–ordinate system ; Unit vector, unit co–ordinate vectors ($\hat{i}$, $\hat{j}$, $\hat{k}$) ; Direction cosines ; Addition/ subtraction of vectors in components form.

Definition of force vector ; Dot product , cross product and the application ; Important vector quantities (position vector , displacement vector) ; Moment of a force about a point and about an axis , moment of a couple ; Representation of force and moments in items of $\hat{i}$, $\hat{j}$, $\hat{k}$. 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.

Module-II [10L]
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.

Concept of friction: Laws of Coulomb's friction; Angle of friction, angle of repose, coefficient of friction -- static and kinematic.

Module-III [12L]
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; Parallel axes theorem.

Concept of simple stress and strain ; Normal stress , shear stress , normal strain, shear strain; Hooke's law; Poisson's ratio; stress- strain diagram of ductile and brittle material; Proportional limit, elastic limit, yield point , ultimate stress, breaking point; Modulus of elasticity.

Module-IV [16L]
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

References:

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. Element of strength of materials by Timoshenko & Young, E W P
5. Fundamentals of Engineering Mechanics by Nag & Chanda – Chhaya Prakashani.

Course Name : PHYSICS I Lab					
Course Code: PHYS 1011					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**2**

1. Determination of Young's modulus by Flexure Method and calculation of bending moment and shear force at a point on the beam.
2. Determination of modulus of rigidity by Static/Dynamic Method.
3. Determination of thermal conductivity of a good conductor by Searle's Method.
4. Determination of thermal conductivity of a bad conductor by Lee's and Chorlton's Method.
5. Determination of dielectric constant of a given dielectric material.
6. Use of Carey Foster's bridge to determine unknown resistance.
7. Determination of wavelength of light by Newton's ring method.
8. Determination of wavelength of light by Fresnel's biprism method.
9. Determination of wavelength of light by Laser diffraction method.
10. Determination of dispersive power of the material of a given prism.
11. Determination of co-efficient of viscosity of a liquid by Poiseulle's capillary flow method.

Course Name : Basic Electronics Engineering Lab					
Course Code: ECEN 1011					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**2**

List of Experiments

1. Familiarisation with passive and active electronic components such as Resistors, Inductors, Capacitors, Diodes, Transistors (BJT) and electronic equipment like DC power supplies, multimeters etc.
2. Familiarisation 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, and Integrators.

Course Name : Workshop Practice					
Course Code: MECH 1011					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	1	**0**	**3**	**4**	**3**

After going through the course, the students will be able

- To have a basic understanding of manufacturing processes.
- To have acquaintance with the various tools and implements as normally used in a workshop.
- To understand basic principle of metal cutting and operate various machines tools like Lathe, Shaper, Milling and drilling.
- To plan and make patterns for sand casting.
- To understand the fabrication processes and practice in MMA and Gas welding.

Job 1: General awareness of a typical workshop.

Theory requirements: Workshop definition, various shops in a typical workshop, Carpentry, Fitting, Foundry; Sheet Metal Shop, Welding and Brazing Shop, Machine Shop , Forging & Blacksmithy, Safety precautions to be followed in a workshop, Familiarization of Various safety devices and their uses.

Job 2: Making of a wooden pattern.

Theory requirements: Market forms of converted Timber, e.g., log, balk, plank,batten, beam ,Types of Wood, Hard Wood, Soft Wood, particle board; Seasoning of wood, Natural seasoning, Artificial seasoning, Carpentry Tools-Marking Tools, Cutting Tools, Planing Tools, Boring Tools, Striking Tools , Holding & Misc. Tools, Carpentry Processes (marking, sawing, planning, chiselling, boring, grooving, joining etc.), Safety precautions in Carpentry Shop.

Job 3: Making of a matched profile form MS plate.

Theory requirements: Work Bench, Fitting Tools (Bench Vice,Chisel,Hammer,Different types of Files, (Rough,Bastard, Second Cut, Half Round, Triangular File),Saw(Hack saw etc.), Scriber, Punch, Try Square, Angle Plate, caliper (outside & inside), Universal Surface Gauge, Centre Punch, Prick Punch, Drill (Flat,straight fluted, taper shank twist drill).
Fitting Operations,Filing, Marking, Drilling, Tapping (Rougher,Intermediate, Finisher taps), Tap Drill size (D=T-2d), Sawing, Dieing . Safety precautions in Fitting Shop.

Job 4: Making of an internal and external thread.

Theory requirements : Thread standards and thread classifications, Internal Thread,External Thread, Thread Nomenclature (Major dia, Minor dia, Pitch dia, pitch, Lead, TPI, Metric, BSP , Nominal size), Specifications of threaded fasteners (in Metric System). Safety precautions in Dieing and Tapping.

Job 5: Making of a green sand mould using the pattern made under Job no. 2.

Theory requirements: Mould making, Preparation of sand, (silica, clay, moisture, and misc items and their functions), Properties of a good sand mould, General procedure for making a good sand mould, Different tools used for preparation of a mould, Explanation of various terms , Cope and Drag Box, Runner, Riser, Gating and its utility, Parting sand, Vent holes.

Job 6: Demonstration of metal melting and casting

Theory requirements: Metal melting furnaces: Ladles, Using of Tongs, Molten metal pouring procedure, Safety precautions in pouring molten metal in a mould.

Job 7. Making of a stepped pin in a centre lathe.

Theory requirements: Machining and common machining operations , Lathe M/c and its specifications, Head stock, Tailstock, Chuck-Self centering chuck , 4 jaw chuck, Bed, Carriage, Feed mechanism, Screw cutting mechanism, various lathe operations like turning, facing, grooving, chamfering, taper turning ,Thread cutting, Knurling, Parting, Cutting speed, Feed, Depth of cut , Different types of cutting tools-Safety precautions in a machine shop.

Job 8: Making of square prism from a round shaft by Shaping Machine

Theory requirements: Description of a Shaping machine, Base , Column, Saddle, Clapper box, Quick return mechanism, Feed Mechanism, Table, Rotation of table, Adjustment of stroke length, Adjustment of starting point of cut. Safety Precautions while working in Shaping Machine.

Job 9: Making of square prism from a round shaft by Milling Machine

Theory requirements: Description of a milling machine, Specification of a Milling machine, Types of Milling-Up Milling, Down Milling, Vertical Milling Machine, Horizontal Milling Machine , Safety precautions while working in Milling Machine.

Job 10 : Arc Welding practice and making of a welded joint

Theory requirements: Welding, Weldability, Types of Welding, MMAW, Gas Welding, Electrode , Functions of Flux, Equipment for MMAW, Different types of Flames in Gas Welding and Gas Cutting (Neutral-Oxidising-Reducing Flames), Different types of welding joints, AC Welding , DC Welding; Safety precautions in Welding Shop.

Job 11 : Sheet Metal forming & Brazing

Theory requirement: Specification of sheet metal, SWG vs. mm, HR sheet, CR sheet, GI Sheet, Stainless Steel Sheet, Aluminum sheets, Tin Plates, Sheet metal working Tools, Micrometer, Chisels, Punches, Hammers, Mallets, Hand Shear or Snippets, Various sheet metal forming operations, Shearing, Marking, Punching, Drilling, Bending, Drawing, Brazing, Safety precautions in Sheet Metal Working Shop.

References:

1. Elements of Workshop Technology (Vol- I and II)- Hajra Choudhury, Media Promoter &Publishers Privet Limited.

2. Workshop Technology (Vol- I and II) – Chapman , Viva Books Privet Limited.

Course Name : Language Practice Lab (level I)					
Course Code: HMTS 1111					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**2**	**2**	**1**

Module 1 [3P]
Introduction to Linguistics (Phonology)
Phonetics-Vowel and Consonant Sounds (Identification &articulation)
Word- stress
Intonation (Falling and rising tone)
Voice Modulation
Accent training

Module 2 [3P]
Listening Skills
Principles of Listening
Approaches to listening
Guidelines for Effective Listening
Listening Comprehension
Audio Visual (Reviews)

Module 3 [2P]
Discourse Analysis-
Spoken Discourse
Conversational Skills/Spoken Skills
Analysing Speech dynamics
(Political Speeches
Formal Business Speeches)

Module 4 [9P]
Writing Skill-
Descriptive, narrative and expository writing
Writing with a purpose---Convincing skill, argumentative skill/negotiating Skill (These skills will be repeated in oral skills).
Writing reports/essays/articles—logical organization of thoughts
Book review

References:

1. Munter, Mary. Guide to Managerial Communication. 5th ed. Upper Saddle River, NJ: Prentice Hall, 1999.
2. Cypres, Linda. Let's Speak Business English. Hauppauge, NY: Barron's Educational Series, 1999. Crystal, David. 1971. *Linguistics.* Baltimore: Penguin Books.
3. Larsen-Freeman, D. (1986). "Techniques and principles in language teaching." Oxford: Oxford University Press.
4. Littlewood, W. (1981). "Language teaching. An introduction." Cambridge: Cambridge University Press.
5. Savignon, S. J., & Berns, M. S. (Eds.). (1983). "Communicative language teaching: Where are we going? Studies in Language Learning," 4(2). (EDRS No. ED 278 226, 210 pages).

Course Name : Co-Curricular Activities					
Course Code: HMTS 1121					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**2**	**2**	**1**

Objective: This course aims at instilling a sense of social responsibility. This objective can be achieved by bringing in awareness about the contemporary issues relevant to the GenX and Gen Y through enlightened discussions and active participation. Since the course has 1 credit detailed planning regarding the area of activities and method of evaluation should be charted at the start of the semester.

Module 1:

Project Work
Development of projects based on integral and holistic developmental models to be implemented in rural areas or underdeveloped areas in the peripheral areas of cities. This could include a wide area of activity –
from taking up a research projects to analyse the need of a particular under-developed area to trying to implement a project already formulated. This could also relate to mobilizing funds for a specific project.

Module 2:

Action-oriented schemes
e.g.Organising Blood –donation camps
Conducting child –healthcare services
Helping the old and sick
(in coordination with NGOs and other institutes)

Module 3:

Society and Youth
Developing Awareness among the youth about social issues both local and global for e.g. Eradication of social evils like drug abuse, violence against women and others.

Module 4:

Youth and Culture
Generating new ideas and help the participants to be creative and innovative for e.g.Enacting street plays, encouraging creative writing by organizing workshops and competitions. Active participation of the students in the nation building process by making positive changes in the social and individual space.

1st Year 2nd Semester Syllabus:

Course Name : Introduction to Computing					
Course Code: CSEN 1201					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

Learning Objective: Introduction to the concept of computer and computation and solving of problems using C as a programming language. Coverage of C will include basic concepts, arithmetic and logic, flow control, and data handling using arrays, structures, pointers and files.

Module 1: [13L]

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. Assembly language, high level language, compiler and assembler (basic concepts).

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). Binary Arithmetic & logic gates. Boolean algebra – expression, simplification, Karnaugh Maps.

Basic concepts of operating systems like MS WINDOW, LINUX. How to write algorithms & draw flow charts.

Module 2: [5L]

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.

Module 3: [8L]

Program Structures in C

Flow of Control:

Statement and blocks, if-else, switch-case, loops (while, for, do-while), break and continue, go to and labels.

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.

Module 4: [14L]

Data Handling in C

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.

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();

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

Module 1 [10 L]

Thermodynamics & Spectroscopy

Chemical Thermodynamics & Thermochemistry

Concept of Thermodynamic system, Introduction to first law of thermodynamics, Enthalpy Heat Capacity, Reversible and Irreversible processes, Adiabatic changes, Application of first law of thermodynamics to chemical processes, 2nd law of thermodynamics, Evaluation of entropy, Work function and free energy, Phase Changes, Clausius Clapeyron Equation, Chemical Potential, Gibbs Duhem Relation, Activity and Activity coefficient.

Spectroscopy

Electromagnetic Radiation, Basic idea of UV-visible & IR spectroscopy.

Module 2 [10 L]

Structure & Bonding

Chemical Bonding

Covalent bond, VSEPR Theory, Molecular Orbital Theory, Hydrogen bond, Intermolecular forces-vander Waals forces, Ionization energy, Electronegativity, Electron affinity, Hybridisation, Dipole moment

Solid State Chemistry

Introduction to stoichiometric defects (Schottky & Frenkel) and non – stoichiometric defects (Metal excess and metal deficiency). Role of silicon and germanium in the field of semiconductor.

Ionic Equilibria and Redox Equlibria

Acid Base Equilibria in water, Strength of acids and bases, Hydrogen ion exponent, Ionic product of water, Salt Hydrolysis and Henderson Equation, Buffer solutions, pH indicator, Common ion Effect, Solubility product, Fractional Precipitation, Redox Equilibria,

Structure and reactivity of Organic molecule

Inductive effect, resonance, hyperconjugation, electromeric effect, carbocation, carbanion and free radicals.

Brief study of some addition, eliminations and substitution reactions.

Module 3 [10 L]

Electrochemistry & Reaction Dynamics

Conductance

Conductance of electrolytic solutions, specific conductance, equivalent conductance, molar conductance, ion conductance, effect of temperature and concentration (Strong and Weak electrolyte). Kohlrausch's law of independent migration of ions, transport numbers and hydration of ions. Conductometric titrations: SA vs SB & SA vs WB; precipitation titration KCl vs $AgNO_3$.

Electrochemical Cell

Cell EMF and thermodynamic derivation of the EMF of a Galvanic cell (Nernst equation), single electrode potentials, hydrogen half-cell and calomel half cell (construction, representation, cell reaction, expression of potential, discussion, application) Storage cell, fuel cell (construction, representation, cell reaction, expression of potential, discussion, application). Application of EMF measurement on a) the change in thermodynamic function (ΔG, ΔH, ΔS) b) the equilibrium constant of a reversible chemical reaction c) the valency of an ion.

Kinetics

Reaction laws: rate expression, order and molecularity, zero, first and second order kinetics. Pseudounimolecular reaction, Arrhenius equation.
Mechanism and theories of reaction rates (Collision theory and Transition state theory,).
Catalysis: Homogeneous catalysis (Definition, example, mechanism, kinetics).

Module 4 [10 L]

INDUSTRIAL CHEMISTRY & POLYMERIZATION

Industrial Chemistry

Solid Fuel: Coal, Classification of coal, constituents of coal, carbonization of coal (HTC and LTC), Coal analysis: Proximate and ultimate analysis.
Liquid fuel: Petroleum, classification of petroleum, Refining, Petroleum distillation, Thermal cracking, Octane number, Cetane number, Aviation Fuel (Aviation Gasoline, Jet Gasoline), Bio-diesel.
Gaseous fuels: Natural gas, water gas, coal gas, bio gas.

Polymerization

Concepts, classifications and industrial applications. Polymer molecular weight (number avg. weight avg. viscosity avg.: Theory and mathematical expression only), Poly dispersity index (PDI). Polymerization processes (addition and condensation

polymerization), degree of polymerization, Copolymerization, stereo-regularity of polymer, crystallinity (concept of T_m) and amorphicity (Concept of T_g) of polymer.

Preparation, structure and use of some common polymers: plastic (PE: HDPE, LDPE, PVC, Bakelite, PP), rubber (natural rubber, SBR, NBR) and Vulcanization., fibre(nylon 6.6, Nylon 6, Polyester).
Conducting and semi-conducting polymers.

Text Books

1. Engineering Chemistry, Gourkrishna Dasmohapatra, Vikas Publishing House
2. A Text book of Engineering Chemistry, Shashi Chawla, Dhanpat Rai & Co Pvt Ltd
3. Engineering Chemistry, K. L. Chugh, Kalyani Publishers.

Reference Books

1. General & Inorganic Chemistry, R. P. Sarkar, Fuels and Combustion, New Central Book Agency P Ltd
2. L. Finar, Organic Chemistry, Addison Wesley Longman, Inc
3. Organic Chemistry, Morrison & Boyd, Prentice Hall of India
4. Physical Chemistry, K. L. Kapoor, McMillan
5. P. C. Rakshit, Physical Chemistry, Sarat Book House (7th Edition).

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

Module 1 [10 L]

Ordinary differential equations (ODE)-

First order and first degree: Exact equations, Necessary and sufficient condition of exactness of a first order and first degree ODE (statement only), Rules for finding Integrating factors, Linear and non-linear differential equation, Bernoulli's equation. General solution of ODE of first order and higher degree (different forms with special reference to Clairaut's equation).

Second order and first degree:

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

Module 2:[10L]

Basics of Graph Theory

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.

Tree:

Definition and properties, 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 3 [10L]

Improper Integral:

Basic ideas of improper integrals, working knowledge of Beta and Gamma functions (convergence to be assumed) and their interrelations.

Laplace Transform:
Introduction to integral transformation, functions of exponential order, Definition and existence of 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.

Module 4 [10L]

Three Dimensional Geometry

Equation of a plane. General form. Transformation to the normal form. Intercepts. Equation of the plane through three given points. Equation of a plane passing through the intersection of two planes. Angle between two intersecting planes. Bisectors of angles between two intersecting planes. Parallelism and perpendicularity of two planes.

Canonical equation of the line of intersection of two intersecting planes. Angle between two lines. Shortest distance between two lines. Condition of coplanarity of two lines. Length of the perpendicular from a point to a given line.

References:

1. Advanced Engineering Mathematics, Erwin Kreyszig, (Wiley Eastern)
2. Graph Theory: V. K. Balakrishnan, (Schaum's Outline, TMH)
3. A first course at Graph Theory: J. Clark and D. A. Holton (Allied Publishers LTD)
4. Introduction to Graph Theory: D. B. West (Prentice-Hall of India)
5. Graph Theory: N. Deo (Prentice-Hall of India)
6. Engineering Mathematics: B.S. Grewal (S. Chand & Co.)
7. Higher Engineering Mathematics: John Bird (4th Edition, 1st Indian Reprint 2006, Elsevier)
8. Calculus: Strauss, Bradley and Smith (3PrdP edition, Pearson Education)
9. Engineering Mathematics (Volume 2): S. S. Sastry (Prentice-Hall of India)
10. Introductory Course in Differential Equations: Daniel A. Murray (Longmans & Green).
11. Co-ordinate Geometry – S. L. Loney.
12. Analytical Geometry And Vector Algebra- R M Khan

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

Module-1: [12 L]

DC Network Theorem: Kirchhoff's law, nodal analysis, mesh analysis, Superposition theorem, Thevenin's theorem, Norton theorem, Maximum power transfer theorem, star-delta conversion.

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.

Module-2 [8L]

Electrostatics: Gauss's law and its applications to electric field and potential calculation. Capacitor, capacitance of parallel plate capacitor, spherical capacitor and cylindrical capacitor.

Electromagnetism: Amperes law, Biot-savart's law, Ampere's circuital law and their applications, Magnetic circuits, analogy between magnetic and electric circuits, Faraday's law, self and mutual inductance. Energy stored in a magnetic field, Hysteresis and Eddy current losses.

Module-3 [10L]

AC single phase system: concept of alternating signal, average and RMS values of alternating signal, peak factor, form factor, phase and phase difference, phasor representation of alternating quantities, phasor diagram, AC series , parallel and series parallel circuits, Active power, Reactive power, power factor, Resonance in RLC series and parallel circuit, Q factor, bandwidth.

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.

Module-4 [10L]

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.

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.

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 : Engineering Thermodynamics and Fluid Mechanics					
Course Code: MECH 1201					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

After going through the course, the students will be able

- To analyze a thermodynamic system and calculate work transfer in various quasi-static processes.
- To understand and apply the first law and 2nd law of thermodynamics.
- To calculate thermal efficiency of Otto, Diesel cycle
- To understand physical properties of fluids
- To apply mass, momentum and energy conservation principles to incompressible fluid flow.

Module 1 [10 L]

Basic concepts of Thermodynamics:

Introduction; Macroscopic and microscopic concept; Definition of Thermodynamic systems; Surrounding, universe; Open, closed and isolated systems; Concept of control volume; Thermodynamic properties: intensive, extensive & specific properties; state.

Thermodynamic equilibrium; Change of state; Thermodynamic processes and cycles; Quasi-static processes; Reversible processes; Zeroth law of Thermodynamics -concept of temperature.

Heat & Work:

Definition 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; Indicated diagram (P-V diagram)
.
Definition of heat; Heat transfer-a path function; Similarities and dissimilarities between heat and work.

Module 2 [8 L]

First law of Thermodynamics: Statement; 1st law 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; Flow work; 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, boiler, condenser and throttling device); PMM-I

Module 3 [10 L]

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.

Reversible process; Irreversible process; Factors for irreversibility; Carnot cycle and Carnot efficiency; Reversible heat engine and heat pump; PMM-ll

Entropy: Mathematical statement of Clausius Inequality: Entropy as a property; Entropy principle; T-s plot for reversible isothermal, adiabatic, isochoric & isobaric processes.

Air standard Cycles:

Otto cycle & Diesel cycle, P-V & T-s plots, Net work done and thermal efficiency.

Module 4 [10 L]

Properties & Classification of Fluid:

Definition of fluid; Concept of Continuum; Fluid properties- density, specific weight, specific volume, specific gravity; Viscosity : definition , causes of viscosity , Newton's law of viscosity, dimensional formula and units of viscosity, kinematic viscosity; Variation of viscosity with temperature. Ideal and Real fluids; Newtonian and Non-Newtonian fluids; No-slip condition.
Compressibility and Bulk modulus of elasticity.
Difference between compressible and incompressible fluids.

Fluid Statics:

Introduction; 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.

Module 5 [10 L]

Fluid Kinematics:
Definition; Flow field and description of fluid motion(Eulerian & Lagrangian method), steady and unsteady flow, uniform and non-uniform flow-examples.
Acceleration of a fluid particle-local acceleration, convective acceleration. Stream line, Stream tube, Path line and Streak line; Laminar and Turbulent flow, Reynolds Number. Equations of streamlines and path lines.
Continuity equation for unidirectional flow and for differential form in 3-D Cartesian coordinate system.

Dynamics of Ideal fluids:

Introduction, Euler's equation of motion along a streamline; Bernoulli's equation-assumptions and significance of each term of Bernoulli's equation.
Application of Bernoulli's equation-problem on pipe line. Measurement of flow rate: Venturimeter and orificemeter .
Static pressure, Dynamic pressure, Stagnation pressure-measurement of velocity by Pitot tube.

References:

1. Engineering Thermodynamics- Nag, P.K. - T. M.H
2. Fundamentals of Thermodynamics- Sonntag, Borgnakke & Van Wylen, Wiley India
3. Thermodynamics- an Engineering approach - 6e, Cengel & Boles, TM
4. Fluid Mechanics & Hydraulic Machines – R.K. Bansal, Laxmi Publications Ltd, India
5. Introduction to Fluid Mechanics and Fluid Machines- S.K. Som, G. Biswas, & S. Chakraborty , T.M.H
6. Fluid Mechanics – A.K. Jain, Khanna Publishers.

Course Name : Introduction to Computing Lab					
Course Code: CSEN 1211					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**2**

Basic Computation & Principles of Computer Programming Lab

Softwares to be used: Cygwin and notepad ++, Tiny C

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

Course Name : CHEMISTRY I LAB					
Course Code: CHEM 1011					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**2**

List of Experiments:

1. To determine the alkalinity in a given water sample.
2. Estimation of iron using $KMnO_4$: self indicator.
3. Estimation of iron using $K_2Cr_2O_7$: redox sensitive indicator.
4. To determine total hardness and amount of calcium and magnesium separately in a given water sample.
5. To determine the value of the rate constant for the hydrolysis of ethyl acetate catalyzed by hydrochloric acid.
6. Heterogeneous equilibrium (determination of partition coefficient of acetic acid between n-butanol and water).
7. Conductometric titration for determination of the strength of a given HCl solution by titration against a standard NaOH solution.
8. pH- metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
9. Iodometric estimation of Cu^{2+}.
10. To determine chloride ion in a given water sample by Argentometric method (using chromate indicator solution)

Course Name : BASIC ELECTRICAL ENGINEERING LAB					
Course Code: ELEC 1011					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**2**

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 Drawing					
Course Code: MECH 1012					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	1	**0**	**3**	**4**	**3**

After going through the course, the students will be able

- To understand the meaning of engineering drawing
- To have acquaintance with the various standards (like lines, dimensions, scale etc.) and symbols followed in engineering drawing
- To represent a 3-D object into a 2-D drawing with the help of orthographic and isometric projection.
- To read and understand projection drawings.

1. Importance of engineering drawing; Acquaintance with different drafting equipment & accessories;
2. Introduction to lines : Practising different types of lines; Basic concepts in Lettering : Practising vertical & inclined letters (Practice Sheet 1)
3. Different systems of dimensioning with practice.Introduction to the concept of scale of drawing. (Practice Sheet 2)
4. Introduction to concept of orthographic projection: 1st angle and 3rd angle projection method; Symbols; projection of points. (Practice Sheet 3)
5. Projection of straight lines for different orientation including inclined to both the planes. (Practice Sheet 4)
6. Projection of plane surfaces inclined to HP and parallel to VP; Inclined to VP and Parallel to HP (Practice Sheet 5)
7. Projection of solids: Cube, rectangular prism, Hexagonal prism, Cylinder, Pyramid, Cone. (Practice Sheet 6)
8. Section of solids and their projections on principal and auxiliary planes for true shape: Cylinder, hexagonal pyramid. (Practice Sheet 7)
9. Isometric projections: Basic concepts, isometric scale; Isometric projection and view.
10. Practice with simple laminar and solid objects. (Practice Sheet 8)

References:

1. "Elementary Engineering Drawing" by Bhatt, N.D; Charotan Book Stall, Anand
2. "Engineering Graphics" by Narayana, K.L. and Kannaaiah P; TMH
3. "Engineering Graphics" by Lakshminarayanan, V. and Vaish Wanar, R.S, Jain Brothers.

2nd Year 1st Semester Syllabus:

Course Name : PHYSICS - II					
Course Code: PHYS 2001					
Contact hrs per week:	L	T	P	Total	Credit points
	3	1	0	4	4

Module 1 :

Classical Mechanics :
Constraints. Generalised coordinates. Lagrange's equation of motion. Hamiltonian formulation, Hamilton's equation of motion.

Course should be discussed along with simple physical problems.

4 lectures

Quantum Mechanics:
Physical interpretation of wave function Ψ(normalization and probability interpretation). Concept of probability and probability density. Operator. Commutator. Formulation of quantum mechanics and basic postulates . Operator correspondence . Time dependent Schrödinger's equation . Formulation of time independent Schrödinger's equation by method of separation of variables. Expectation values. Application of Schrödinger equation-Particle in an infinite square well potential (1-D and 3-D potential well), discussion on degenerate energy levels.

6 lectures

Module 2 :
Statistical Mechanics:
Concept of energy levels and energy states. Macrostates. Microstates and thermodynamic probability. Equilibrium macrostate. MB, FD and BE statistics (no deduction necessary). Fermions, Bosons (definitions in terms of spin, examples). Physical significance and application. Classical limit of quantum statistics. Fermi distribution at zero and non –zero temperature. Fermi Level.

6 lectures

Applications of Statistical Mechanics
Planck's Black body radiation. Fermi level in intrinsic and extrinsic semiconductors. Intrinsic semiconductors and carrier concentration. Extrinsic semiconductors and carrier concentration. Equation of continuity. Direct & indirect band gap semiconductors.

4 lectures

Module 3 :
Dielectric Properties:
Electric dipole moment. Dielectric constant. Polarizability. Electric susceptibility. Displacement vector. Electronic, ionic and orientation polarizations. Calculation of polarizabilities - Internal fields in solids. Piezo-electricity, pyro-electricity and ferro- electricity.

5 lectures

Magnetic Properties:
Permeability, field intensity, magnetic field induction, magnetization, magnetic susceptibility. Origin of magnetic moment, Bohr magneton. Classification of dia, para and ferro magnetic materials on the basis of magnetic moment. Domain theory of ferro magnetism. Explanation of hysteresis curve. Soft and hard magnetic materials. Properties of anti-ferro and ferri magnetic materials. Ferrites and their applications. Concept of perfect diamagnetism.

5 lectures

Module 4 :

Band Theory of Solids:
Electron in a periodic potential. Bloch theorem. Kronig-Penny model (qualitative treatment). Origin of energy band formation in solids. Classification of materials into conductors, semi conductors & insulators. Concept of effective mass of an electron and hole.

6 lectures

Super Conductivity:
Introduction (experimental survey). General properties of super conductivity. Effect of magnetic field. Meissner effect . Explanation in view of wave mechanical property. Hard and soft superconductors. Thermal properties of superconductor. London equations and penetration depth.

4 lectures

Recommended Text Book:

Quantum Physics

- Atomic Physics – S.N. Ghoshal – S Chand
- Quantum Physics– Eisberg and Resnick – Wiley
- Quantum Mechanics – A.K. Ghatak and S. Lokenathan –Springer

Classical Mechanics

- Introduction to Classical Mechanics – R.G Takwale & P S Puranik –Tata MaGraw Hill
- Classical Mechanics – N C Rana & P S Joag – Tata MaGraw Hill

Solid State Physics

- Atomic Physics – S.N Ghoshal
- Elementary Solid State Physics – M.Ali Omar – Pearson Education
- Solid State Physics – A.J Dekkar – Macmillan
- Introduction to Solid state Physics – C.Kittel

Statistical Mechanics

- Thermodynamics, Kinetic Theory, and Statistical Mechanics–Sears and Salinger–Narosa

MECH 2101: APPLIED THERMODYNAMICS

Contacts: 3L **Credits: 3**

Course objective:

After going through the course, the students will be able

- To analyze a thermodynamic system and calculate work transfer in various quasi-static processes.
- To 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.
- To quantify irreversibility in a process by evaluating entropy generation.
- To calculate thermal efficiency of Otto, Diesel and Rankine cycle.
- To understand the basics of a refrigeration system and to calculate the COP using table of refrigerants.

Sl. No.	Syllabus	Contact Hrs.
Module 1	**Review of fundamentals:** Introduction; Macroscopic and microscopic concept; Thermodynamic systems; Control mass and control volume; Thermodynamic properties; Thermodynamic equilibrium; Thermodynamic processes and cycles; Quasi-static processes; Reversible processes; Zeroth law of Thermodynamics.	1
	Heat & Work: Thermodynamic work; Work transfer- displacement work for a simple compressible system; Pdv work for various processes; Path function and point function; Heat transfer.	1 2
	First law of Thermodynamics: First law for closed system; First law for steady and unsteady flow processes;	
	Pure substance: Definition, properties of pure substance; Phases of pure substance — Gibbs phase rule; 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.	5
Module 2	**Second law of Thermodynamics:** Qualitative difference between heat and work; 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. Reversible process; 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; Tds equation and calculation of entropy change of ideal gases for various processes; entropy change of solids; Concept and uses of entropy, Entropy principle; Entropy generation, entropy transfer; 2nd law applied to control volume. **Joule Thomson Effect:** Isenthalpic plots, inversion curve, Joule Thomson coefficient	4 2
Module 3	**I C Engines and Gas Power Cycles:** Air standard cycles — Otto cycle, Diesel cycle, Dual combustion cycle; P-v, T-s plots; Efficiency, net work done, mean effective pressure; Principles of 4-stroke S I engine and C I engine; Engine nomenclature. **Reciprocating air compressor:** Compression process, work of compression, Single stage reciprocating compressor, volumetric efficiency, efficiency of a compressor; Multistage compression, advantages, ideal intermediate pressure.	5 4
Module 4	**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. **Introduction to refrigeration systems:** Reversed heat engine cycle; Vapour compression refrigeration cycle; Absorption refrigeration cycle; Refrigerants.	5 4
	Total Classes	**36**

Text Books:

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

Reference Books:

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

MECH 2102: STRENGTH OF MATERIALS

Contacts:3L **Credits: 3**

Course Objectives:

After going through the course, the students will be able

- To distinguish clearly between normal and shear stresses and normal and shear strains. He/She should be able to discern a statically determinate problem in axial deformation of bars clearly from a statically indeterminate one. Additionally, he/she should be able to analyze clearly a state of biaxial stress and compute the principal stresses and the orientations of the principal planes.
- To draw shear force, axial force and bending moment diagrams of beams subjected to in-plane loadings in pure bending. He / She should be able to compute normal stresses in beams of isotropic materials.
- To solve problems on beam deflection using the standard methods.
- To solve problems on torsion of circular cross-sections (bars) and annular cross-sections.
- To grasp the concept of buckling (as being a kind of instability) rather than being another type of loading and to find the critical loads determining the onset of buckling under different boundary conditions using standard formulae.

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.	8
Module 2	Transformation of stresses in two-dimensional problems, principal stresses, maximum and minimum shear stresses, Mohr's circle of stress. Thin-walled pressure vessels. Beam Deflections: deflections by simple integration, method of superposition, energy methods, Castigliano's theorems. Statically determinate and indeterminate problems on beam deflections.	9
Module 3	**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.	9

Module 4	**Torsion** of circular shafts, strain energy in torsion, stresses and deflections of open and closely coiled helical springs, combined bending and torsion. **Columns:** Buckling of columns, 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.	10
	Total Classes	36

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.

MECH 2103: FLUID MECHANICS

Contacts: 3L **Credits: 3**

Course Objective:

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

- Understand fundamental physical and analytical principles of fluid mechanics.
- Apply the fundamental laws to solve problems in fluid mechanics on applications dealing with the flow of incompressible fluids in engineering systems.
- Analyze fluid flow problems with application of mass, momentum and energy conservation equations.
- Perform the dimensional analysis for fluid flow problems.
- Develop concept of boundary layer growth and flow around submerged bodies.

Sl. No.	Syllabus	Contact Hrs.
Module 1	Review of fluid properties and fluid statics- variation of pressure within a static fluid – equation of hydrostatic pressure distribution.	1
	Hydrostatic thrust on submerged plane and curved surfaces; buoyancy, stability of submerged and floating bodies.	4
	Kinematics of Fluid Flow: Continuity Equation, Deformation of fluid particle- Translation and Rotation; Circulation and Vorticity; Irrotational and Rotational flow; Stream function, Velocity Potential.	4
Module 2	Review of fluid dynamics (Euler's equation of motion and Bernoulli's equation); Bernoulli's Equation for a real fluid with applications (Venturi meter, Orifice meter, Pitot tube).	3
	Application of linear momentum to control volume-linear momentum equation, analysis of force exerted by a fluid stream on a solid boundary- thrust on pipe bends etc.	3
	Flow through notches and weirs (rectangular and triangular cross section)	3
Module 3	Characteristics of Laminar and Turbulent flow; Reynolds experiment, critical Reynolds number; Laminar flow through pipe- Hagen-Poiseuille equation	4
	Flow through closed conduits: Darcy Weisbach equation, concept of friction factor in a pipe flow, Variation of friction factor, Moody's diagram and its use; minor losses- at sudden expansion,	5

	at sudden contraction, at bends, at valves, and fittings etc.	
Module 4	Boundary layer theory: concept of boundary layer; boundary layer thickness, displacement thickness, momentum thickness, growth of boundary layer, momentum integral equation; Boundary layer separation. Flow of fluid around submerged bodies; basic concepts of drag and lift, aerofoils. Dimensional analysis and Buckingham Pi theorem, similarity and model study.	4 2 3
	Total Classes	36

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

MECH 2104: ENGINEERING MATERIALS

Contacts: 3L **Credits: 3**

Course Objective:

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

- Identify and classify the structure of metals, polymers, ceramics, composites and advanced materials –
  Semiconductors, smart materials, nano-materials and analyze their failures by identifying their imperfection.
- Understand the changes in the physical properties of materials by heat treatment.
- Specify mechanical, thermal, electrical and magnetic properties of materials.
- Select materials based on required properties, availability, cost and environmental issues.

Sl. No.	Syllabus	Contact Hrs.
Module 1	**Introduction:** Material Science –its importance in engineering: Classification of Materials--metals, polymers, ceramics, composites; Advanced materials –semiconductors, smart materials, nano-materials; Atomic structure, Atomic bonding in solids — bonding forces and energies; Ionic/covalent/metallic bonding.	**2**
	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; Anisotropy & Isotropy.	**2**
	Imperfections in Metals: Point defects due to vacancy & impurities, alloys, solid solutions; Dislocations—linear defects, interfacial defects, grain boundaries, grain growth, grain structure.	**2**
	Phase Diagrams: Definition and basic concepts; solubility limit; phase Equilibrium, one component phase diagram, binary phase diagram, interpretation of phase diagrams.	**3**
Module 2	**Iron-carbon system:** Allotropy of iron, iron-iron-carbide phase diagram, Properties and uses of plain carbon steel.	**3**
	Classification of Metals and Alloys- compositions, general properties and uses: **Ferrous alloys:** Classification –low carbon steels, medium carbon steels, high carbon steels, stainless steels, alloy steels, tool and die steel, cast irons	**2**
	Non-ferrous alloys : Copper and copper alloys, Aluminum	**2**

	alloys; zinc Alloys; Nickel alloys; Lead and Tin alloys. **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**
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, impact tests, Hardness- Brinnel, Rockwell and Vickers hardness and their testing procedures, correlation between hardness and tensile strength; Strain hardening; Fatigue strength; Effect of temperature on tensile strength and impact properties, creep failure, slip, twining. **Thermal Properties:** High temperature materials, thermally insulating materials, specific heat, thermal conductivity, thermal expansion **Electrical Properties :**Dielectric Materials, Factors affecting dielectric constant, Polarization, mechanism of polarization. **Magnetic Properties:** Magnetism, diamagnetism, paramagnetism ferromagnetism, magnetic energy.	**7**
4.	**Polymers & Elastomers:** Definition; How polymers are made-polymer molecular structures, Thermoplastics & Thermosets; Special characteristics like low specific gravity, optical, electrical & thermal property, decorative color, easy formability, low corrosion etc. Uses of polymers and elastomers. **Ceramic Materials :** What is ceramics common ceramic materials and their characteristics; How ceramics are made-sintering and vitrification process; Ceramic structures , Properties and applications. **Composite Materials :** What is composites; Polymers matrix and their applications; Metal matrix and ceramic matrix composites and their applications; How composites are made. **Corrosion and Degradation 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** **1**
	Total Classes	**36**

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 ,2e, Tata McGraw Hill
3. Materials Science and Engineering by V.Raghavan, 5e, Prentice Hall India

Reference books:

4. Engineering Materials Properties & Selection by Budinski & Budinski, 9e, Prentice Hall India
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

MECH 2105: METROLOGY AND MEASUREMENT

Contacts: 3L **Credits: 3**

Course Objective:

After attending the course the students will be able to

- Learn the importance of various measuring techniques.
- Understand the precision and accuracy of various measuring instruments.
- Appreciate the importance of interchangeability and concept of fits and tolerance.
- Understand the structure and characteristics of a measuring instrument.
- Decide the type of instruments to be used given the specification of the measurand.
- Use various measuring instruments according to requirement.

Sl. No.	Syllabus	Contact Hrs.
Module 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.	**2**
	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 straight edge, interferrometry (Newton's rings) and surface plate; Parallelism, cylindricity and concentricity using dial indicator. Alignment & testing methods. Gear tooth measurement.	**4**
Module 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) optical comparator-profile projector.	**4**

Module 3	Measuring Instruments: Functional elements of an instrument – sensing, conversion & manipulation, data transmission and presentation element; Characteristics – accuracy, precision, repeatability, sensitivity, reproducibility, linearity, threshold, response, dynamic or measurement error; Transducers – definition, primary and secondary, active and passive. Tolerance analysis in manufacturing and assembly. Calibration methods of thermocouple, vernier caliper, pressure gauge 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.	**5** **4**
Module 4	Principle of operation of a few measuring instruments: displacement by LVDT; force by strain – gauge load cell and piezoelectric load cell; pressure by Bourdon – tube gauge; temperature by liquid-in-glass thermometer, thermocouples, optical pyrometer; liquid velocity by pitot tube; water flow by orifice meter. Level measurement.	**7**
	Total Classes	**36**

Text Books:

1. R. Rajendra, Principles of Engineering Metrology, Jaico Pub. House. 2e
2. 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

HMTS 2002: INDIAN CULTURE AND HERITAGE

Contacts: 2L **Credit: 1**

Module 1
Indian Religion &Philosophy

1. Orthodox Indian Philosophy:
2. Unorthodox Indian philosophy:
3. Essentials of Hinduism
4. An overview of Jainism, Buddhism, Sikhism, Islam, Christianity religions

Module 2
Values and Personality

1. Aspects of Indian Values
2. Essentials of Personality Building
3. Ethics at work place
4. Aspects of Leadership qualities

Module 3
Indian Scriptures

1. Selections from the Vedas
2. Select verses from Upanishad
3. An overview of Gita
4. XVIth chapter of Gita

Module 4
Indian Psychology
1. Aspects of Yoga Philosophy
2. Mind and its workings according to Yoga
3. Law of Karma
4. Selections from Manusmriti

References:

1. Indian Philosophy by S.C. Chatter and D. M. Dutta, Calcutta University Press
2. Spiritual Heritage of India, Swami Prabhavananda, Sri Ramakrishna Math, Chennai
3. Raja Yoga by Swami Vivekananda, Advaita Ashrama, Mayavati
4. Vedic Selection, Calcutta University Press
5. Gita by Swami Swarupananda, Advaita Ashrama, Kolkata
6. Upanishads by any press
7. Carving a Sky (MSS) by Samarpan
8. Essentials of Hinduism (MSS) by Samarpan
9. The Call of the Vedas — Bharatiya Vidya Bhavan

HMTS 2011: LANGUAGE PRACTICE LAB (LEVEL II)

Contact: 3P **Credit: 2**

Modules

Module 1
Formal verbal communication:

- Introduction to formal verbal communication, Interpersonal Skills & Public Speaking: Building Positive Relationships, Focusing on Solving Problems, Time Management, Dealing with Criticism: Offering Constructive Criticism, Responding to Criticism – Managing Conflict: Approaches to Conflict, Resolving Conflict.
- Conversational skills in the business scenario: One-to-one and Group communication, Gender and Culture Sensitivity, Etiquette, Sample Business Conversation, Telephonic Conversation.

Module 2
Presentation skills:

- Speech Purposes - General: Informative Speeches, Persuasive Speeches, Entertaining Speeches, Methods of Speaking: 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, Post- presentation Discussion.

Module 3
Group Discussion:

- Introduction to Group Communication, Factors in Group Communication, Status – Group Decision Making: Reflective Thinking, Brainstorming, Body Language, Logical Argument, The Planning Process, Strategies for Successful GDs, Role of Social Awareness (Newspapers, Magazines, Journals, TV News, Social Media), Practice GDs.

Module 4
Job Application and Personal Interview:

- 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 Chronological

and Functional Resume – Content of the Resume: Heading, Career Goal or Objectives, Education, Work Experience, Summary of Job Skills/Key Qualifications, Activities, Honours and Achievements, Personal Profile, Special Interests, References.

- **Interviewing**:
  Types of Interviews, Format for Interviews: One-to-one and Panel Interviews, Employment Interviews, Frequently Asked Questions, Dress Code, Etiquette, Questions for the Interviewer, Simulated Interviews.

Module 1- 20 marks
Module 2- 30 marks
Module 3- 20 marks
Module 4- 30 marks

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. Raman, M. and Sharma, S., Technical Communication: Principles and Practice, 2nd Ed., 2011

MECH 2111: MACHINE DRAWING-I

Contacts: 3P **Credit: 2**

Module	Topics	Contact Hrs. / No. of sheets
1A	***Introduction:-*** Representation of different types of lines, Representation of different materials, like - ferrous, non-ferrous, bricks, wood, concrete etc.	1 class/ Theory
1B	**Dimensioning:-** Placing of dimensions, Functional and Non-functional dimensions, Dimensioning common features like: Circular Arcs, Diameters, Holes, Angles, Chamfers, Tapers, Undercut, Repetitive features, Countersunk, Square, Sphere, Across flat, Threads.	2 classes/ 2 sheets
2	***Conversion of Projection:-*** ***a)*** Conversion of Isometric Views into Orthographic Projection. ***b)*** Conversion of Orthographic Views into Isometric Projection.	3 classes/ 2 sheets
3	***Nuts and Bolts:-*** Classification of nuts, terminology used in the drawing of nuts and bolts, studs. Drawing of orthographic projections (top view, front view and side view) of a bolt, Imperical relations of dimensions of nut and bolt with respect to bolt head diameter.	2 classes/ 2 sheets
4A	***Orthographic Sectional View of*** a) Shaft Coupling	2 classes/ 2 sheets
4B	***Assembling of*** Shaft with antifriction bearing mounted on a Plummer Block.	2 Class/ 1 Sheet

N.B: *Each class comprises of 3 periods*

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. Machine Drawing, N. Sidheswar, McGraw Hill Education, 1e,
4. Machine Drawing, Basudeb Bhattacharya, Oxford University Press, 1e, 2011
5. SP 46-2003 (Detailed procedure of engineering drawing)

MECH 2112: APPLIED MECHANICS LAB

Contacts: 3P **Credits: 2**

List of Experiments:

1. Tension Test of Mild Steel
2. Torsion Test of Mild Steel
3. Deflection of Cantilever Beam using a strain gauge
4. Rockwell Hardness Test
5. Brinell Hardness Test
6. Vickers Hardness Test
7. Determination of Stiffness of Leaf Spring
8. Determination of Coefficient of Friction.

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

MECH 2113: WORKSHOP PRACTICE –II.

Contacts : 3P **Credit: 2**

1. Pattern making: Pattern material, pattern allowances and types of patterns- Making a wooden pattern. (6P)

2. Mould making Practice: Uses of moulding tools: green sand moulding, gating system, risering system, use of core. (6P)

3. Making a typical product using sheet metal; Brazing/Gas Welding. (3P)

4. Basic Forging processes like upsetting, drawing down and forge welding. (3P)

5. Practicing Resistance Spot Welding, Shielded Metal Arc Welding. (6P)

6. Machining of typical products involving lathe, milling/shaping /drilling operations and finishing process. (9P)

7. Machining of gears. (6P)

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

2nd Year 2nd Semester Syllabus:

MATH 2002: NUMERICAL AND STATISTICAL METHODS

Contact: 3L **Credit: 3**

Course Objective:
After completing the course students will be able to

- Apply numerical methods to obtain approximate solutions to mathematical problems where analytic solutions are not possible.
- Develop algorithmic solutions for problems like system of linear equations, integration, ordinary differential equations which are pertinent to many physical and engineering problems.
- Apply probabilistic methods to engineering problems where deterministic solutions are not possible.
- Analyze probability distributions required to quantify phenomenon whose true value is uncertain.
- Find numerical solutions to algebraic and transcendental equations appearing in a vast range of engineering problems e.g in the study of Ideal and non ideal gas laws, pipe friction , design of electric circuits.
- Apply numerical methods to find solutions to linear system of equations appearing in spring-mass systems, resistor circuits, steady state analysis of a system of reactors.
- Solve problems in data analysis, least-cast treatment of wastewater where the knowledge of interpolation will be required.
- Compute numerical solution to integrals to find root mean square current.

MODULE-1
NUMERICAL SOLUTION TO LINEAR AND NON-LINEAR EQUATIONS (8L)

SOLUTION OF NON-LINEAR ALGEBRAIC EQUATIONS 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.

MODULE-2
NUMERICAL SOLUTION TO INTEGRATION AND ORDINARY DIFFERENTIAL EQUATIONS (8L)

INTERPOLATION AND INTEGRATION: Newton's Forward and Backward Interpolation Method, Lagrange's Interpolation, Trapezoidal and Simpson's 1/3rd Rule.

SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS: Euler's and Modified Euler's Method , Runge-Kutta Method of 4th order.

MODULE-3
FUNDAMENTALS OF PROBABILITY (5L)

Prerequisites- Set Theory.
Random experiment, Sample space , Events .
Definition of Probability ,
Addition law of probability, Multiplication law and Conditional Probability.
Bayes' Theorem (Statement only)

MODULE-4
PROBABILITY DISTRIBUTIONS AND STATISTICS (15L)

Random Variables – Discrete and Continuous, Probability Mass Function, Probability Density and Cumulative Distribution Functions, Mathematical Expectation and Variance.
Special Distributions: Binomial, Poisson, Uniform, Exponential and Normal.
Measures of Central Tendency and Dispersion – Mean, Median, Mode and Standard Deviation for grouped and ungrouped frequency distribution.
Simple Correlation and Regression.

Suggested Books:

1. Miller & Freund's Probability and Statistics for Engineers
R.A.Johnson
Prentice Hall of India

2. Numerical Mathematical Analysis
J.B.Scarborough
Oxford and IBH Publishing Co. Pvt. Ltd.

3. Numerical Methods (Problems and Solution)
Jain, Iyengar , & Jain
New Age International Publishers

4. Fundamentals of Mathematical Statistics
S.C. Gupta and V.K. Kapoor
Sultan Chand & Sons

5. A First course in Probability
Sheldon Ross
Pearson

MATH 2001: MATHEMATICAL METHODS

Contact: (3L + 1T) **Credit: 4**

Course Objective:
After completing the course students will be able to

- Synthesize components of a physical phenomenon and consequently construct a mathematical model of the system.
- Classify engineering problems like forced oscillations, RLC Circuits etc.
- Apply suitable analytic methods to solve wave equations, heat conduction equation.
- Evaluate the efficiency of a method to solve ordinary and partial differential equations.

Module 1

Functions of Complex Variables (12L)
Complex numbers and its geometrical representation .
Functions of a complex variable – Limits, Continuity, 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 2

Fourier Series, Integrals and Transforms (12L)
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 3

Series solutions to Ordinary Differential equations and Special Functions (12L)
Series solution of ODE: Ordinary point, Singular point and Regular Singular point, series solution when $x = a$ 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 4
Partial Differential Equations (12L)
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

MECH 2201: FLUID MACHINERY

Contacts: 3L **Credits: 3**

Course Objective:

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

- Classify different types of fluid machines.
- Understand the basic working principle of turbo machines.
- Identify different losses in fluid machines.
- Select an appropriate class of turbomachine for a particular application
- Analyze different performance characteristics of various fluid machines.

Sl. No.	Syllabus	Contact Hrs.
Module 1	Introduction: Definition, Classification and Application of fluid machinery. Rotodynamic Machines: Classification, Incompressible and compressible flow machines, Pump, Turbines and Compressor. Radial, Axial and Mixed flow type machines, Basic equation of energy transfer in Rotodynamic machines. Centrifugal Pump: Classification, Main components and their functions- Casing, Inlet Guide Vane, Impeller, diffuser. Principles of Energy Transfer, Euler one-dimensional equation, Euler head, Rotor work, Velocity diagram; Different heads and efficiencies for centrifugal pump. Priming in centrifugal pump.	2 8
Module 2	Hydraulic Turbines: Classification; Impulse Turbine: Pelton Turbine- Main components and their functions, velocity triangle and work done . Wheel 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, head). Theory & different types of draft tube. Axial flow reaction turbine: Propeller and Kaplan turbines, component parts: construction and operation; Difference between Francis and Kaplan Turbine	8
Module 3	Performance characteristics curves: System resistance curve; Pumps- Radial, Mixed flow and Axial flow. Turbines-Francis, Kaplan and Pelton wheel- Main, Operating characteristics and Muschel curves, Dimensional analysis for fluid machinery: Dimensionless quantities and their use in design, selection and testing. Series and parallel operation of pump. Cavitation: NPSH, Thoma's cavitation parameter and methods to avoid cavitation.Specific speed of a pump and turbine. Unit quantities	7 3
Module 4	Positive Displacement Pumps: Reciprocating and Rotary Pumps, Main components of reciprocating pump. Working principle- 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; Indicator diagram for reciprocating pump; Air vessel.	8
	Total Class	**36**

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 Massey, Taylor & Francis, 8e

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), 1st Indian reprint 2011
3. Incompressible Flow Turbomachines –Rowal, Elsevier (Yes Dee Publishing Pvt. Ltd), 1st Indian reprint 2011
4. Principle of Turbomachinery- Turton R. K, Springer (Yes Dee Publishing Pvt. Ltd), 1st Indian reprint 2011
5. Turbomachines by B.U.Pai; WILEY, 1e, 2013

MECH 2202: KINEMATICS OF MACHINES

Contacts : 3L **Credit: 3**

Course Objectives:

On completion of this course student will be able to-

- Specify a mechanism on the basis of its technical parameters.
- Analyze velocity of different components in a mechanism.
- Analyze acceleration of different components in a mechanism.
- Design a detailed layout for transmitting power using belt drive.
- Have a detailed knowledge about different gear trains.
- Construct different power transmission layout using gears.
- Design layouts of a cam drive for specified follower motion.

Module	Syllabus	Contact Hrs.
1	Introduction to mechanisms, Difference between Machine and Mechanism; Kinematic link, Types of links, Kinematic pair, Types of constrained motions, Types of Kinematic pairs, Kinematic chain, Types of joints, Mechanism, Machine, Degree of freedom (Mobility), Kutzbach criterion, Grubler's criterion. Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions, Double slider crank chain and its inversions.	8
2A	**Velocity Analysis of mechanisms (mechanisms up to 6 links).** Velocity analysis by instantaneous center of rotation method (Graphical approach) Velocity analysis by relative velocity method (Graphical approach)	5
2B	**Acceleration analysis of Mechanism** Acceleration Images, Klein's construction, Coriolis acceleration. Analytical expression of velocity & acceleration.	4
3A	**Belt-drive** – introduction; Law of belting, Length of flat belt for open and cross belt connections;Stepped pulley for open flat belt; Tension in flat belt and V-belts; Power transmitted in belt drive.	3
3B	**Gear and Gear trains :** Types of Gears, Gear terminologies, Simple, compound, Epicyclic gear train; Speed-torque analysis of geartrains.	5

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

Text Books:

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

Reference Books:

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

MECH 2203: PRIMARY MANUFACTURING PROCESSES

CONTACTS: 3L **CREDITS: 3**

Course objectives:

After completing the course, students will be able to

- Form basic idea of different mechanical manufacturing processes (except machining) & related equipment along with type of products manufactured through such processes.
- Acquire working knowledge of sand casting process.
- Know about different joining processes.
- Acquire working knowledge of arc welding process.
- Form basic understanding of different forming processes like rolling, forging, extrusion, presswork & their specific applications.
- Form basic idea of powder metallurgy process & plastic processing methods.

Sl. No.	Syllabus	Contact Hrs.
Module 1	**Introduction& casting process:** Engineering materials (metals & plastics); classification of manufacturing processes. Casting: Definition; Ferrous & non ferrous casting materials; Example of cast products. Types of casting & their application: (1) Sand casting, (2) Sodium silicate-CO_2 moulding, (3) Shell moulding, (4) Expendable mould, (5) Investment casting, (6) Full mould & lost foam casting, (7) Die casting, (8) Centrifugal casting. Sand mould making procedure;definition & meaning of different terms, gating system. Properties of moulding sand; moulding sand composition; effect of grain size, clay & water content on moulding sand properties. Testing of sand properties: moisture content, clay content, grain size, calculation of GFN, permeability, mould strength & hardness. Pattern: materials, allowance; type of patterns: single piece, split, gated, matchplate, cope & drag, loose piece, sweep. Core: Definition & use; Core making with oven/no baking, properties & constituents; core prints & chaplets. Basic idea of gating system & riser design. Process & utility of die casting & centrifugal casting. Defects in sand casting & remedies.	11
Module 2	**Welding process:** Different joining (fabrication) processes; metal welding process; types of joints. Gas welding: oxy-acetylene flame; gas welding equipment; welding process. Electric arc welding: principle of arc; arc welding equipment- Ac &	8

	Dc m/c.; 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 welding. Hot forge welding & Friction welding process. Causes & remedy of welding defects: under cut, incomplete fusion, porosity, slag inclusion, hot cracking, cold cracking. NDT methods.	
Module 3	**Forming process:** Elastic & plastic deformation of perfect crystal; effect of mechanical working on mechanical properties; hot & cold working; recrystalization process. **Forging:** Definition; forging operation; application; hot & cold forging. Forging methods: smith forging, drop forging, press forging & m/c forging. Design features of forging dies; forging defects. **Rolling:** definition; hot & cold rolling; rolled products- sections & flats. Rolling stand: 2 Hi, 3Hi, 4Hi & cluster mill; different parts & mechanisms of a mill stand. Rolling load & torque; roll pass sequence. **Extrusion:** process & product; hot & cold extrusion; forward & backward extrusion; impact extrusion. Tooling for solid sections & tubes. **Wire drawing:** process & products; drawing dies, drawing machine.	10
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).	7
	Total Class	**36**

Text Books:

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

Reference Books:

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

HMTS 2001: HUMAN VALUES AND PROFESSIONAL ETHICS

CONTACTS: 2L CREDITS: 2

Module 1

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 2

Ethics and Ethical Values.
Principles and theories of ethics.
Consequential and non-consequential ethics.
Egotism,Utilatirianism, 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, Giligan's theory(consensus and controversy)
Code of Professional Ethics Sample Code of ethics like ASME, ASCE. IEEE,Institute 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 3

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 4

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).

CHEM 2001: BASIC ENVIRONMENTAL ENGINEERING & ECOLOGY

Contacts: 3L **Credits: 3**

Module 1

Environment & Ecology (General discussion) (9L)

Basic ideas of environment and its component (1L)
Mathematics of population growth: exponential and logistic and associated problems, definition of resource, types of resource, renewable, non-renewable, potentially renewable, Population pyramid and Sustainable Development. (2L)
General idea of ecology, ecosystem – components, types and function. (1L)
Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Mangrove ecosystem (special reference to Sundarban); Food chain [definition and one example of each food chain], Food web. (2L)
Biogeochemical Cycle- definition, significance, flow chart of different cycles with only elementary reaction [Oxygen, carbon, Nitrogen, Phosphorus, Sulphur]. (2L)
Biodiversity- types, importance, Endemic species, Biodiversity Hot-spot, Threats to biodiversity, Conservation of biodiversity. (1L)

Module 2

Air pollution and control (9L)

Atmospheric Composition: Troposphere, Stratosphere, Mesosphere, Thermosphere, Tropopause and Mesopause. (1L)
Green house effects: Definition, impact of greenhouse gases on the global climate and consequently on sea water level, agriculture and marine food. Global warming and its consequence, Control of Global warming. Acid rain: causes, effects and control. Earth's heat budget, carbon capture, carbon footprint. (2L)

Lapse rate: Ambient lapse rate, adiabatic lapse rate, atmospheric stability, temperature inversion (radiation inversion). Atmospheric dispersion, Maximum mixing depth. (2L)

Definition of pollutants and contaminants, Primary and secondary pollutants: emission standard, criteria pollutant. Sources and effect of different air pollutants- Suspended particulate matter, oxides of carbon, oxides of nitrogen, oxides of sulphur, particulate, PAN. (1L)
Smog: Photochemical smog and London smog. Depletion Ozone layer: CFC, destruction of ozone layer by CFC, impact of other green house gases, effect of ozone modification. (1L)
Standards and control measures: Industrial, commercial and residential air quality standard, control measure (ESP, cyclone separator, bag house, catalytic converter, scrubber (ventury), Statement with brief reference). (2L)

Module 3

Water Pollution and Control (9L)

Hydrosphere, Hydrological cycle and Natural water. Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, thermal application, heavy metals, pesticides. (2L)
River/Lake/ground water pollution: River: DO, 5 day BOD test, Unseeded and Seeded BOD test, BOD reaction rate constants, COD. (1L)
Lake: Eutrophication [Definition, source and effect]. Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only) (1L)

Water Treatment system [coagulation and flocculation, sedimentation and filtration, disinfection, hardness and alkalinity, softening]
Waste water treatment system, primary and secondary treatments [Trickling filters, rotating biological contractor, Activated sludge, sludge treatment, oxidation ponds]. (2L)
Water pollution due to the toxic chemicals effects: Lead, Mercury, Cadmium, Arsenic. (1L)

Noise Pollution

Definition of noise, effect of noise pollution, noise classification [Transport noise, occupational noise, neighbourhood noise]. Definition of noise frequency, noise pressure, noise intensity, noise threshold limit value, equivalent noise level, L_{10} (18 hr Index), effective perceived noise level.
Noise pollution control. (2L)

Module 4
Land Pollution (9L)

Solid Waste: Municipal, industrial, commercial, agricultural, domestic, pathological and hazardous solid wastes, electronic waste. (2L)
Recovery and disposal method- Open dumping, Land filling, incineration, composting, recycling. (2L)

Social Issues, Health and Environment

Environmental disasters: Bhopal gas tragedy, Chernobyl disaster, Three Mile Island disaster, cancer and environment: carcinogens, teratogens and mutagens (general aspect). (2L)
Environmental impact assessment, Environmental audit, Environmental laws and protection act of India. (1L)
Energy audit, Green building, Green sources of energy, Concept of Green Chemistry, Green catalyst, Green solvents (replacement of VOC). (2L)

References/Books

1. Masters, G. M., "Introduction to Environmental Engineering and Science", Prentice-Hall of India Pvt. Ltd., 1991.
2. De, A. K., "Environmental Chemistry", New Age International.
3. Asim K. Das, Environmental Chemistry with Green Chemistry, Books and Allied P. Ltd
4. S. C. Santra, Environmental Science, New Central Book Agency P. Ltd
5. Gour Krishna Das Mahapatra, Basic Environmental Engineering and Elementary Biology, Vikas Publishing House P. Ltd.

MECH 2211: MACHINE DRAWING-II

Contacts: 3P **Credits: 2**

Module	Topics	Contact Hrs. / No. of sheets
1A	**I S Conventions:-** Need and Types, I S conventions of Threads, Nuts, Bolts, Gears, Bearings, Springs, Washers, Knurling, array of holes, Ratchet & Pawl,	1 class/ Theory
1B	***Limits, Fits & Dimensional Tolerances:-*** Terminology, Necessity of Limit system,Unilateral and Bilateral Tolerances, Relation between Tolerances and ManufacturingProcesses, Methods of indicating tolerances on drawings, IT grades, Systems of fits,Types fits, Selection of fits, Selection of tolerances based on fits.	1 class/ Theory
1C	***Geometrical Tolerances:-*** Need of Geometrical Tolerances, Terminology, Tolerancesfor Single Features such as Straightness, Flatness, Circularity, Cylindricity. Tolerancesfor Related Features such as Parallelism, Perpendicularity, Angularity, Concentricity,Tolerance Symbol and Value, Indicating Geometrical Tolerances on drawings.	1 class/ Theory
1D	***Surface Finish:-*** Surface Texture, Surface Roughness Number, Roughness Symbols,Range of Roughness obtainable with different manufacturing processes.	1 class/ Theory
2	***A detailed discussion on Drafting software*** 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.	4 classes/ Practical
3	***Assembling of:-*** a) Cotter Joint. b) Cross head of steam engine.	2 Class/ Practical
4	***Disassembling of:-*** a) Lathe Tail Stock.	2 Classes/ Practical

N.B: *Each class comprises of 3 periods*

Recommended Books

1. Machine Drawing, Basudeb Bhattacharya, Oxford University Press, 1e, 2011
2. 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)
3. AutoCAD 2013 for Engineers and Designers, Sham Tickoo, Dreamtech Press, 1e, 2013

MECH 2212: METROLOGY AND MEASUREMENT LAB

Contacts: 2P **Credits: 1**

Taking measurements using following instruments:

1. Group A: (i) Vernier height & depth gauge, (ii) Dial micrometer, (iii) Slip gauge (2P)
2. Group B: (iv) Thread gauge, (v) Radius gauge, (v) Feeler gauge. (2P)
3. Measurement of angle of a component using :(i) Vernier bevel protractor, (ii) angle gauges , (iii) Sine-bar and slip gauges. (2P)
4. Checking / measuring parallelism, cylindricity and concentricity of components using dial indicator. (2P)
5. Measurement of a specific dimension for a lot of components, and prepare a histogram from the data obtained. (2P)
6. Measurement of surface finish by a Talysurf instrument. (2P)
7. Measurement of micro feature of a product (e.g. Thread of a bolt or saw etc.) in a profile projector. (2P)
8. Determine natural cooling characteristics of a heated object by using a thermocouple. (2P)
9. Measurement of air velocity across an air duct using anemometer. (2P)
10. Gear Measurement (2P)

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

MECH 2213: MANUFACTURING TECHNOLOGY LAB

Contacts: 3P **Credits: 2**

FIELD	EXPERIMENTS
A. CASTING	1. To Find grain fineness number (GFN) of sand specimen. 2. To Determine permeability of moulding sand. 3. To determine clay content of moulding sand. 4. To determine green compression strength of moulding sand. 5. To determine hardness of green sand mould. 6. To find out the moisture content of moulding sand.
B. FORGING	1. Compare the hardnesses of a aluminium annealed sample after reducing thickness by 15% and 30% by cold hammering (surface grinding before hardness testing). 2. Study micro structure of MS sample after annealing and after 30% deformation by both hot and cold process.
C. PLASTICS & POWDER METALLERGY	1. Tensile strength testing of Plastic. 2. Compaction and Sintering of Powder Metallurgical samples (Demonstration).
D.WELDING	1. Welding efficiency testing on MS samples (Demonstration).

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

MECH 2214: MATERIAL TESTING LAB

Contacts: 2P **Credits: 1**

1. Impact Test –Charpy.
2. Impact Test – Izod.
3. Drawability test of sheet metal by cupping.
4. Fatigue test of a typical sample.
5. Sample preparation and etching of ferrous and non-ferrous metals and alloys and metallographic observations.
6. Observations of presence of surface cracks by Dye Penetration Test.
7. Observations of presence of surface and sub-surface cracks by Magnaflux Test.
8. Experiments on heat treatment of carbon steels under different rates of cooling and testing for the change of hardness.
9. Experiments on heat treatment of carbon steels under different rates of cooling and observing the change of microstructure.

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

MATH 2012: NUMERICAL AND STATISTICAL METHODS LAB

Contacts: 2P **Credits: 1**

Course outcome: After completing the course the student will be able to:

- Reproduce customized programs to solve problems based on Numerical Methods.
- Develop algorithms to handle large systems of equations appearing in physical and engineering problems.

Development of computer programs in C for the following problems:

1. Regula-Falsi Method
2. Newton-Raphson Method
3. Gauss-elimination Method
4. Gauss-Seidel Method
5. Newton's Forward Interpolation
6. Lagrange's Interpolation
7. Trapezoidal and Simpson's $1/3^{rd}$ rule
8. Euler's and Modified Euler's Method
9. Runge-Kutta method of 4^{th} order
10. Computation of Mean , Median , Mode and Standard Deviation for grouped and ungrouped frequency distribution
11. Computation of Correlation coefficient and Regression equation for Bivariate data.

3rd Year 1st Semester Syllabus:

HMTS 3101: ECONOMICS FOR ENGINEERS

Contacts: 3L **Credits: 3**

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.

MECH 3101: DYNAMICS OF MACHINES

Contacts: 3L **Credit: 3**

Course Objectives:

On completion of this course students will be able to:

- Calculate Inertia Torque of a Reciprocating Mechanism.
- Determine dimensional specifications of a flywheel for a predefined requirement.
- Calculate balancing mass and its position for any unbalanced rotary and reciprocating machine.
- Analyze vibration of a system of single degree of freedom subjected to free, damped and forced vibration.
- Have knowledge about gyroscopic effects and their applications for stability of motion of different system.
- Learn technical details of different governors used in different applications.

Module	Syllabus	Contact Hrs.
1A	**Dynamic analysis of Mechanism:** Inertia force and inertia torque in reciprocating engine; Dynamic Equivalent System; correction couple (torque); Turning moment diagram and flywheel design.	5
1B	**Introduction:** Definition & types of vibration **Free Undamped 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), About Natural Frequency of the free undamped linear and rotary vibration. Effect of inertia in longitudinal vibration and its natural frequency.	4
2A	**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
2B	**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
2C	**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

3	**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
4A	**Governors**: Use and classification; Study and analysis of Porter, Proell, Hartnell and Wilson-Hartnell governors; Sensitiveness, stability, isochronism, hunting, effort and power of governors; Controlling force diagram and stability criteria analysis; coefficient of insensitiveness.	4
4B	**Gyroscope:** Gyroscopic Torque; Gyroscopic effects on Aero-plane; Gyroscopic Effects on Naval Ship; Stability of an Automobile; Stability of Two-wheel Vehicles.	4
	Total Classes	**36**

Text Books:

3. Theory of Machines – S S Rattan, Tata McGraw Hill, 4e, 2014.
4. 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 (3^{rd} edition) – Ghosh and Mallik; East West Press, 3e, 2006.

MECH 3102: HEAT TRANSFER

Contacts: (3L +1T) **Credit: 4**

Course Objectives:

On completion of this course students will be able to:

- Learn the basic laws of heat transfer, and account for the consequence of heat transfer in thermal analyses of engineering systems.
- Analyze problems involving one-dimensional steady-state heat conduction in simple geometries.
- Develop solutions for transient heat conduction in simple geometries.
- Calculate radiation heat transfer between black surfaces, as well as radiation heat exchange between gray bodies.
- Evaluate heat transfer coefficients for: (i) forced convection inside ducts and over external surfaces, and (ii) free convection on a vertical flat plate.
- Analyze heat exchanger performance by using the method of log mean temperature difference, and using the method of heat exchanger effectiveness.

Module	Syllabus	Contact Hrs.
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: Derivation 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

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	3
	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, Kirchhoff'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
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	2
	Derivation of continuity, momentum and energy equations in 2-D Cartesian co-ordinates.	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 plates.	3
	General solution of von Kármán integral energy equation of boundary layer; Relation between fluid friction and heat transfer;	3
	Concept of thermally fully developed flow.	
4	**Forced Convection (Continued):** Heat transfer in laminar tube flow; Bulk temperature; Empirical relations for pipe and tube flow.	2
	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.	3
	Heat Exchangers: Uses and types of heat exchangers; Parallel and counter-flow types.	1

	Introduction to LMTD method; correction factors; Fouling factor. ϵ-NTU method for heat exchangers	2 2
Total Classes		**48**

Text Books:

1. Introduction to Heat Transfer- S.K. Som, PHI.
2. Heat & Mass Transfer- P.K. Nag, TMH, 3e.
3. Fundamentals of Heat and Mass Transfer- Incropera, DeWitt, Bergmam, & Lavine, Wiley India.

Reference Books:

1. Heat and Mass Transfer: A Practical Approach- Yunus A. Cengel, McGraw-Hill, 2007.
2. Heat Transfer- J P Holman & Souvik Bhattacharyya, TMH.
3. Heat Transfer- A Basic Approach by Necati Ozisik.

MECH 3103: DESIGN OF MECHANICAL SYSTEMS-I

Contacts: (3L+1T) **Credit: 4**

Course Objectives:

On completion of this course student will be able to:

- Understand the influence of material properties of any machine component in designing it.
- Know the effect of different manufacturing parameters of any object when designing it.
- Design a component or object under static loading condition as well as fluctuating loading condition.
- Design different machine components like power screw and screw jack, different fastener, springs, belt drive, chain drive, shaft and couplings.
- Consult Design Hand Book for required data.

Module	Syllabus	Contact Hrs.
1A	**Introduction:** Objective and scope of Mechanical Engineering Design, Design considerations; Review and selection of materials and manufacturing processes; codes and standards, Importance of preferred size.	4
1B	**Design Under Static Load:** Modes of failure; Design/allowable stress; Factor of safety (fs); Bi-linear Stress –Strain; Theories of failure– maximum normal stress theory, maximum shear stress theory, Distortion energy theory. Choice of Failure criteria; Design for stability: buckling analysis – Johnson and Euler columns, Design of (i) Cotter joint; (ii) Knuckle joint.	8
2	**Design Under Fluctuating Load:** Fatigue in metals; S-N curve; Endurance limit and fatigue strength; Stress concentration factors – effect of discontinuity, fillets and notches; Effect of size, surface finish, stress concentration and degree of reliability on endurance limit; Design for finite and infinite life; Cumulative fatigue damage – Miner's equation, Goodman, modified Goodman and Soderberg diagrams with respect to fatigue failure under variable stresses; Fatigue design under combined stresses.	11
3	**Design of :** **(a) Bolted joints** : Fasteners- Metric thread, standard sizes, use of lock nuts and washers; Applications in structures including brackets, turn buckle; Pre-stressed bolts, Design under concentric loading and eccentric loading (b) **Riveted joints** : Unwin's formula; Brief discussion on single, double and triple row lap joints, butt joints with single or double	10

	strap / cover plate; simple strength design; joint efficiencies, Design under concentric loading as well as eccentric loading. (c) **Welded Joints**: Butt Joint, Single Fillet and Double Fillet Joint under concentric loading as well as Eccentric Loading **Design of Transmission screw and Screw jack.**	2
4	**Design of :** (i) Solid and hollow shafts: design under transverse and torsional load. (ii) Helical compression spring: stress and deflection equations, stiffness, curvature effect : Wahl's factor, springs in parallel and series. (iii) Multi-leaf springs: load-stress and load-deflection equations, Nipping. (iv) Shaft coupling-rigid, pin-bush and geared flexible type, alignment of coupling. (v) Belt drives-geometrical relations, derivation of torque and power transmission by flat and V-belt drives, selection of belt from manufacturers' catalogues, pulley. (vi) Chain drives – roller chains, polygonal effect, power rating, sprocket wheel, silent chain.	13
	Total Classes	**48**

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.

Professional Elective I

MECH 3131: FLUID POWER CONTROL

Contacts: 3L **Credit: 3**

Course Objectives:

On completion of this course students will be able to:

- Understand the application of Fluid Power.
- Specify the basic components of fluid power circuits.
- Identify and explain the operation of different types of pumps and actuators used in fluid power.
- Use of different types of valves used in fluid power circuits.
- Prepare the layout of hydraulic and pneumatic circuits.

Module	Syllabus	Contact Hrs.
1	**Fluid power:** Applications and advantages; Components of a hydraulic and pneumatic system. Desired properties of a working fluid; advantage of mineral oil over water; compressibility and incompressibility.	3
	Pascal's law; analysis of simple hydraulic jack, Mechanical advantage; continuity equation.	2
	Hydraulic Pumps: positive displacement pumps; constructional features, working principle and volumetric capacity of external gear pump, vane pump, axial piston pump and radial piston pump.	4
2	**Hydraulic Actuators :** (i) Constructional features of single acting and double acting hydraulic cylinders; mounting of cylinders, cushioning of cylinder; different application of cylinder through mechanical linkages; force, velocity and power from a cylinder. (ii) Hydraulic motors; torque, power and flow rate in a hydraulic motor.	5
	Hydraulic Valves: (i) Direction control valves – operation and graphical symbol of 3 way and 4 way valves; different modes of activation of valves; (ii) Operation and graphical symbols of check valves, pressure relief valve, pressure reducing valve, unloading valve and flow control valve.	4

3	**ANSI symbols for different hydraulic components. Analysis of hydraulic circuits for :** i) Single acting cylinder control. ii) Double acting cylinder control. iii) Regenerative circuit. iv) Pump unloading circuit. v) Double pump hydraulic system. vi) Cylinder synchronization circuit. vii) Speed control of a hydraulic motor. viii) Circuit to lift and hold heavy load. ix) Automatic sequencing of two cylinders.	9
4	Advantages & disadvantages of pneumatic system compared to hydraulic system; constructional details and operation of a reciprocating compressor; working principle and use of filter, pressure regulator, lubricator and silencer; symbols of different pneumatic components; compressed air distribution system in a plant; drawing pneumatic circuits for different operations. Use of electrical devices for controlling fluid circuits; function of electrical devices like push-button switches, limit switches, pressure switches, solenoids, relays and timers and their symbols; concept of ladder diagram; study of following circuits using electrical control devices : i) control of a solenoid actuated cylinder using one limit switch. ii) reciprocation of a cylinder using pressure or limit switches. iii) two cylinder sequencing circuit using two limit switches.	9
	Total Classes	**36**

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.

MECH 3132: REFRIGERATION & AIR CONDITIONING

Contacts: 3L **Credit: 3**

Course Objectives:

On completion of this course students will be able to:

- Understand VCRS, VARS, and Air Refrigeration systems.
- Analyze the different refrigeration cycles and methods.
- Understand the various types of compressors that are used in domestic and industrial applications.
- Calculate ventilation load for a given space.
- Specify the refrigerator and air conditioning units.
- Compare various refrigeration systems and their suitability.

Module	Syllabus	Contact Hrs.
1	**Introduction:**	
	Concepts of Refrigeration and Air-conditioning, Unit of refrigeration, Refrigerants-Desirable Properties, Nomenclature.	2
	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.	3
	Multi-stage and multiple evaporator system, Cascade system, COP comparison.	2
	Dry compression and wet compression of refrigerant; Actual Vapour Compression Cycle.	2
2	**Air Refrigeration System (ARS):**	
	Bell-Coleman refrigerator. COP determination, actual air refrigeration cycle.	3
	Vapour Absorption Refrigeration System (VARS): Advantages of VARS over VCRS, Working principle of simple VARS, practical VARS, Refrigerant-absorbent combinations.	3
	Limitations of VARS, Maximum COP of VARS, Lithium bromide-water System, Aqua-ammonia systems.	3
3	**Equipment and Control:** Major Refrigeration Equipment - Compressors: reciprocating, rotary & centrifugal, volumetric efficiency, Condensers: types used in refrigeration systems; Evaporators: expansion devices: capillary tubes and thermostatic expansion valves.	6

	Air-conditioning equipment: Airhandling units, Cooling Towers.	4
4	Basic definitions and principles related to Psychometry ; Psychometric Charts & Their Uses;	4
	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.	2
	Ventilation: Definition & Requirements, Natural & Mechanical Ventilation, Ventilation Load Calculation, Duct Sizing & Design.	2
	Total Classes	**36**

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.

MECH 3133: ELECTRICAL MACHINES

Contacts: 3L **Credits: 3**

At the end of this course students will be able to

- Apply the knowledge of behavior of DC machines to solve complex electrical engineering problems related to different types of DC generator and motor.
- Identify and analyze the problems related to performance analysis of single phase transformer reaching substantiated conclusion.
- Identify, formulate and solve the numerical problems related to 3 phase induction motor.
- Apply the knowledge of behavior of synchronous machine identify and analyze the problems related to performance analysis.

Module	Syllabus	Contact Hrs.
1	Construction of DC machine. Different methods of excitation of DC machine.	2
	DC Generators:- EMF equation. Concept of armature reaction. Voltage build-up of shunt Generator. Different characteristics of DC Generator- separately and self excited. Losses and Efficiency of Generator. Applications of different types of DC Generators.	4
	D.C. Motors:- Principle of operation. Back EMF. Torque equation. Different characteristics of DC motors - separately and self excited. Speed control of DC motor. Starting of DC shunt motor. Losses and efficiency- Hopkinson and Swinburne's test. Different methods of braking. Applications of different types of DC Motors.	4
2	**Single phase Transformers:-** Construction of Transformer- transformer tank, methods cooling. Operating principle of 1-ph transformer. Equivalent circuit. Phasor diagram of 1-ph transformer. - Losses and efficiency- Open & short circuit tests. Voltage regulation. Parallel operation.	5
	Three phase Transformer:- Construction, Various types of connection.	2
3	**Three phase Induction Motor:-**Construction. 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. Applications.	8

4	**Alternator:-** Construction. Excitation Systems. E.M.F equation. Armature reaction- Lagging, Leading, Unity p.f load. Equivalent circuit and phasor diagrams. Voltage regulation- Open circuit and short circuit test. Synchronization of alternator. Use of salient and cylindrical type of 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. Selection of motors in different drives,	2
	Total Classes	**36**

Text Books:

1. Electrical Machinery - Dr. P.S. Bimbhra.
2. Electrical Machines - S. K. Bhattacharya
3. Electrical Machines -Ashfaq Hussain

Reference Books:

1. Theory & Performance of Electrical Machines- J.B.Gupta
2. Electrical Machines- Abhijit Chakarabarti and Sudipta Debnath.

Professional Elective II

MECH 3141: TOTAL QUALITY MANAGEMENT (TQM)

Contacts: 3L **Credit: 3**

Course Objectives:

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

- Understand the meaning and evolution of total quality management (TQM).
- Identify and reduce costs of quality.
- Know key leaders in the field of quality and their contributions.
- Identify features of the TQM philosophy and implement them.
- Use tools for identifying and solving quality problems.
- Differentiate between technical quality and system quality.
- Appreciate ISO system standard and implement in industry.

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 ; Documentation ;Internal Audits and Implementation; ISO 9000 certification process. **EMS (ISO 14000):** Concepts of ISO 14001 ; Requirements of ISO 14001 ; Benefits of ISO 14001	9
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; Measures of central tendency; Measurers of dispersion; control charts for variables; Control charts for attributes; OC Curve ; Process capability; six sigma and its applications; Design of experiments and Taguchi Methodology	9
	Total Classes	**36**

Text Books:

1. Total Quality Management – J.D. Juran , MHE.
2. Total Quality Management - Besterfield,Pearson Education.

Reference Books:

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

MECH 3142: FINITE ELEMENT METHOD

Contacts: 3L **Credit: 3**

Course Objectives:

On completion of this course student will be able to:

- Understand the fundamental concepts of Finite Element Method (FEM).
- Understand the mathematical background of FEM.
- Understand the basic concepts on element selection, boundary conditions, and loading condition imposition for FEA modeling.
- Model simple structural problems for analysis.

Module	Contents	Contact Hrs.
1	**Introduction:** Historical background, FEM application on design problems, Concept of governing Equations for continuum, Solution of Governing Equation using Galerkin method, Weighted residual and Weak form method, Piece wise continuous trial function solution of weak form, Concept of Shape Function and Element stiffness matrix, Principle of Stationary Total Potential (PSTP) (Ritz Method), Coordinates and Shape Function	10
2	**One Dimensional Problem:** The Potential Energy Approach to find Element Stiffness Matrix of BAR Element, FEA formulation and understanding of Boundary Condition terms and Force Terms, Shape function and Stiffness Matrix of Quadratic BAR Element and BEAM element,	8
3	**One Dimensional Problem (contd):** Concept of FRAME Elements. Assembly of elements and Technique of Stiffness Matrix Globalization, Solving 2-Dimensional Truss Problems. **Two Dimensional Problem:** Dimensionality of a Problem, Overview about different Two Dimensional elements and their geometrical approximation, CST element (Iso-parametric Representation, Potential Energy Approach, Element Stiffness; Basic concept of Jacobian Method, Numerical integration of Two Dimensional Iso-parametric Elements.	10
4	**Two Dimensional Problems (contd):** Stress Calculation and Heat Transfer problems. **Computer implementation:** Pre-processor, Processor, Post-processor. Discussion about finite element packages.	8
Total Classes		**36**

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.

MECH 3143: TURBO MACHINERY

Contacts: 3L **Credit: 3**

Course Objectives:

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

- Classify different types of turbo machines.
- Understand the basic working principle of different types of turbo machines.
- Identify different losses in turbo machines.
- Select an appropriate class of turbo machine for a particular application.

Module No.	Syllabus	Contact Hrs.
	Introduction: Definition, Classification and Application of turbo machines. Incompressible and compressible flow turbo machines. Radial, Axial and Mixed flow type machines. Basic equation of energy transfer in turbo 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, Main components and their functions. Velocity diagram; Different heads and efficiencies for centrifugal pump. Priming in centrifugal pump. Multi stage of pump, influence of vane exit angle on head capacity & power capacity relationship, slip factor, pump losses and efficiencies; minimum speed of pump to deliver liquid; overall design considerations of pump; similarity relations and specific speed, selection of pump, cavitation and NPSH, horizontal and vertical pump, bore hole pump/ deep well pump / submersible pump.	9
3	**Hydraulic Turbines:** Classification, main components and their functions; degree of reaction, comparison between impulse and reaction turbines; design aspects of Pelton wheel, Francis and Kaplan turbines; model and selection of turbine: models and their testing, similarity considerations, relation between the characteristics data of a turbine and that of its model; governing of water turbine; water conveyance system and surge tank.	9
4	**Compressible flow machines:** Introduction: comparison among fans, blowers & compressors; classification and applications; set up and operating characteristics 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.	9
Total Classes		**36**

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 Massey, Taylor & Francis, 8e.

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), 1st Indian reprint 2011.
3. Incompressible Flow Turbomachines- Rowal, Elsevier (Yes Dee Publishing Pvt. Ltd), 1st Indian reprint 2011.
4. Principle of Turbomachinery- Turton R. K, Springer (Yes Dee Publishing Pvt. Ltd), 1st Indian reprint 2011.
5. Turbomachines- B.U.Pai; WILEY, 1e, 2013.

MECH 3144: NEW PRODUCT DEVELOPMENT

Contacts: 3L **Credit: 3**

Course Objectives:

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

- Understand the opportunities and challenges of new product development.
- Assess market demand, develop broad outline of the product and work out its profitability.
- Prepare detailed product architecture and product costing.
- Set final product specification taking into account its manufacturability, prototype making and validation.

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.	**8**
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.	**8**
4	**Design Process:** Bench marking process steps; Setting product specifications; Design for manufacture, assembly and disassembly; maintenance, quality and usability; Prototype making and validation; Casus of new product failure; Case studies.	**10**
	Total Classes	**36**

Note to the Teachers: Sufficient number of case studies should be cited and discussed during teaching the subject.

Text Books:

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

Reference Books:

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

MECH 3145: TOOL ENGINEERING

Contacts: 3L **Credits: 3**

Course Objectives:

On completion of this course, students will be able to:

- Select different materials for manufacturing various tools.
- Learn design features of various types of tools used in Manufacturing Industry.
- Explain various tool making practices.
- Design Jigs and fixtures for various work holding and machining situations.
- Design 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.	**4**
	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).	**5**
Module 2	**Manufacturing tools:** Drills, Milling Cutters: Profile sharpened Milling Cutters, Form relieved Milling Cutters, Inserted blade Cutters, Gear tooth Milling Cutters, Gear Hobs, Gear shaping Cutters; Press tools.	**9**
Module 3	**Tool Manufacturing:** Blank Preparation, Machining locating datum surfaces, Manufacturing body of cutting tool, Marking of cutting edge, Sharpening and lapping.	**4**
	Punch and Die Manufacture, Tracer and Duplicating Mills for cavity applications, EDM for cavity applications.	**4**
	Production of carbide tools.	**1**
Module 4	**Jigs & Fixtures:** **Drill Jigs:** Introduction, Types of Drill Jigs, Drill Bushings, and Methods of construction.	**3**
	Fixtures: Introduction, Types of fixtures, Milling, Boring, Lathe and Grinding fixtures.	**3**
	Inspection Gauges: Introduction, Fixed gauges, Gauge tolerances, Material selection, Methods of construction.	**3**
	Total	**36**

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.

MECH 3146: INDUSTRIAL ROBOTICS

Contacts: 3L **Credits: 3**

Course objectives:

On completion of this course, students will be able to:

- Learn basic concept of Robotics and its capabilities.
- Define and formulate kinematics of robots.
- Select end effectors, actuators and sensors used in robots.
- Specify a robot for industrial application.
- Write program for a robot.

Module No.	Syllabus	Contact Hrs.
Module 1	Introduction: Brief history of robotics; definition of robot; Main components of robot, Robot geometry: types of joints, workspace, number of degrees of freedom; Common configurations used in arms: rectangular, cylindrical, spherical, jointed; Classification of robot according to coordinate system: Cartesian, cylindrical, polar, articulated or jointed; Classification of robots according to control method: non-servo, servo; Robot specifications. Robot Kinematics: Definition of Robot kinematics, Tool frame and base frame. World – coordinate system, Direct kinematics, Inverse kinematics, Position and orientation of objects, Homogenous transformation, Denavit-Hartenberg (D- H) representation.	**3** **7**
Module 2	Robot End Effector: Definition, gripper, tools; Types of grippers: mechanical grippers, vacuum cups, magnetic grippers, adhesive grippers; Robot Tools: Spot welding gun, pneumatic wrench, welding torch, grinder, spray painting gun. Characteristics: Power to weight ratio, Stiffness, Compliance, Reduction gears; Conventional actuators: Hydraulic actuator, Pneumatic actuator, Electric motor: DC motor, Stepper motor, Servo motor; Special actuators: Magnetostrictive, Shape memory alloy, Elastomeric.	**4** **4**
Module 3	Robot Sensors: Basic categories of sensing devices: analog, digital; Types of sensors: tactile and non-tactile; position, velocity, acceleration, force, pressure, torque, slip, and proximity. Robot Vision System: definition, use, functions, components, classification; Application of robot vision system.	**8**
Module 4	Robot Programming: Different methods of robot programming: teach-pendant programming, key board programming; Programming languages:	**8**

	VAL II, AML/2, ARM BASIC Industrial applications: Welding, Spray painting, Grinding; Machine loading and unloading, Assembly operation; Inspection. Special applications: Underwater prospects and repairs, Mining, Space Exploration, Surgery.	 **1** **1**
	Total	**36**

Text Books:

1. Industrial Robotics: Technology, Programming and Applications, Mikell P. Groover, Mitchell.Weiss, Roger N. Nagel, Nicholas G. Odrey, McGraw-Hill International Edition.
2. Robotics Technology and Flexible Automation, S.R. Deb, Tata McGraw-Hill Publication.
3. Robotics for Engineers, Koren, Yoram, McGraw-Hill Book Company, Singapore.

Reference Books:

1. Robotic Engineering:An Integrated Approach, Klafter, Richard D. Chmielewski, Thomas A. and Negin, Michael (2001), Prentice-Hall of India Pvt. Limited.
2. Introduction to Robotics: Analysis, Systems, Applications, Niku, Saeed B., Prentice Hall of India Private Limited, New Delhi.
3. A Textbook on Industrial Robotics, Hegde, Ganesh S., Laxmi Publications (P) Ltd.

MECH 3111: FLUID MECHANICS & HYDRAULIC MACHINES LAB

Contacts: 3P **Credits: 2**

List of Experiments:

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

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

MECH 3112: DESIGN PRACTICE-I

Contacts: 3P **Credit: 2**

Experiment / Study	Syllabus	Contact Hrs.
1	**Introduction:** A comparative discussion on Computer Aided Design (CAD) software and Computer Aided Drafting (CADr) software, Discussion of different capabilities of a CAD software and different categories of its tools.	3
2	**3D modeling tools:** Discussion about following tools of a 3D modeling software like ***PTC Creo Parametric*** with suitable examples-Extrude, Revolve, Sweep, Blend, Variable section sweep, Sweep-Blend, Helical Sweep, Hole, Pattern, Mirror, Copy, Round, Chamfer, Draft and Shell.	6
3	**Assembly:** Discussion on the methodology about generating an assembly of different machine parts following perfect constraints using software like ***PTC Creo Parametric.***	6
4	**Drafting:** A detailed discussion on the methods of generating detailed drafting from a 3-Dimensional model using software like ***PTC Creo Parametric.***	3
5	**To design and create 3D model of following machine part and assembly and to generate their 2D drafting automatically using software like *PTC Creo Parametric.*** a) Knuckle/Cotter joint b) Bolted bracket/ turn buckle c) Helical compression spring/ Leaf spring	9
6	**To design and create 3D model of following machine part and assembly and to generate their 2D drafting automatically using software like *PTC Creo Parametric.*** c) Screw jack d) Shaft Couplings e) Belt pulley drive	9
	Total	**36**

Recommended Book:

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

Professional Elective-I Lab

MECH 3136: FLUID POWER CONTROL LAB

Contacts: 3P **Credits: 2**

List of Experiments:

1. Study of a Hydraulic Trainer system, making a circuit diagram of the system and labeling all the components with their basic specifications.
2. Study of a Pneumatic Trainer system, making a circuit diagram of the system and labeling all the components with their basic specifications.
3. Controlling the speed of a hydraulic/pneumatic cylinder by operating a Flow Control Valve and measurement of piston velocity.
4. Prepare an AND logic circuit using pneumatic components.
5. Prepare an OR logic circuit using pneumatic components.
6. Operation and study of the function of a pressure reducing valve in a hydraulic circuit.
7. Design, preparation and operation of a hydraulic circuit for sequencing of two hydraulic cylinders using a sequence valve.

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

MECH 3137: REFRIGERATION AND AIRCONDITIONING LAB

Contacts: 3P **Credits: 2**

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 Domestic Refrigerator.
4. Study of a room (window type) Air Conditioner.
5. Experiment in an Air Conditioning Test Unit; Determination of bypass factor and plotting of the cooling – dehumidification process on a psychometric chart.
6. Performance test of thermoelectric refrigeration system.

MECH 3138: ELECTRICAL MACHINES LAB

Contacts: 3P **Credit: 2**

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 a 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.

Sessional

MECH 3121: SEMINAR – I

Contacts: 3 P **Credits: 2**

The students have to deliver a talk individually through power point presentation on technical topics, preferably related to mechanical engineering. The topic will be chosen by the students but subject to the respective teacher's approval. The topic should not be a part of the subjects already taught in the class. Score will be based on presentation and its defense, quality of the slides, and novelty of the topic and class attendance. The students have to submit a report on the seminar talk which will also carry marks.

3rd Year 2nd Semester Syllabus:

HMTS-3201: PRINCIPLES OF MANAGEMENT

Contacts: 2L **Credits: 2**

Module 1:

Management: Definition, nature, purpose and scope of management, Skills and roles of a Manager, functions, principles; Evolution of Management Thought: Taylor Scientific Management, Behavioral Management, Administrative Management, Fayol's Principles of Management, Hawthorne Studies. **(4L)**

Module 2:

a) **Planning:** Types of plans, planning process, Characteristics of planning, Traditional objective setting, Strategic Management, premising and forecasting.
b) **Organizing:** Organizational design and structure, Coordination, differentiation and integration.
c) **Staffing:** Human Resource Management and Selection, Performance appraisal and Career strategy, Managing Change.
d) **Decision-Making:** Process, Simon's model of decision making, creative problem solving, group decision-making.
e) **Coordinating:** Concepts, issues and techniques.
f) **Controlling:** Concept, planning-control relationship, process of control, Types of Control, Control Techniques (**8L)**

Module 3:

Span of management, centralization and de-centralization Delegation, Authority & power - concept & distinction, Line and staff organizations. **(4L)**

Module 4:

Organization Behaviour: Motivation, Leadership, Communication, Teams and Team Work**. (6L)**

Management by Objectives (MBO): Management by exception; Styles of management: (American, Japanese and Indian), McKinsey's 7-S Approach, Self Management. **(2L)**

Suggested Readings:

1. Harold Koontz & Heinz Weihrich, Essentials of Management, TMH.
2. Stoner, Freeman, Gilbert Jr., Management, PHI.
3. Bhatt & Kumar, Principles of Management, OUP.

MECH 3201: I C ENGINES

Contacts: 3L **Credits: 3**

Course objectives:

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

- Calculate the work output and thermal efficiencies of engines working with Otto/Diesel/Dual combustion cycle.
- Understand and quantify the differences in work outputs between theoretical cycles and actual cycles in operation.
- Compare the differences between combustion processes in SI and CI engines and accordingly appreciate the characteristics of fuels.
- Make a quantitative analysis of air-fuel ratio in a simple carburetor.
- Understand ignition system in an SI engine.
- Analyze the requirement of heat transfer with cooling.
- Learn the various performance testing procedures and estimate IHP, BHP, FHP and efficiency parameters.
- Analyze an ideal gas turbine cycle and calculate thermal efficiency and work output.

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.	4
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	2
	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 3 2 2
	Total Classes	**36**

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 - Obert, Edward Frederic.
4. Internal Combustion Engines; Applied thermo sciences- Colling R Farguson, Allan T, Kirkpatrick, Willey Publication, 3e.
5. Internal Combustion Engine Fundamentals -John B Heywood, Mc-Graw Hills.

MECH 3202: MACHINING PRINCIPLE & MACHINE TOOLS

Contacts: 3L **Credits: 3**

Course objectives:

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

- Understand basic principle and purpose of machining.
- Be familiar with tool geometry and to designate a single point cutting tool.
- Analyze mechanism and mechanics of machining.
- Define and assess tool life and understand tool failure mechanisms.
- Select an appropriate cutting tool material for a particular application.
- Understand the use of different power drives, gear layout, gear box etc.
- Understand kinematic structure of different machine tools
- Appreciate principles and applications of CNC machine tools.
- Determine time of machining.

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.	1
	2. Conversion of tool angles from one system to another by graphical methods.	2
	3. Geometry of drills and milling cutters.	1
	Ic. Mechanism of machining: 1. Chip formation mechanism, yielding and brittle fracture, chip reduction coefficient, cutting ratio, shear angle and cutting strain.	1
	2. Built-up edge formation, cause, type and effects, orthogonal cutting and oblique cutting.	1
	3. Machining chips: types and conditions, chip formation in drilling and milling.	1
2	**IIa. Mechanics of machining:** 1. Purposes of determination of cutting forces and basic two approaches, cutting force components in orthogonal cuttings and merchant's circle diagram. 2. Determination of cutting forces, analytical methods, measurement. 3. Dynamometers, construction and working principles of strain gauge type and piezoelectric crystals type turning, drilling dynamometers.	3
	IIb. Cutting temperature:	

	1. Heat generators and cutting zone temperature, sources, courses and effects on job and cutting tools, role of variation of the machining parameters on cutting temperature. 2. Determination of cutting temperature by analytical and experimental methods. 3. Control of cutting temperature and application of cutting fluids (purpose, essential properties, selection and methods of application). **IIc. Cutting tools-failure, life and materials:** 1. Methods of failure of cutting tools mechanisms, 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. Grinding:** 1. Modes and mechanisms of chip formation, selection and application. 2. grinding forces, surface roughness and wheel life.	3 5
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:** Broad classification of machine tools. **IIIc. General constructional features and functions of machine tools :** 1. Major components and their functions in lathes ; shaping , planning and slotting machines ; drilling machines and milling machines, capstan and turret lathes. 2. Machining operations and application of the common machine tools and their way of specification. **IIId. Kinematic structure of machine tools:** 1. Types of kinematic structures and diagrammatic representation. 2. Kinematic structure of centre lathe & shaping machine.	2 1 3 3

4	**IVa. Machinability and machining economics:** 1. Machinability: definition, assessment, improvement and evaluation of optimum cutting velocity and toll life. **IVb. Control of speed and feed of machine tools :** 1. Need of wide ranges of speeds and feeds, 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 and hydraulically driven machine tools. **IVc. Machining time :** 1. Estimation of time required for various operations like turning, drilling , shaping and milling. **IVd. Computer numerical controlled machine tools :** 1. NC and CNC system; purpose, principle, advantages, limitations and application in machine tools.	1 4 1 2
Total Classes		**36**

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.

CSEN 3206: DATA STRUCTURE & RDBMS

Contacts: 3L **Credits: 3**

Module 1: **(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 2: (10L)
Recursion: Design of Recursive algorithm.
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.

Module 3: (10L)
Database Concept
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 relational algebra & SQL: Operators like select, project, rename, Cartesian product, join, union, intersect, minus, DDL, DML.

Module 4: (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 and Recoverability

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

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

Database Concept:
1. Title: Fundamentals of Database Systems

Author: Elmasri Ramez and Navathe Shamkant
Publication: Pearson.

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

Reference Books:
Data Sturucture:
1. Title: Data Structures using C.
Author: Tanenbaum A. S, Langsam Y., Augenstein M.J.
Publication: Pearson.

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

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

2. Title: Principles of Database Systems
Author: Ullman JD.
Publication: Galgottia Publication

Professional Elective – III

MECH 3251: DESIGN OF MECHANICAL SYSTEMS -II

Contacts: 3L **Credit: 3**

Course Objectives:

On completion of this course student will be able to:

- Know different technical terminologies of different gears and their physical interpretation.
- Understand design methodology of different gears like Spur, Helical, Bevel and Worm wheel.
- Learn the process of sliding contact and rolling contact bearing design and selection.
- Design and select Clutch and Brake for a drive system.
- Design thin as well as thick walled pressure vessel design.

Module	Syllabus	Contact Hrs.
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.	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.	4
1C	**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.	2
2A	**Design of Bevel Gear:** Terminologies, formative number of teeth; Lewis equation, dynamic load, endurance strength and wear strength checking.	2
2B	**Design of Worm- worm wheel:** Terminologies and their inter-relation; Preferred combination of various parameters; Efficiency; Materials.	2
2C	**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.	5
3	**Design of Clutch and Brakes:** **Clutches:** Function, types; Friction clutches – torque capacity based on uniform pressure and uniform wear theory for disc and	9

	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.	
4A	**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
4B	**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.	4
	Total Classes	**36**

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.

MECH 3252: MECHATRONICS

Contacts: 3L **Credit: 3**

Course Objectives:

On completion of this course student will be able to:

- Understand the basic Mechatronics system.
- Apply mechanical engineering knowledge to problems in the areas of Mechatronics engineering.
- Integrate Mechanical and Electronic systems.
- Communicate and work effectively on multi-disciplinary design work.

Module	Syllabus	Contact Hrs.
1	**Mechanical:** Introduction, Mechanical Drives: Different mechanisms, Ball screws, Linear motion bearings, Transfer systems. **Pneumatic and Hydraulic Drives:** Elements of pneumatic and hydraulic drives, comparison between them. Design of pneumatic and hydraulic circuits, symbolic representations of such circuits indicating different valves, actuators, etc. **Electrical Drives:** Stepper and Servo motors.	8
2	**Analog:** Review of negative feedback control, Op-amp- Review of inverting and non-inverting amplifier, Adder, Subtractor, Differential amplifier, Comparators, Schmitt trigger, Astable and Monostable multivibrators.	8
3	**Digital:** Review of number systems (+ve and –ve number representation), Digital codex (BCD, GRAY, XS3, and ASCII), Digital GATES (AND, OR, NOT, NAND, NOR, XOR, and XNOR), Concept of Decoder and Encoder, Concept of Multiplexer and Demultiplexer, Flip-flops and Registers, Counters and shift registers, Analog to Digital and Digital to Analog converter.	10
4	**Microcontroller:** Introduction, Instruction set, Programming in Assembly and C language, Ports, Counters, Interrupts, Design of microcontroller based circuits, **PLC:** Introduction to PLC.	10
	Total Classes	**36**

Text Books:

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

Reference Books:

1. Digital principles and applications- Albert Paul Malvino, Donald P. Leach, McGraw Hill.
2. The 8051 Microcontroller based embedded systems- Manish. K. Patel, McGraw Hill.
3. Microcontrollers: principles and applications- Ajit Pal, PHI
4. Mechatronics- HMT Ltd., Tata McGraw Hill Publication 8.

MECH 3253: ADVANCED FLUID MECHANICS

Contacts: 3L **Credits: 3**

Course Objectives:

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

- Understand fundamental physical and analytical principles of ideal fluid flow.
- Apply the fundamental laws to solve problems in fluid mechanics on applications dealing with the flow of compressible fluids in engineering systems.
- Understand standard bench mark problems like Couette flow, annular flow etc.
- Analyze the effect of drag and lift force on submerged bodies.

Module	Syllabus	Contact Hrs.
1	**Ideal Fluid Flow and flow kinematics:** Velocity potential function and stream function, equipotential line, relation between stream function and potential function.	2
	Circulation and vorticity; Vortex flow: forced and free vortex flow, equation of motion for vortex flow.	3
	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
2	**Viscous Laminar Flow of Incompressible Fluid:**	
	Flow between parallel surfaces: Couette flow and plane Poiseuille flow.	3
	Flow between concentric rotating cylinders.	2
	Laminar boundary layer equation through scale analysis- Prandtl boundary layer equation, Blasius flow over flat plate and shooting technique.	4
3	**Compressible Flow:** Compressible Flow: speed of propagation of a small disturbance through a compressible fluid, sonic velocity, Mach number, Mach cone and Mach wave; isentropic flow, stagnation 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:** drag on a sphere and cylinder; development of lift on a circular cylinder(both stationary and rotating). Expression of lift coefficient for rotating cylinder, location of stagnation point for a rotating cylinder in a uniform flow field, Magnus Effect.	8
	Development of lift on an aerofoil.	1
Total Classes		**36**

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.

Professional Elective -IV

MECH 3261: MAINTENANCE ENGINEERING

Contacts: 3L **Credits: 3**

Course Objectives:

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

- Understand the importance of Maintenance Engineering.
- Differentiate between TQM and TPM.
- Learn different methods of lubrication.
- Learn techniques of common repairs.
- Form a general idea about maintenance tasks of various mechanical components.
- Get an idea about activities of a maintenance department.
- Appreciate importance of reliability in engineering.

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Module	Syllabus	Contact Hrs.
1	**Introduction:** Definitions of repair and maintenance; Importance of maintenance. Different maintenance systems- breakdown, preventive, planned; predictive maintenance through condition monitoring; Safety engineering, Maintainability, failure pattern, availability of equipment / systems, design for maintainability. **Total Productive Maintenance (TPM):** definition, objective & methodology; Implementation of TPM; Lean maintenance; Overall equipment effectiveness (OEE)	5 4
2	**Organizational structures for maintenance:** Objective; Maintenance functions and activities; Organizational requirements; Types of maintenance organizations, maintenance planning & scheduling. Manpower planning; Engineering stores. **Economic Aspect of Maintenance:** Life cycle costing; Maintenance cost & its impact; Maintenance budget; Cost control; Maintenance audit- Procedure, tools, planning, reports.	4 5
3	**Function and use of Maintenance Equipment, Instruments & Tools:** Facilities like NDT, painting, coating and cladding, Gas cutting and welding, crack detection, vibration monitor, balancing equipment, compressor, basic machine tools, lubricators and lubricants, chain pulley block, Tools like different types of wrenches, torque wrench, pipe wrench, plier, screw driver, dimension measuring instruments, feeler gauge, scraper, fitting shop tools, spirit level, hand grinder & drill, screw jack, etc. **Lubrication:** Purpose & importance; Type of lubricants, Properties of lubricants; Types of lubrication and their typical applications, lubrication devices, centralized lubrication system; Gasket, packing and seals;	5 4

4	**Repair & Maintenance Procedures:** Repair of cracks, threads, worn shafts, keyways, bush bearing, damaged gear tooth. Assembly and dismantling of antifriction bearing; Maintenance of bearing, clutches, coupling, brakes, Alignment of shafts, belt and chain drives, gear drives, centrifugal pump, pipe and pipe fittings, small induction motors; Steps for installation of a machine.	9
	Total Classes	**36**

Text Books:

1. Maintenance Engineering and Management- Mishra and Pathak, PHI.
2. Maintenance Engineering and Management- Srivastava, S. Chand & Company Ltd., New Delhi.
3. Maintenance Engineering and Management- K. Venkataraman, PHI.

MECH 3262: RENEWABLE ENERGY SYSTEMS

Contacts: 3L **Credits: 3**

Course Objectives:

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

- Describe the fundamentals and characteristics of various renewable energy sources.
- Recognize the effects of present-day energy systems based on fossil fuels over environment and the society.
- Explain the technological basis for harnessing and storing renewable energy sources.
- Describe the main components of different renewable energy systems.
- Compare different renewable energy technologies and choose the most appropriate based on local conditions.
- Understand how to utilize local energy resources (renewable and non-renewable) to achieve the sustainable energy system.

Module	Syllabus	Contact Hrs.
1	**Introduction:** Common forms of non-conventional energy resources and their importance; Energy chain; Energy consumption trend and standard of living.	1
	Classification of energy resources; Advantages and limitations of conventional resources; Environmental aspects; Global and local energy scenario; Sustainable development.	2
	Review of principles of thermodynamics, fluid dynamics and heat transfer.	1
	Energy Conservation: Salient features; principles and aspects; Ideas of Combined Cycle power plants; Cogeneration.	2
	Energy storage: Necessity of energy storage; Energy storage-mechanical, chemical, electromagnetic, thermal, and biological methods.	3
2	**Solar Energy-Basics:** The Sun-Earth geometry and radiation spectrums; Extraterrestrial and terrestrial radiation; Measurement of solar radiation; Empirical equations for estimation of solar radiation.	3
	Solar Thermal Systems: Solar Water Heaters: Flat Plate Collectors-constructional details, heat transfer analysis and testing; Evacuated Tube Collectors	3
	Other Solar Thermal Applications: Solar passive space-heating and cooling systems; Solar R&AC systems; Solar concentrators; Solar distillation.	3

3	**Solar Photovoltaic Generation:** Photon absorption at Silicon p-n junction; Solar Cell-classification and characteristics; Application and Systems.	3
	Wind Energy: Sources and potential; Wind turbines-types and terminologies; Wind Energy Conversion Systems; Wind-Diesel hybrid systems; Environmental aspects; Potential in India.	2
	Hydel Energy: Macro Hydel Power-Characteristics of hydropower plants; Demand profiles and System considerations; Mathematical modeling of hydropower systems.	1
	Theory of Hydraulic Design and Hydraulic Turbines-Selection of turbine types, Francis turbines, Pelton turbines, Kaplan turbines; Efficiency measurements; Regulators and load control, Valves and gates, Auxiliary equipment; Design strategies for hydraulic structures— Head works and intakes, Spillways and outlets, Penstocks and conduits.	2
	Mini Hydel Power-Advantages and disadvantages; Layout of a Micro-Hydro Scheme; Water turbines-classification, characteristics and selection; Generators; Present status and environmental impacts.	1
4	**Biomass & Bio-fuels:** Usable forms and composition of biomass; biomass conversion technologies; urban waste to energy conversion; biomass gasification and liquefaction; biogas production from waste biomass; energy farming.	3
	Miscellaneous Non-conventional Technologies: Tidal Power: Tidal Energy-origin and nature; limitations; Tidal range power; Conversion schemes; Present status and Environmental impacts.	1
	Geothermal Energy: Sources and potential; Hydrothermal resources-vapour dominated system, liquid dominated system; geo-pressured resources; hot dry rock resources; Analysis of hot dry rock and hot aquifer resource; Exploration and development; Environmental aspects.	2
	Wave Energy: Power in waves; Wave energy technology; Present status and environmental impacts.	1
	Ocean Thermal Energy: Origin and characteristics; Ocean Thermal Energy Conversion technology; Present status and Environmental impacts.	2

Text Books:

1. Renewable Energy,-G. Boyle, OUP, 2e
2. Non-Conventional Energy Resources-B.H. Khan, McGraw Hill Education (India) Private Limited.
3. Non-Conventional Energy Sources-G.D. Rai, Khanna Publishers.

Reference Books:

1. Renewable Energy Resources- Tiwari & Ghosal, Narosa Publishers.
2. Renewable Energy Technologies- Ramesh & Kumar, Narosa Publishers.
3. Non-Conventional Energy Systems- K Mittal, Wheeler.
4. Renewable Energy Sources and Emerging Technologies- Kothari & Singhal, Prentice Hall of India.
5. Renewable Energy Resources- Twidell & Wier, CRC Press (Taylor & Francis).

MECH 3263: MATERIALS HANDLING

Contacts: 3L **Credit: 3**

Course Objectives:

Students will be able to:

- Appreciate the importance of materials handling.
- Identify the application of different types of material handling systems and equipment.
- Understand the concept of maximizing productivity through effective materials handling.
- Select & specify suitable materials handling equipment for specific applications.

Module	Syllabus	Contact Hrs.
1	**Introduction :** Definition, importance and scope of materials handling (MH); Objectives of Material Handling; classification of materials; codification of bulk materials; utility of following principles of MH – (i) materials flow, (ii) simplification, (iii) gravity, (iv) space utilization, (v) unit size, (vi) safety, (vii) standardization, (viii) dead-weight, (ix) idle time (x) motion. **Unit load :** Definition; advantages & disadvantages of unitization; unitization by use of platform, container, rack, sheet, bag and self contained unit load; descriptive specification and use of pallets, skids, containers, boxes, crates and cartons; shrink and stretch wrapping. **Classification of MH Equipment :** Types of equipment – (i) industrial trucks & vehicles, (ii) conveyors, (iii) hoisting equipment, (iv) robotic handling system and (v) auxiliary equipment; Independent equipment wise sub classification of each of above type of equipment.	9
2	**Industrial trucks & vehicles:** Constructional features and use of the following equipment – (i) wheeled hand truck, (ii) hand pallet truck, (iii) fork lift truck; Major specifications, capacity rating and attachments of fork lift truck. **Auxiliary Equipment :** Descriptive specification and use of – (i) Slide and trough gates, (ii) belt, screw and vibratory feeders, (iii) Chutes, (iv) positioners like elevating platform, ramps, universal vise; (v) ball table.	8
3	**Conveyors :** Use and characteristics of belt conveyor, constructional features of flat and troughed belt conveyor; Use and constructional features of Flg. types of chain conveyors – apron, car and trolley type; Construction of link-plate chains; Dynamic phenomena in chain drive; Use and constructional features of roller conveyors; Gravity and powered roller conveyor; Pneumatic conveyor-use and advantages; Positive, negative and combination system of pneumatic conveyors; constructional feature, application and conveying capacity of screw conveyor, bucket elevator.	9

4	**Hoisting Equipment:** Advantage of using steel wire rope over chain; constructional features of wire ropes; Rope drum design; Pulley system-simple vs. multiple pulley; Load handling attachments : hooks, grabs, tongs, grab bucket; Arrangement of hook suspension with cross piece and pulleys (sheaves); Use and constructional features of (i) hand operated trolley hoist, (ii) winch; (iii) Jib crane, (iv) overhead traveling crane and (v) wharf crane; Level luffing system of a wharf crane; Utility of truck mounted and crawler crane. **Robotic handling:** Materials handling at workplace; Major components of a robot; Applications of robotic handling; AGV (automated guided vehicle)	10
	Total Classes	**36**

Books Recommended:

1. Introduction to Materials Handling- S. Ray, New Age Int. Pub.
2. Mechanical Handling of Materials- T. K. Ray, Asian Books Pvt. Ltd.
3. Materials Handling: Principles and Practices- T.H. Allegri, CBS Publishers and Distributors.
4. Material Handling System Design- J.A. Apple, John Wiley & Sons.

MECH 3264: CAD/CAM

Contacts: 3L **Credits: 3**

Course Objectives:

On completion of this course, students will be able to:

- Learn about the Computer Aided Design process.
- Customize the design software and digital design process as per industry requirement.
- Create new tools in the Computer Aided Design process.
- Generate CNC machine program using software.

Module No.	Syllabus	Contact Hrs.
Module 1	**INTRODUCTION:** Fundamental of Computer Aided Design process, Benefits of Computer Aided Design process, Basics of Computer Graphics, Transformations-Introduction, Formulation, Translation, Rotation, Scaling, and Reflection. Homogenous Representation, Concatenated Transformation, Mapping of Geometric Models, Inverse Transformations.	8
Module 2	**MODELLING:** Curves: - Introduction, Analytic Curves - Line, Circle, Ellipse, Parabola, Hyperbola. Synthetic Curves - Bezier Curve, B-Spline Curve and NURBS. Numericals on Line, Circle, Ellipse. Surfaces:- Introduction, Surface Representation, Analytic Surfaces, Synthetic Surfaces, Bezier surfaces, B-spline Surfaces, Coons Surface [no analytical treatment]. Solids:- Introduction, Geometry and Topology, Solid Representation, Boundary Representation, Euler's equation, Constructive Solid Geometry, Boolean operation for CSG, Hybrid Modeling, Feature Based Modeling, Parametric Modeling, Constraint Based Modeling, Mass, area, volume calculation.	10
Module 3	**FINITE ELEMENT ANALYSIS:** Introduction, Stress and Equilibrium, Boundary Condition, Strain – Displacement Relations, Stress- Strain Relation, Potential Energy and Equilibrium: - Rayleigh-Ritz Method, Galerkin‘s Method. One Dimensional Problem: Finite Element Modelling, Coordinate and Shape function, Potential Energy Approach, Galerkin Approach, Assembly of Stiffness Matrix and Load Vector, Finite Element Equations, Quadratic Shape Function, Temperature Effects . Trusses: Introduction, 2D Trusses, Assembly of Stiffness Matrix.	10

Module 4	**<u>COMPUTER AIDED MANUFACTURING</u>:** Introduction to computer aided manufacturing (CAM) systems, Basic building blocks of computer integrated manufacturing (CIM). CNC programming using CAM Software.	8
	Total	**36**

Text Books:

1. CAD/CAM - Theory and Practice, Ibrahim Zeid and R. Sivasubramanian, Tata McGraw Hill Publishing Co.
2. Introduction to Finite Elements in Engineering, Chandrupatla T.R. and Belegunda A.D, Prentice Hall India.

Reference Books:

1. Fundamentals of Finite Element Analysis, David V. Hutton, Mcgraw-Hill.
2. Introduction to CAD/CAM, P N Rao, Tata McGraw Hill Publishing Co.
3. Automation, Production Systems and Computer Integrated Manufacturing, Groover M. P., Prentice Hall of India

MECH 3265: OPERATIONS MANAGEMENT

Contacts: 3L **Credits: 3**

Course objectives:

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

- Appreciate importance of production and operations management.
- Learn various forecasting methods.
- Apply inventory control strategies and plan materials requirement in an industry.
- Implement concepts of machine scheduling and project scheduling.
- Develop an idea of quantity assurance practices.

Module No.	Syllabus	Contact Hrs.
Module 1	**Introduction**: System concept of production; Product life cycle; Types and characteristics of production system; Productivity, Line balancing. **Forecasting**: Patterns of a time series-trend, Forecasting techniques: moving average, simple exponential smoothing, linear regression; Forecasting a time series with trend and seasonal component, Qualitative methods, Forecasting errors.	3 6
Module 2	**Materials Management and Inventory Control :** Components of materials management; Inventory control : EOQ model, Economic lot size model, Inventory model with planned shortages, Variable demand and variable lead time, ABC analysis; Just-in-time inventory management. **Materials Requirement Planning:** MRP concept – bill of materials (BOM), master production schedule; MRP calculations. Concept of aggregate planning.	6 4
Module 3	**Machine Scheduling:** Concept of Single machine scheduling – shortest processing time (SPT), Minimize mean flow time, Earliest due date (EDD), Minimize maximum lateness, Total tardiness Minimizing model; Johnson's rule for 2 and 3 Machines scheduling. **Project Scheduling:** Activity analysis; Network construction; critical path method (CPM), PERT; Crashing of Project network, Resource planning.	4 5
Module 4	**Quality Assurance:** Meaning of Quality; Quality assurance system; choice of process and quality; Inspection and control of quality; Maintenance function & quality; Process control charts : X-chart and R-Chart, p-chart and c-chart; Acceptance sampling : Operating characteristic (O.C) curve, Single sampling plan, Double sampling plan, Acceptance sampling by variables; concept of Six Sigma.	8
	Total	**36**

Text Books:

1. Modern Production/Operations Management, Buffa and Sarin, John Wiley & Sons.
2. Production and Operations Management, R. Panneerselvam, PHI.
3. Operations Management, Russell & Taylor, PHI.

Reference Books:

1. Production and Operations Management, Adam and Ebert, PHI.
2. Production & Operations Management, Starr, Cenage Learning India

MECH 3211: DYNAMICS OF MACHINES LAB

Contacts: 3P **Credits: 2**

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.

MECH 3212: APPLIED THERMODYNAMICS & HEAT TRANSFER LAB

Contacts: 3P **Credits: 2**

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.

CSEN 3216: RDBMS LABORATORY

Contacts: 3P **Credits: 2**

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

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

Professional Elective –III Lab

MECH 3256: DESIGN PRACTICE-II LAB

Contacts: 3P **Credit: 2**

Experiment/ Study	Topics	Contact Hrs.
1	**Introduction:** A over view about 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).	6
2	A Detailed discussion on methodology of solving a structural problem using FEA software MSC Patran and Nastran or equivalent software.	6
3	A Detailed discussion on methodology of solving a thermal problem using FEA software MSC Patran and Nastran or equivalent software.	3
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 3.0 ➢ Numerical validation of the design using a FEA software like MSC Nastran or equivalent software.	9
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 3.0 or equivalent software. ➢ Numerical validation of the design using a FEA software like MSC Nastran or equivalent software.	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 3.0	3

	or equivalent software. ➢ Numerical validation of the design using FEA software like MSC Nastran or equivalent software.	
7	Determination of critical speed of a shaft using dynamic module of any FEA soft ware like MSC Nastran or equivalent software.	3
	Total	**36**

Recommended Books:

1. Mechanical Component Design- Robert C Juvinall and Kurt M Marshek. Published by Wiley Publication, 5th Edition 2012.
2. Mechanical Design of Machine Elements and- Jack A Collins, Henry Busby and George Staab. Published by 'Wiley Publication', 2nd Edition, 2010.
3. ISO Codes: All parts of ISO 6336.
4. AGMA Codes: AGMA 901/908/913/917/918/923/933, ANSI/AGMA- 2004 and ANSI/AGMA-2012.
5. ASME Codes: BPVC Section I- Rules for Construction of Power Boilers and BPVC Section IV-Rules for Construction of Heating Boilers.

MECH 3257: MECHATRONICS LABORATORY

Contacts: 3P **Credit: 2**

Experiment No.	Experiment
1	**Op-Amp:** Application of operational amplifier to i. add two signals. ii. operate a relay. iii. generate a square wave/pulse. (HARDWARE)
2	**Logic Gate:** i. To verify the input/output of digital logic gates. ii. To operate a relay using digital logic gates.
3	Verification of Encoder/Decoder/MUX/DMUX. (HARDWARE/SOFTWARE)
4	**Flip-flops:** i. To verify the input/output of different Flip-flops (R-S, D, J-K). ii. To verify the sequence of Binary/ Decade counter. (HARDWARE/SOFTWARE)
5	**ADC and DAC convertion:** i. To operate a Digital to Analog converter (DAC) (HARDWARE) ii. To operate a Analog to Digital converter (ADC) (HARDWARE)
6	**Microcontroller:** i. To run assembly level programming in AT 89S52 microcontroller and use its ports. (HARDWARE) ii. To interface DAC and ADC to the ports of AT 89S52 for generating analog signals and taking digital signal from analog input. (HARDWARE)
7	**Stepper/ DC motor interfacing and control:** i. To interface a stepper motor and its motion control. ii. To interface a DC motor and its motion control.
8	**A compulsory project work:** to be assigned using microcontrollers, Sensors, Hydraulic/ Pneumatic drives and actuators, Motors, Link and Mechanisms, etc.

MECH 3258: ADVANCED FLUID MECHANICS LAB

Contacts: 3P **Credits: 2**

List of Experiments:

1. Study of Characteristics of Hydraulic Jump.
2. Study of Minor Losses in pipes fitting apparatus.
3. Verification of Stokes Law.
4. Determination of Cavitation parameters of a Centrifugal Pump.
5. Performance test of centrifugal pumps in Series & in Parallel.
6. Performance Test of Submersible Pump.

Sessional

MECH 3221: SEMINAR – II

Contacts: 3 P **Credits: 2**

This seminar presentation will be prepared and presented by a group consisting 4/5 students, based on a topic to be assigned by the Department. The seminar presentation will be evaluated by a group of senior faculty members, based on depth of understanding of the topic, quality of presentation, its defense and report; to be submitted after presentation.

HMTS 3221: PERSONALITY DEVELOPMENT

Contacts: 1L **Credits: 1**

Module 1
Self-Growth
i)Self Growth- Maslow's Hierarchy of Needs Theory

ii) Anger, Stress & Time Management- Theories and application

iii) SWOT Analysis

Module 2
Stepping Up
i)Growth & Environment

ii)Competitive Spirit
iii)Responsibility Factor

Module 3
Professional Communication
i) Impression Management- theory on social psychology
ii)Employability Quotient
iii)Cross-cultural communication

Module 4
Leadership & Team Playing
i)Leadership & Team Playing: Theories, Styles, Stages
ii) Motivation, Negotiation Skills, Conflict Management
iii)Planning & Envisioning: Initiative and Innovation in the Work Environment- De Bono's Six Thinking Hats

Evaluation:
Marks-100 (sessional)
25 marks/ module
Methodology: Assignment and project

Suggested Reading

1. Personality Development and Soft Skills by Barun K. Mitra, Oxford University, 2011

2. Soft Skills: An Integrated Approach to Maximise Personality by Gajendra Singh Chauhan and Sangeeta Sharma, Wiley, 2016

3. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success by Gopalaswamy Ramesh and Mahadevan Ramesh, Pearson, 2010

4th Year 1st Semester

MECH 4101: POWER PLANT ENGINEERING

Contacts: 3L **Credits: 3**

Course objectives:

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

- Identify and learn the basic components of a simple thermal power plant and their working.
- Evaluate the performance of boilers.
- Analyze the working of a steam turbine and calculate the efficiency.
- Learn various condensing methods and make simple calculations on cooling towers.
- Assess the economic viability of a thermal power plant.

Module No.	Syllabus	Contact Hrs.
Module 1	Review of fundamentals; Power plant cycles - Rankine, Reheat, regenerative cycles; Binary vapour and co-generation; Introduction to Boilers: Fire tube and water tube boilers, mountings and accessories, Super-critical boilers.	1 3 3 2
Module 2	Draft in boilers- natural, induced, forced and balanced; Chimney height, power requirement of fans. Performance of boilers - equivalent evaporation, boiler efficiency, losses in boilers and heat balance. Coal combustion- properties of coal, ultimate analysis, proximate analysis, combustion calculations, Coal and ash handling system.	3 3 3
Module 3	Steam turbines- parts and classification, nozzle types, flow through nozzles, condition for maximum flow rate, nozzle efficiency. Impulse turbine- velocity diagram, work done and blade efficiency. Condition for maximum blading efficiency. Pressure compounding or Rateau Turbine and velocity compounding or Curtis Turbine of steam turbine. Impulse, reaction turbine- velocity diagram, degree of reaction. Parsons turbine: condition for maximum blading efficiency. Governing in steam turbines.	3 6
Module 4	Condensing systems- basic ideas. Classification of steam condensers. Leakage in condensers, condensing efficiency, Cooling Tower –Dry cooling tower and Wet cooling tower; Cooling tower calculations. Power plant economics: load curve and various factors, cost of power generation. Introduction to nuclear and hydel power plants.	4 3 2
	Total	**36**

Text Books:

1. Power Plant Engineering - 4e, Nag, P. K. – TMH.
2. Thermal Engineering- 8e, R. K. Rajput, Laxmi Publication (P) Ltd

Reference Books:

1. Thermal Engineering- 24e, B. L. Ballaney, Khanna Publishers
2. Power Plant Engineering -8e, Domkundwar- Arora- Domkundwar, Dhanpat Rai & Co.
3. Powerplant Technology, M. M. El-Wakil, Tata McGraw-Hill Education
4. Power Station Engineering and Economy, William A. Vopat, Tata McGraw-Hill Education

MECH 4102: ADVANCED MANUFACTURING TECHNOLOGY

Contacts: (3L+1T) **Credits: 4**

Course objectives:

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

- Form basic ideas on advanced Manufacturing Processes.
- Acquire working knowledge on Computer Integration with Mechanical systems.
- Learn about Computer Aided Design, Manufacturing, process planning, and quality Control.
- Practice Reverse Engineering & Rapid Prototyping Techniques.
- Learn various Non-traditional Machining process and their application.

Module No.	Syllabus	Contact Hrs.
Module 1	**MODULE: 1A** Introduction to CAD/CAM/CAE, Solid modeling concepts, Computers in design, computers in Manufacturing, CNC/DNC, Cellular Manufacturing, Flexible Manufacturing System (FMS), Intelligent Manufacturing System. **MODULE: 1B** Computer Integrated Manufacturing (CIM), Computer Networking, Robots in Manufacturing, Palletized Material Handling, Automated Guided Vehicle (AGV), Automated Storage & Retrieval System (AS/RS).	6 6
Module 2	**MODULE: 2A** Group Technology Concept (GT), Classification & Coding system, Computer Aided Process Planning (CAPP), Computer Aided Quality Control (CAQC), Co-ordinate Measuring Machine (CMM) **MODULE: 2B** Modern Cutting Tools, High Speed Machining Reverse Engineering, Rapid Prototyping & Tooling	6 2 4
Module 3	Introduction to Non-Traditional Machining (NTM) Processes: USM, AJM, WJM, ECM, EDM, PAM, LBM, EBM	14
Module 4	**MODULE: 4A** Comparison between different NTM processes for MRR, Surface finish & Accuracy; Electro-Thermal Energy Processes- PAM, LBM, EBM, IBM; **MODULE: 4B** High Energy Rate Process - Explosive forming, Electro-Magnetic Forming, Electro-Hydraulic Forming.	4 6
	Total	**48**

Text Books:

1. CAD/CAM, P. N. Rao, TMH
2. CAD/CAM, M.P.Groover and E.W.Zimmers, Prentice Hall of India.
3. Manufacturing Technology, Kalpakjian, Pearsons Publications.
4. Non-conventional Machining, P.K.Mishra, Narosa Publishers

Reference Books:

1. Manufacturing Engineering & Technology, K. Jain, Pearson Education
2. Manufacturing Technology, Radhakrishnan, Scitech
3. Manufacturing Science, Ghosh & Mallik, Affiliated East-West Press Pvt. Ltd.

MECH 4103: OPERATIONS RESEARCH

Contacts: 3L **Credits: 3**

Course Objectives:

On completion of this course, students will be able to:

- Learn the meaning and appreciate importance of Operations Research.
- Identify and use different OR optimization models.
- Formulate mathematical models from the description of the problem.
- Solve waiting line & Non-linear programming problems.

Module No.	Syllabus	Contact Hrs.
Module 1	**Introduction**: Brief history of OR; Introduction to different OR problems: Decision Theory, Linear Programming, Transportation and Assignment problems, Network Analysis (CPM/ PERT), Integer Programming, Non-linear Programming, Queuing or Waiting line problems.	**2**
	Decision Theory: Decision making under certainty, risk and uncertainty, Multi-criteria decision making (MCDM) problems.	**4**
	Network Analysis: Network models and terminologies, shortest path/route problem; The minimum spanning tree problem; The maximal flow problem.	**3**
Module 2	**Transportation Problems:** Tabular representation of a transportation problem; North-West corner initial solution; stepping stone method; concept of dummy source or destination; Vogel's approximation method.	**3**
	Assignment Problems: Hungarian method for solving Assignment problems.	**2**
	Linear Programming Problem (LPP): Nature of LPP through examples; General form of LP model; Formulation of LPP; Graphical solutions; Simplex method, Duality in LPP, Sensitivity analysis.	**6**
Module 3	**Waiting Line Problems:** Structure of a waiting line system; single-channel waiting line; process of arrivals; distribution of service times, queue discipline, steady stage operation; single channel model with Poisson arrivals and exponential service time; Multiple channel model with Poisson arrivals and arbitrary service. time (M/G/I); Economic analysis of waiting lines	**7**
Module 4	**Non-Linear Programming:** Graphical illustration of a non-linear programming; Unconstrained optimization by (i) direct search method (ii) steepest decent method, constrained optimization by Lagrange multipliers; Integer linear programming by branch & bound techniques; Dynamic programming problems and their characteristics, Bellman's principle of optimality; solving (i) Stagecoach problem (ii) Knapsack problem.	**9**
	Total	**36**

Text Books:

1. Quantitative Techniques in Management, N. D. Vohra, Mc-Graw Hill.
2. Operations Research, V.K.Kapoor, Sultan Chand & Sons.
3. Operations Research, Hira and Gupta, S Chand & Co.

Recommended Books:

1. Operations Research: An Introduction, H. A. Taha, PHI Pub.
2. Principles of Operation Research, Wagner, PHI Pub.

MECH 4141: ADVANCED WELDING TECHNOLOGY

Contacts: 3L **Credits: 3**

Course objectives:

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

- Apply the fundamentals of welding processes.
- Apply the principles of metallurgy during the welding process.
- Perform metal layout processes.
- Follow industry safety practices.
- Weld work materials using basic welding processes.

Module No.	Syllabus	Contact Hrs.
Module 1	**Introduction**: Review of various welding processes.	**3**
	Process Descriptions and Parametric influences: On fusion welding, arc welding-SMAW, GMAW, GTAW, FCAW, Submerged Arc Welding, solid state welding, pressure welding, friction welding, diffusion welding, resistance welding processes.	**6**
Module 2	**Arc Welding:** Different types of equipment, power sources, arc characteristics, electrode selection.	**3**
	Critical and Precision Welding Processes: PAW, LBW, EBW, USW, Friction Stir Welding, Under Water Welding. Welding of Plastics, Ceramics and Composites.	**6**
Module 3	**Welding Metallurgy:** Heat Affected Zone (HAZ), Effects of different process parameters on the characteristics of weldment, Post welding heat treatment.	**5**
	Welding fixtures, welding automation and robot welding.	**2**
	Weldability of plain carbon steels, stainless steel, cast iron, aluminum and its alloys.	**2**
Module 4	**Welding Defects:** Types, causes, inspection and remedial measures;	**4**
	Testing of welded joints by visual inspection, Dye Penetration (DP) test, ultrasonic and radiography.	**3**
	Safe Practices in Welding.	**2**
	Total	**36**

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

MECH 4142: COMPUTATIONAL METHODS IN ENGINEERING

Contacts: 3L **Credits: 3**

Course objectives:

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

- Identify suitable engineering problems and convert them into mathematical framework.
- Learn methods of approximations and ascertain validity of the results.
- Apply interpolation methods to evaluate function values.
- Apply different numerical methods to obtain solutions for simple physical systems.

Module No.	Syllabus	Contact Hrs.
Module 1	Simple Mathematical model of engineering problem, Conservation Laws in Engineering. Approximations– Significant figures, Accuracy, Precision & Error; definition and formulations. Round-off and truncation errors, error propagation. Formulation and solution of linear algebraic equations, Gauss elimination, LU decomposition.	2 4 3
Module 2	Solution of linear algebraic equations through iteration methods, convergence. Linear and polynomial regression, multiple linear regression, general linear least squares. Interpolation methods: Newton's divided difference interpolation of polynomials, Lagrange interpolation of polynomials.	2 4 3
Module 3	Numerical Integration: The Trapezoidal rule, Simpson's rule, Gauss quadrature. Initial and boundary value problems, Eigen value problems- applied to a physical system.	5 4
Module 4	Finite difference method and application in mechanical engineering. Simple one dimensional steady state problems and solution techniques. Nodal network in two dimensions, Finite difference form, Solution procedure for finite difference equations.	3 6
	Total	**36**

Text Books:

1. Numerical Methods for engineers, Steven C Chapra & Raymond P. Canale, McGraw- Hill
2. Numerical Analysis, P Sivaramakrishna Das and C Vijaykumari, Pearson Education
3. Computational Methods in Engineering, S.P. Venkateshan and Prasanna Swaminathan, Academic Press

Reference Books:

1. Numerical Methods for Engineers, S K Gupta, New Age International
2. Principles of Heat and Mass Transfer, F P Incropera & D P Dewitt, Wiley

MECH 4143: QUANTITY PRODUCTION METHOD

Contacts: 3L **Credits: 3**

Course objectives:

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

- Acquire knowledge of various mass manufacturing processes.
- Apply mass manufacturing knowledge for manufacturing common engineering items.
- Improve productivity and quality through application of planning, group technology and quality control.
- Learn various non-conventional and emerging production techniques.

Module No.	Syllabus	Contact Hrs.
Module 1	Genesis of production of goods; Engineering Production: Definition, aims and objectives. Levels of production; job, batch, lot, mass and quantity production. Mechanization and need, degree and types of automation. Role of automation in industrial production. Broad classification of engineering production methods. Major sequential steps in industrial production: pre-forming, semi-finishing, heat treatment, finishing, assembly and inspection. Quantity production by spinning, bulging, magneto forming, hydro forming, explosive forming.	**8**
Module 2	Quantity production of common items: Shafts and spindles. Gears and bearings. Bolts and nuts. Automobile parts: Engine block, crank shaft, etc. Quantity produced small engineering products like washers, pins, etc.	**10**
Module 3	Process planning & scheduling for quantity production with semi-automatic and automatic lathes, Transfer machines. CNC machining systems (including machining centre, FMS). Design and use of jigs and fixtures for batch production in machine shops. Group Technology: concept and application in large scale production. Inspection and quality control in quantity production	**10**
Module 4	Application of Computer and Robot in quantity production. Production of tool inserts by powder metallurgical process. Quantity production of ceramic and polymer products.	**8**
	Total	**36**

Text Books:

1. Manufacturing Processes for Engineering Materials, Serope Kalpakjian and Steven R. Schmidt- Pearson.
2. Process and Materials for Manufacture, R. A. Lindberg, Prentice Hall.

Reference Books:

1. Fundamentals of modern manufacturing, M. P. Groover, Wiley.

MECH 4144: COMPUTATIONAL FLUID DYNAMICS

Contacts: 3L **Credits: 3**

Course Objectives:

On completion of this course, students will be able to:

- Identify fluid flow problems and apply fundamental conservation laws.
- Discretize governing differential equations.
- Solve convection and diffusion problems.
- Learn about pressure-velocity coupling, algorithms, boundary conditions & solutions.
- Learn CFD software terminologies.

Module No.	Syllabus	Contact Hrs.
Module 1	Introduction, Control Volume, Eulerian & Lagrangian frame.	**1**
	Substantial, Temporal and Convective derivatives, Examples.	**1**
	Equations of state, Conservation laws for fluid motion (mass, momentum and energy conservation equations).	**4**
	Navier-Stokes equations for Newtonian fluid.	**1**
	General transport equations (Differential & Integral forms).	**2**
Module 2	Time averaged Navier-Stokes equations for Turbulent flow, Turbulence models (brief idea).	**2**
	Different differencing schemes (Upwind, Central, Power law).	**2**
	Finite volume method for steady state:- (a) Diffusion (b) Convection-Diffusion problems.	**5**
Module 3	Pressure-Velocity coupling for steady flow- Staggered grid and Momentum equation,	**4**
	SIMPLE Algorithm	**2**
	SIMPLER Algorithm	**2**
	Explicit and Implicit methods.	**2**
Module 4	Solution of discretized equations: TDMA, Boundary conditions; problem solving.	**5**
	CFD Software, Pre-processor (Grid Generation, Grid topology), Processor, and Post-processor.	**3**
	Total	**36**

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

MECH 4145: SUPPLY CHAIN MANAGEMENT & LOGISTICS

Contacts: 3L **Credits: 3**

Course Objectives:

On completion of this course, students will be able to:

- Learn end-to-end business activities carried out in any business.
- Implement the concept of traditional transport management, distribution management, sales management, and logistics management.
- Gain knowledge about Customization of production systems.
- Forecast demand and plan for material requirement.
- Apply inventory control & purchase management systems.

Module No.	Syllabus	Contact Hrs.
Module 1	**Introduction**: Changing Business Environment & present need of Supply Chain Management (SCM), Conceptual Model of SCM, Traditional vs. Modern SCM approach, elements of SCM.	**2**
	Demand Management in Supply Chain: Demand planning and forecasting, Forecasting methods & characteristics, Measures of Forecast errors, Need for SCM in the Market Today, Supply chain strategy.	**3**
	Operations Management in Supply chain: Principles of Manufacturing Management, Role of Production in Business, QRM (Quick Response Manufacturing), Key concepts in Lean Manufacturing.	**4**
Module 2	**Mass customization**: Drivers of mass customization- Technology & Globalization, Characterizers of Mass customization, SCM & Mass customization, Implications & benefits.	**2**
	Outsourcing: Core Competencies, Strategic Approach to Outsourcing, Theory of constraints, Control measures, Licensing.	**1**
	Service Operations Management: 4 M's Management : Man, Method, Material, Machine, Managing supply and Demand	**1**
	Procurement Management in Supply Chain: Purchasing cycles, Types of purchases, Traditional Inventory Management, Inventory models, EOQ (Economic Order Quantity) system, EPQ (Economic Production Quantity), Fixed order Interval/ Quantity system, Buffer stock.	**3**
	Material Requirements Planning (MRP): Introduction, Just-In-Time (JIT), Elements & Benefits of JIT, Vendor Managed Inventory (VMI), Steps in setting up VMI, Benefits of VMI.	**2**
Module 3	**Logistics Management:** Elements of Logistics Management, Customer order processing, Material Handling, Packaging/ Transportation/ Warehousing & customer service.	**3**

	Distribution Management: Distribution Strategies, Transportation Management, Warehousing (Logistics) Automation, WMS (Warehouse Management Systems), Packaging for Logistics, Third Party & Fourth Party Logistics, Packaging and Forwarding.	**6**
Module 4	**Information Technology for Supply Chain Management:** Concepts / Need for IT, IT tools for Business, IT Application in SCM, Benefits of Integrated SCM Tools, Advanced Planning & Scheduling (APS), Data Mining. **Performance Measurement and Controls in SCM:** Bench Marking: Introduction and concept, Forms of Bench Marking, Gap Analysis, Achieving Maximum Value, Benefits of Benchmarking, Key Actions in Benchmarking for Best Practices, concept of configurability, Balanced Scorecard for Organizational Performance.	**5** **4**
	Total	**36**

Text Books:

1. Text Book of Logistics and Supply Chain Management, D.K.Agarwal, Lakshmi Publications Pvt. Ltd.
2. Distribution and Logistics Management, D.K.Agarwal, Lakshmi Publications Pvt. Ltd.

Reference Books:

1. Logistics Management, S K Bhattacharya, S. Chand Pub.
2. Supply Chain Management (Concepts and Cases), Rahul V. Altekar, PHI Learning Pvt. Ltd.
3. Logistics & Supply Chain Management – Strategies for reducing cost & improving services, Martin Christopher, PITMAN Publishing, 2000.
4. Supply Chain Risk Management – Vulnerability & Resilience in Logicstics, Donald Waters, Kogan Page, 2008.

Free Elective I

AEIE 4181: INSTRUMENTATION AND TELEMETRY

Contacts: 3L **Credits: 3**

Course objectives:

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

- Gain knowledge in the area of pressure, flow, level and temperature transducers.
- Justify the selection criteria for measurement techniques adopted in industrial environment.
- Gain knowledge about different telemetry systems.

Module No.	Syllabus	Contact Hrs.
Module 1	Measurement of pressure and vacuum: Introduction, diaphragm, capsule, bellows, bourdon tube, DP transmitters – capacitive, Mcleod gauge. Flow rate measurement: head type flow meters – orifice, pitot tube, venturimeter; variable area flow meters –rotameters; electromagnetic flow meters; ultrasonic flow meters.	9
Module 2	Level measurement: float and displacers type instruments, resistive and capacitive type level instrument; D/P type sensors; ultrasonic level instruments. Temperature measurement: RTD – working principle, different wired configuration, characteristics, typical industrial application; thermocouples – working principle, cold junction compensation, different types of thermocouples and their application in industry and laboratory, thermopiles, thermowells, thermistor, pyrometers.	9
Module 3	Basic classification of telemetry systems: voltage, current, position, frequency and time components of telemetering and remote control systems, quantization theory, sampling theorem, sample and hold, data conversion, coding, and conversion.	**11**
Module 4	Multiplexing; time division multiplexers and demultiplexer theory, scanning procedures, frequency division multiplexers with constant and proportional bandwidth, demultiplexers. Fundamentals of radio-telemetry system, RF link system design. Pipeline telemetry; Power system telemetry.	9
	Total	**38**

References:

1. B. G. Liptak, *Instrument Engineers Handbook, vol-I and vol-II*; Chilton Book Co. Philadelphia.
2. D. Patranabis, *Principles of industrial Instrumentation*; TMH, New Delhi, 2nd Ed.
3. Eckman, *Industrial Instrumentation*; Wiley Eastern Ltd.
4. D. Patranabis, *Telemetry Principles*, Tata McGraw-Hill Education Pvt. Ltd.
5. Telemetry and Data Transmission", R. N Baral, *S. K. Kataria & Sons.*

CHEN 4182: PROJECT MANAGEMENT

Contacts: 3L **Credits: 3**

Module No.	Syllabus	Contact Hrs.
Module 1	Project Management Fundamentals: Definition of a Project, Project Management, Scope Management, Program Management, Portfolio Management, Stakeholder Management: Identify Stakeholders, Plan Stakeholder Management; Manage Stakeholder Engagement, Control Stakeholder Engagement, Organization Structure; Project Lifecycle vs. Product Lifecycle; Feasibility Analysis; Project Evaluation Techniques; Summary Illustrative Review Problems / Incidents.	9
Module 2	Project Network Techniques: PERT/CPM; Project Planning & Scheduling; Project Work Breakdown Structure & networking; Project Network Techniques PERT / CPM, Time & Cost based calculations using PERT, Scheduling Projects, Resourcing Projects, Budgeting Projects, Project Risk Planning, Project Quality Planning and Project Kickoff, Summary Illustrative Review Problems / Incidents.	9
Module 3	Planning Projects: Stakeholder Analysis and Communication; Planning & Defining Scope, Capital Estimates, Investment Analysis and Justification; Project scheduling with unlimited Resources, Project scheduling with limited Resources, Risk Management: Planning Risk Management, Risk Identification, Qualitative & Quantitative Risk Analysis, Planning Risk Responses; Risks Control; Summary Illustrative Review Problems / Incidents.	**9**
Module 4	Project Resource Allocation: Project Human Resource, Procurement & Materials Management; Project Organization Structure, Leadership Style, Effective Project Teams, Managing Conflicts; Project Total Quality Management, Project Contract Management, Project Procurement & Materials Management, Computer Based Project Management, Project Management using MS Project & Prinavera, Software Project Management, Project Monitoring & Control, Project Case Study Project Integration Management; Summary Illustrative Review Problems/ Incidents.	9
	Total	**36**

Text Books:

1. M. Peter, K. Timmerhaus, R. West, Plant Design and economics for Chemical Engineers, McGraw-Hill Science/Engineering/Math, 5th Edition,2002.
2. K. Nagarajan, Project Management, 2nd edition, New Age International publisher, 2004.
3. Eugene Grant and Richard Leavenworth, Statistical Quality Control, 6th Edition, McGraw-Hill 1996.

Reference Books:

1. R. K. Sinnott, Coulson and Richardson's Chemical Engineering, Volume 6, Second Edition: Chemical Engineering Design (Chemical Engineering Technical Series), 2nd Edition, Pergamon,1993.
2. P.C.Jain, Handbook for new entrepreneur, Oxford University Press, 2012.
3. V.G. Patel, The Seven-Business Crisis. How to beat them? Tata McGraw-Hill Co. Ltd, 1995.
4. Daniel Goleman, Working with emotional intelligence; Butam Books, 2000.
5. John Happel, Donald G. Jordan, Chemical process economics, 2nd Edition, Marcel Dekker, Inc., New York, 1976.
6. Ernest E. Ludwig, Applied project management for the process industries, Gulf Pub. Co. 1974.
7. Jack R. Meredith, Samuel J. Mantel, Jr., Scott M. Shafer, "Project Management: A Managerial Approach", 9th Edition International, Student Version, February 2015.
8. Russell Darnall and John M. Preston, Project Management: from Simple to Complex, ©2016 Flat World Education, Inc. v. 1.0,Version: 1.0, Pub Date: May 2010, eISBN: 978-1-4533-2704-3.

CIVL 4181: BUILDING MATERIALS

Contacts: 3L **Credits: 3**

Course objectives:

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

- Learn and use common terms used in building industry.
- Able to understand and utilize basic principles used in building industry.
- Will be aware of the application of these materials.
- Can display safe and professional work practice.

Module No.	Syllabus	Contact Hrs.
Module 1	**Building Materials - I** Bricks: Introduction, Classification, Characteristics of good bricks, Ingredients of good brick earth, Harmful substance in brick earth, Different forms of bricks, Testing of bricks, Defects of bricks, Fly ash brick. Cement: Introduction, Chemical Composition of Cement, Hydration of Cement. Tests on Cement and Cement Paste – specific gravity, fineness, consistency, setting time, soundness, strength. Manufacturing of cement. Types of Portland Cement – Ordinary, Rapid hardening, Low-heat, Sulphate resisting, Portland slag, Portland pozzolana, Super sulphated cement, White cement. Aggregates: Introduction, Classification, Mechanical and Physical Properties, Deleterious Substances, Alkali-Aggregate Reaction. Testing of Aggregates – Particle size distribution, Flakiness, Elongation Tests, Aggregate Crushing Value, Ten Percent Fines Value, Impact Value, Abrasion Value	2 5 5
Module 2	**Building Materials -II** Ferrous Metals: Introduction, Pig Iron- composition, properties, uses. Cast Iron- Properties, Manufacturing, uses. Wrought iron- properties, uses. Steel- composition, properties, manufacturing, uses. Rolled steel sections, Wide flanged section, Reinforcing steel bars (TMT bars). Corrosion of steel, Tensile testing of steel, Alloy steel. Mortars: Introduction, Classification, Uses, Characteristics of good mortar, Ingredients. Paints, Enamels and Varnishes: Composition of oil paint, characteristic of an ideal paint, preparation of paint, covering power of paints, Painting: Plastered surfaces, painting wood surfaces, painting metal Surfaces. Defects, Effect of weather, enamels, distemper, water wash and colour wash, Varnish, French Polish, Wax Polish. Miscellaneous Materials	5 1 1

Module 3	**Building Construction -I** Foundations: Function of Foundations, Essential requirement of good foundation, Different types of shallow and deep Foundations. Brick masonry: Definitions, Rules for bonding, Type of bonds – stretcher bond, Header bond, English bond, Flemish Bond, Comparison of English Bond and Flemish Bond (one and one and half brick thick wall) Wall, Doors and Windows Load bearing wall, Partition wall, Reinforced brick wall Common types of doors and windows of timber and metal.	**4** **4** **2**
Module 4	**Building Construction -II** Stairs: Technical Terms, Requirements of good stair, Dimension of steps, Classification, Geometric design of a dog legged stair case. Flooring: Components of a floor, selection of flooring materials, Brick flooring, Cement concrete flooring, mosaic, marble, Terrazzo flooring, Tiled roofing. Roofs: Types, Pitched roofs and their sketches, Lean – to roof, King Post – Truss, Queen post truss and Simple steel Truss, Roof Covering materials: AC sheets GI sheet.	2 2 2
	Total	**35**

Text Books:

1. Building Materials , Duggal S.K., New Age International.
2. Building Materials, Varghese P.C., PHI Learning Pvt. Ltd-New Delhi.
3. Building Construction, Punmia B.C., Laxmi Publications.

Reference Books:

1. Concrete Technology, M. S. Shetty R., S. Chand.
2. Concrete Technology, Nevile A.M. & Brooks J.J., Pearson Education.
3. Engineering Materials, S.C. Rangwala, Charotar Publishing.

MECH 4111: I C ENGINE LAB

Contacts: 3P **Credits: 2**

Course objectives:

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

- Learn the working principles of 2/4-stroke SI/CI engines through models.
- Calculate calorific value of a fuel by Bomb calorimeter.
- Explain the implication of opening and closing of valves through the valve timing diagram.
- Analyze the performance (IHP, BHP, FHP, bsfc, ηvol, etc.) of CI/SI Engines through various experiments using various dynamometer arrangements.
- Make analysis of flue gas by ORSAT apparatus and Smoke-meter.
- Learn the MPFI (multipoint fuel injection) system through a model.
- Analyze the effectiveness of a Catalytic Converter.

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 Diesel Engine.	3
Expt 4	Performance Test of a C I Engine using electric (eddy current). dynamometer.	3
Expt 5	Performance Test of a multi-cylinder S I Engine by Morse method.	3
Expt 6	Flue gas analysis by ORSAT apparatus.	3
Expt 7	Use of catalylitic converters and its effect on flue gas of an I C 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.

MECH 4112: MACHINING AND MACHINE TOOLS LAB

Contacts: 3P **Credits: 2**

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

- Select appropriate cutting process parameters for a particular machining operation.
- Analyze mechanism of chip formation in turning operation.
- Learn basic principle of tool-wear and evaluate of tool life.
- Produce a Helical gear.
- Design speed structure and construct Ray Diagram of an all-gear headstock Lathe.
- Analyze Apron Mechanism of a Centre lathe and Quick-return mechanism & stroke length adjustment of a Shaping Machine.

Sl. No.	List of Experiments	Contact Hrs.
Expt 1	**Machine Tool:** Study of speed structure & construction of Ray Diagram of an all gear headstock Lathe.	3
Expt 2	**Machine Tool:** Study of Apron Mechanism of a Centre / Engine Lathe.	3
Expt 3	**Machine Tool:** Study Quick-return mechanism and stroke length adjustment of a Shaper Machine.	3
Expt 4	**Machine Tool:** Study of spindle rotation and table feed system of a Milling Machine.	3
Expt 5	**Machining:** Measurement of cutting forces in straight turning at different feeds and speeds.	3
Expt 6	**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
Expt 7	**Machining:** Measurement of tool-wear and evaluation of tool life in turning mild steel by HSS.	3
Expt 8	**Machining:** Production of a Helical gear from a cast or forged disc.	3
	Viva-voce	

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

HMTS 4121: PROFESSIONAL DEVELOPMENT

Contacts: 3P **Credits: 2**

Module No.	Syllabus
Module 1	**ProfessionalGrowth** • Goal Setting- Characteristic of goals, Short-term and long-term goals, Goal-achievement timeline • Skill identification and Skill up gradation- Washington Accord and Skills for engineers (generic and specific), Local and global skills, Knowledge sources such as MOOC, NPTEL • Career Planning- Vision and mission, Skill mapping to job profile, Basic and add-on qualifications, Career growth, Self-appraisal, Lifelong learning Assessment - Activity (20 marks)
Module 2	**Entrepreneurship** • The start-up ecosystem in India- Why entrepreneurship?, Indian tech start-up landscape, Stand-up India policies, funding agencies, market development, trends and best practices • E-Commerce- India as a growing E-commerce market, Possibilities of growth, funding, niche retailers • Make in India- New processes, Investments, Focus sectors, Makers of Make In India, Opportunities, Policies Assessment-Project (30 marks)
Module 3	**Industry specific opportunities** • Industry prospects in India and Beyond • Industry-specific job opportunities • Research & Development • Other opportunities Assessment---Presentation (30 marks)
Module 4	**Working and living happily** • Managing crisis- Organisational and personal crisis, Analysing crisis, Turnaround strategies, Learning from crisis as opportunity • Work-life balance- Performance-expectation management, Personal and professional goal- mapping • Understanding happiness- Components, Conflicts, Happiness Index Assessment: Activity/case (20 marks)

Suggested Reading:

1. Basic Managerial Skill for All by E. H. McGrath.SJ. Pub:PHI, New Delhi.
2. The Start-up Equation by Steven Fisher and Jae-Nae Duane. Pub: Mc Graw Hill Education (India) Pvt. Ltd. New Delhi.
3. Live Happily, Work Happily by Siddhartha Ganguli. Pub: Allied Publishers Pvt.Ltd. New Delhi.
4. Crisis Management: Planning for the Inevitable by Steven Fink. Pub: iUniverseInc.USA.
5. Influencer:The New Science of Leading Change by Joseph Grenny&Kerey Patterson. Pub:McGraw Hill Education , USA.

MECH 4131: INDUSTRIAL TRAINING EVALUATION

Credits: 2

This is a compulsory industrial training of 4 weeks duration, which all the students have to undergo at the end of 6th semester. Individual student has to submit a bound report along with the training certificate within a specified date and as per specified format which will be notified by the department.

All the students have to undergo a viva-voce examination to establish6 actual outcome of the training undergone.

MECH 4191 : PROJECT-I

Contacts: 6P **Credits: 4**

This is a sessional course work. Students in a group of maximum six (6) will do a project work under one specified faculty member, over two semesters, 7th and 8th. The topics of the projects will be selected by the department and will be allotted to the students as per merit.

Under Part-I in 7th semester the scope will be complete design of the project, determination of methodology for doing the project and preparation of manufacturing drawings, etc. to be completed. There will be one mid semester and one end semester viva voce examination in front of a team of faculty members for evaluation of the project work. The group has to submit bound report on the outcome of the project work.

Free Electives offered by ME dept. for other departments

MECH 4181: QUANTITATIVE DECISION MAKING

Contacts: 3L **Credits: 3**

Course Objectives:

On completion of this course, students will be able to:

- Learn the meaning and appreciate importance of Operations Research.
- Identify and use different OR optimization models.
- Formulate mathematical models from the description of the problem.
- Solve linear and non-linear programming problems.

Module No.	Syllabus	Contact Hrs.
Module 1	**Introduction**: Brief history of OR; Introduction to different quantitative decision making (QDM) problems: Decision Theory, Linear Programming, Transportation and Assignment problems, Network Analysis, Scheduling by CPM, Inventory models, Integer Programming, Non-linear Programming, Dynamic Programming.	**2**
	Decision Theory: Decision making under certainty, risk and uncertainty.	**3**
	Network Analysis: Network models and terminologies, shortest path/route problem; The minimum spanning tree problem; The maximal flow problem.	**3**
Module 2	**Transportation Problems:** Tabular representation of a transportation problem; North-West corner initial solution; stepping stone method; concept of dummy source or destination; Vogel's approximation method.	**3**
	Linear Programming Problem (LPP): Nature of LPP through examples; General form of LP model; Formulation of LPP; Graphical solutions; Simplex method, Duality in LPP, Sensitivity analysis.	**7**
Module 3	**Assignment Problems:** Hungarian method for solving Assignment problems.	**2**
	Scheduling: Project scheduling, Network construction, Critical path method-computation of float and slack, determination of critical path and time; Crashing of network; Resource leveling process.	**7**
Module 4	**Non-Linear Programming:** Graphical illustration of a non-linear programming; Unconstrained optimization by (i) direct search method (ii) steepest decent method, constrained optimization by Lagrange multipliers; Integer linear programming by branch & bound techniques;	**9**

	Dynamic programming problems and their characteristics, Bellman's principle of optimality; solving (i) Stagecoach problem (ii) Knapsack problem.	
	Total	**36**

Text Books:

4. Quantitative Techniques in Management, N. D. Vohra, Mc-Graw Hill.
5. Operations Research, V.K.Kapoor, Sultan Chand & Sons.
6. Operations Research, Hira and Gupta, S Chand & Co.

Recommended Books:

3. Operations Research: An Introduction, H. A. Taha, PHI Pub.
4. Principles of Operation Research, Wagner, PHI Pub.

MECH 4182: QUALITY CONTROL & MANAGEMENT

Contacts: 3L **Credit: 3**

Course Objectives:

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

- Understand the meaning of Quality Control.
- Identify and reduce costs of quality.
- Know key leaders in the field of quality and their contributions.
- Identify features of the TQM philosophy and implement them.
- Use tools for identifying and solving quality problems.
- Appreciate ISO system and implement in industry.
- Understand and use statistical quality control methods.

Module	Syllabus	Contact Hrs.
1	**Introduction:** Definition of quality; Quality control vs. Quality Assurance; Quality control and inspection, Statistical quality control, Quality Gurus ; Quality Planning and Quality costs; TQM: Components of TQM; 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.	9
2	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; KAIZEN; 5S Principle; Concept of quality circles.	9
3	**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 ; Documentation ;Internal Audits and Implementation; ISO 9000 certification process. **EMS (ISO 14000):** Concepts of ISO 14001 ; Requirements of ISO 14001 ; Benefits of ISO 14001	9
4	Statistical process control; Measures of central tendency; Measures of dispersion; control charts for variables; Control charts for attributes; OC Curve ; Process capability; six sigma and its applications; Design of experiments and Taguchi Methodology	9
	Total Classes	**36**

Text Books:

3. Total Quality Management – J.D. Juran , MHE.
4. Total Quality Management - Besterfield,Pearson Education.

Reference Books:

3. Total Quality Management – Arasu & Paul , Scitech.
4. Total Quality Management – Poornima M Charanteemath , Pearson Education .

MECH 4183: ECOLOGY & ENVIRONMENTAL ENGINEERING

Contacts: 3L **Credits: 3**

Course Objectives:

On completion of this course, student will be able to:

- Identify current and emerging environmental engineering issues.
- Learn ethical and societal responsibilities and to act accordingly.
- Assess the impact of human activities on the environment.
- Design and construct solutions to minimize and mitigate environmental impacts.
- Practice the profession of environmental engineering in the public and /or private sectors.

Module No.	Syllabus	Contact Hrs.
Module 1	**Introduction**: Components of environment, basic ideas of ecology and environment, concepts related to environmental perspective: man, society, environment and their inter relationship.	**1**
	Population growth and associated problems, definition of resource; renewable, non-renewable, potentially renewable; effect of excessive use vis-a-vis population growth, definition of pollutant and contaminant; EIA (Environmental Impact Assessment).	**2**
	Environmental degradation: acid rain, toxic element; primary and secondary pollutants: emission standard, criteria pollutant, oxides of carbon, nitrogen and sulphur, particulates; overall methods for pollution prevention; environmental problems and sustainable development.	**3**
	Ecological concepts and natural resources: Introduction to ecological perspective, the value of environment, levels of organization in the biotic component of the environment, ecosystem processes, the human dimension, environmental gradients, tolerance and adaptation, environmental changes and threats to the environment.	**3**
Module 2	Air Pollution and Control: Atmospheric composition-troposphere, stratosphere, mesosphere, thermosphere;	**1**
	Energy Balance: conductive and convective heat transfer, radiation heat transfer, simple global temperature modal.	**1**
	Green –house effects: Definition, impact of greenhouse gases on the global climate; climate, weather: Difference between climate and weather ; Global weather and its consequences.	**2**

	Depletion of ozone layer: CFC, destruction of ozone layer by CFC, impact of other greenhouse gases, effect of ozone modification.	**1**
	Standards and control measures: Industrial, commercial and residential air quality standard.	**1**
	Emission controls: Emission controls for coal fired power plants; Emission controls for Highway Vehicles.	**1**
	Air pollution & Biosphere: Meteorology and air pollution, adiabatic lapse rate, atmospheric stability, temperature inversions.	**2**
Module 3	Water Pollution: Water resources-unusual properties of water, the hydrologic cycle; organic pollutants, inorganic pollutants, sediments, radioactive materials.	**2**
	Thermal pollutants, ground water pollution/ arsenic contamination.	**1**
	Surface water quality: Rivers & Streams, Bio chemical oxygen demand (BOD); water quality in lakes and reservoirs.	**1**
	Water pollution control & water recycling.	**1**
	Noise Pollution: Sound and Human Acoustics, Noise Measurement Units.	**1**
	Noise classification: Transport noise, Road traffic noise, occupational noise, Neighborhood noise, noise pollution hazards, permissible noise levels, Noise control.	**3**
Module 4	Hazardous substances and risk analysis: Definition of Hazardous substances, legislation, Risk Assessment, Hazard Identification.	**3**
	Environmental Engineering Technologies: Water treatment, Waste water treatment, solid waste treatment, Hazardous waste treatment.	**3**
	Environmental Management Systems (EMS): Meanings, Goals & Objectives, Implementation, EMS Model, ISO 14001-Certification, Importance, usefulness	**3**
	Total	**36**

Text Books:

1. Introduction to Environmental Engineering & Science, G. M. Masters, Prentice Hall India.
2. Environmental Management, Dey & Dey, New Age International (P) Ltd.

Reference Books:

1. Environmental Engineering, Gerard Kiely, Mcgrw Hill Education.

4th Year 2nd Semester

HMTS 4202: PROJECT MANAGEMENT

Contacts: 2L **Credits: 2**

Course Objectives:

On completion of this course, student will be able to:

- Manage the selection and initiation of individual projects and the portfolios of projects in the enterprise.
- Conduct project planning activities that accurately forecast project costs, timelines, and quality.
- Demonstrate effective project execution and control techniques that result in successful projects.
- Conduct project closure activities and to obtain formal project acceptance.
- Demonstrate a strong working knowledge of ethics and professional responsibility.
- Demonstrate effective organizational leadership and change skills for managing projects, project teams, and stakeholders.

Module No.	Syllabus	Contact Hrs.
Module 1	**Introduction** : Indian Project Management Scenario: Concept of a Project & subsequent development, characteristics, importance of project management, external causes for delay of a project, internal constraints, how to avoid overruns.	1
	Project Planning: Capital investments- importance & types, phases of capital budgeting , levels of decision making, facets of project analysis, feasibility studies.	1
	Project scheduling: Importance of project scheduling - work breakdown structure and organization breakdown structure, scheduling techniques- Gantt chart and project control by line of balance (LOB).	2
	Network Analysis: objectives, concept, Programme Evaluation & Review Technique (PERT): Construction of PERT, Slack & critical activities.	1
	Critical Path Method (CPM): Genesis of CPA(Critical Path Analysis), Event oriented or activity oriented networks, construction of CPM.	1
Module 2	Crashing: concepts & need for crashing; Aspects of Time Cost Trade –off-Analysis, Optimum Project Duration , Effective project cost control.	2
	Resource Monitoring and Control: Resource constraints, resource leveling, integrated resource management.	2

	Project Life Cycle (PLC): Methodology, Phases, Graphical representation of time line and level of effort for a project.	2
Module 3	Dynamics of Project Cost : Capital costs , Costs pertaining to the pre-investment / investment phase, costs pertaining to operational phase , Capital cost-time-value (CTV) system, economic study estimates, project life cycle costing, project cost reduction methods. Project Quality Management : concept of project quality, Inspection & TQM in projects, standardization. Project Audit : Definition & scope, objectives ; Project Auditor's role, contract baseline.	3 2 1
Module 4	Project Management Software : Overview of types of software for projects -MS Project, Web based; criteria for software selection, computer PERT simulation. Characteristics of project management software: collaboration, scheduling, issue tracking, project portfolio management, document management, resource management.	3 3
	Total	**24**

Recommended Books:

3. Text Book of Project Management, Macmillan, Gopalkrishnan P. and Rama M Moorthy.
4. Project Management, New Age International Publishers, K Nagarajan.
5. Projects –Planning, Analysis, Financing, Implementation, and Review, Prasanna Chandra, Tata McGraw-Hill Publishing Limited.

Free Elective II

AEIE 4281: SENSOR TECHNOLOGY

Contacts: 3L **Credits: 3**

Course Objectives:

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

- have the basic concepts of sensors, their properties and industrial applications.
- have the fundamental knowledge in micro sensors, sensor materials, properties and industrial applications.

Module No.	Syllabus	Contact Hrs.
Module 1	Overview of Sensors: Sensor: classification of sensors; mechanical, electrical, thermal, acoustic, optical, chemical, bio- sensors, their calibration and determination of characteristics.	11
Module 2	Mechanical Sensors: Displacement, acceleration, pressure sensing components, components of seismic system. Electrical Sensors: Temperature, pressure, flow, level sensing components Acoustics Sensor: Piezo electric sensor, microphones, ultrasonic sensors.	11
Module 3	Micro-Sensor: IC technology used in micro sensor system; crystal growth and wafer making, different techniques of deposition; physical vapor deposition -evaporation, thermal oxidation, sputtering, epitaxy, ion implantation and diffusion; chemical vapor deposition- LPCVD, APCVD, PECVD, spin coating, electrochemical deposition; pattern generation and transfer- masking, photolithography: photoresists and application, light sources, photo resist development and removal; different types of etching: chemical and plasma; overview of micro-manufacturing techniques: bulk micro-machining, surface micro-machining, LIGA. Testing and Packaging: Partitioning, layout, technology constraints, scaling, compatibility study; scaling laws in miniaturization; examples of selected micro sensors.	10
Module 4	Smart Sensors: Introduction; present trends, nature of semiconductor sensor output, information coding, integrated sensor principles, sensor networking.	4
	Total	**36**

References:

1. J. W Gardner, V. K. Varadan, Microsensors, MEMS And Smart Devices, Wiley, 2001.
2. Stephen Beedy, MEMS Mechanical Sensors, Artech House, 2004.
3. N. P. Mahalik, *MEMS*, McGraw Hill, 2007.
4. Jon Wilson, Sensor Technology Handbook, Elseiver, 2005.
5. Leondes, Cornelius T. (Ed.), Mems/Nems Handbook Techniques and Applications, Springer, 2006.
6. Mohamed Gad-el-Hak, *The MEMS Handbook*, CRC Press; 2nd edition, 2005.
7. B. G. Streetman And Sanjay Banerjee, Solid State Electronic Devices, Prentice Hall; 6th Edition, 2005.

CIVL 4282: PRINCIPLES OF SURVEYING

Contacts: 3L **Credits: 3**

Course Outcome:

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

1. Carry out preliminary surveying in the field,
2. Take accurate measurements, field booking, plotting and adjustment of traverse,
3. Use various conventional instruments involved in surveying.

SL. No.	Module	Details of Course Content	Contact Hours	Total
1.	I	INTRODUCTIONTO SURVEYING Definition, principles of surveying, types of scales (numerical problems), basic concepts of plans and maps. CHAIN SURVEYING Types of chains,accessories for chain surveying with their use, methods of ranging and methods of offsets, obstacles in chain surveying.	5 5 (10)	40
2.	II	COMPASS SURVEYING Definition, instrument and terminology, local attraction and its elimination, Open and closed traverse, adjustment of traverse. PLANE TABLE SURVEYING Principle, equipment and methods, two and three point problems.	5 5 (10)	
3.	III	LEVELLING Definitions and terminology, types and methods of leveling, use of leveling instruments and supporting accessories. CONTOURING Different terms used in contouring, characteristicsof contour and contour interval, preparation of contour maps.	5 5 (10)	
4.	IV	THEODOLITE SURVEYING Components of Theodolite, adjustments, measurement of vertical and horizontal angels, concepts of trigonometric leveling, TACHEOMETRY Definitions and principles of tachometry and stadia system, fixed hair stadia method, calculation of horizontal and vertical distance using tachometer.	5 5 (10)	

Recommended books:-

TEXT BOOKS	
Sl. No.	**Name of the books**
1.	Basak N.N. *Surveying and Levelling.* 2nd edition, McGraw Hill Education.
2.	Roy S.K. *Fundamentals of Surveying*. 2nd edition, PHI Learning Pvt. Ltd-New Delhi.

REFERENCE BOOKS	
Sl. No.	**Name of the books**
3.	Venkatramaiah C. *Textbook of Surveying*. 2nd edition, Orient Blackswan Pvt. Ltd. –New Delhi.
4.	Duggal S. K. *Surveying (Vol-1 and 2).* 4th edition, McGraw Hill Education (India) Pvt Ltd.

CIVL 4283: PROJECT PLANNING AND MANAGEMENT

Contacts: 3L **Credits: 3**

Course Outcome:

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

1. Prepare the bar chart for the project.
2. Prepare the tender documents.
3. Estimate the critical path of the project i.e. the maximum duration which the project requires for completion.
4. Familiar with the uses of various construction equipments at site
5. Familiar with by laws of different authorities to get the approval of drawings for construction.
6. Know the process of arbitration incase the projects suffer from disputation.

SL. No.	Module	Details of Course Contents	Hours	Total
1	I	**Planning**: General consideration, Definition of aspect, prospect, roominess, grouping, circulation, Privacy. **Regulation and Bye laws** : Bye Laws in respect of side space, Back and front space, Covered areas, height of building etc., Lavatory blocks , ventilation, Requirements for stairs, lifts in public assembly building, offices **Fire Protection**: Fire fighting arrangements in public assembly buildings, planning , offices, auditorium	2 4 2	36
2	II	**Construction plants & Equipment**: Plants & equipment for earth moving, road constructions, excavators, dozers, scrapers, spreaders, rollers, their uses. **Plants &Equipment for concrete construction**: Batching plants, Ready Mix Concrete, concrete mixers, Vibrators etc., quality control.	4 4	
3	III	**Planning &Scheduling of constructions Projects**: **Planning by CPM**: Preparation of network, Determination of slacks or floats. Critical activities. Critical path. Project duration. **Planning by PERT**: Expected mean time, probability of completion of project, Estimation of critical path, problems.	4 4	
4	IV	**Management: Professional practice**, Definition, Rights and responsibilities of owner, engineer, Contractors, types of contract **Departmental Procedures**: Administration, Technical and financial sanction, operation of PWD, Tenders and its notification, EMD and SD, Acceptance of tenders, Arbritation.	4 8	

Recommended books, IS Codes:-

1. Estimating, costing, Specification and Valuation in Civil Engineering by M. Chakroborty
2. Construction Planning, Equipments and methods Puerifoy, R.L. McGraw Hill.
3. Management in construction industry P.P.Dharwadkar Oxford and IBH Publishingcompany New Delhi
4. Construction Management, Critical path Methods in Construction, J.O.Brien Wiley Interscience
5. PERT and CPM L.S. Srinath
6. Project planning and control with PERT and CPM' Construction equipments and its management B.C.Punmia, K.K.Kandelwal and S.C.Sharma
7. National Building code BIS

HMTS 4281: INTRODUCTION TO INDUSTRIAL SOCIOLOGY

Contacts: 3L **Credits: 3**

Module 1

Industry –the sociological perspective –sociology of work and industry, social relations in Industry.

Social organisation in Industry-Bureaucracy, Scientific Management and Human relations.

Module II

Rise and Development of Industry.

Early industrialisation-Types of productive systems-The Manorial or Feudal system, TheGuild system, The Domestic or Putting out System and The Factory system.

Characteristics of the factory system, causes and consequences of industrialization, obstacles and limitations of Industrialisation. Industry in India.

Module III

Social impact of industrialization-Nature of modern societies, Social Change –nature, process, causes, factors- cultural, developmental, technological.

Emergence of Industrial Capitalism, Information Society after Industrial Society, Post modernity, Globalization and Convergence, Significance of the Service Sector, Work Restructuring and Corporate Management

Module IV

Contemporary Issues –

Work experiences in Industry.

Labour Characteristics in sociological perspectives.

Worker, Supervisor and Management relations- An Overview.

Industrial disputes- Causes, Strike, Lockouts.

Preventive machinery of industrial disputes- Grievances and Grievance Handling Procedure.

Worker participation in Management -Works Committee, Collective Bargaining, Bipartite and Tripartite Agreement, Code of Discipline, Standing Orders, Labour Courts and Industrial Tribunals.

Reference:

1. **Gisbert Pascal**, *Fundamentals of Industrial Sociology*, Tata McGraw Hill Publishing Co., New Delhi, 1972.

2. **SchneuderEngno V**, *Industrial Sociology* 2nd Edition, McGraw Hill Publishing Co., New Delhi, 1979.

3. **Mamoria C.B. And Mamoria S**., *Dynamics of Industrial Relations in India*.

4. **Sinha G.P. and P.R.N. Sinha**, *Industrial Relations and Labour Legislations*, New Delhi, Oxford and IBH Publishing Co., 1977.

5. **Nadkarni, Lakshmi**, *Sociology of Industrial Worker*,Rawat,Jaipur,1998.

6.**BhowmickSharit**, *Industry,Labour and Society*, Orient 2012.

HMTS 4283: ELEMENTARY SPANISH FOR BEGINNERS

Contacts: 3L **Credits: 3**

Module 1 – 9L
The Spanish Alphabet, the vowels, pronunciation rules, stress and accents
Greetings, giving and requesting personal details
Resources for asking about words
The numbers, nationalities, professions
Gender
The three conjugations: **-ar**, **-er**, **-ir**
The verbs **ser**, **llamarse**and **tener**
Vocabulary Resources: the days of the week, the parts of the day, about habits
Expressing frequency
Asking and telling the time

Module II – 9L
The **presenteindicativo**
Some uses of **a**, **con**, **de**, **por**, **para** and **porque**
The definite article: **el**, **la**, **los**, **las**
Personal pronouns
Qualifiers: **bien**, **bastantebien**, **regular**, **mal**
Expressing intentions
Expressing existence and location
Vocabulary Resources: leisure activities, the weather, geography, tourist attractions
Speaking about physical appearance and character
Expressing and comparing likes, dislikes and interests
Asking about likes and dislikes
Speaking about personal relationships, the family
Adjectives to describe character, music

Module III – 9L
Some uses of **hay**, the verb **estar**, the superlative
un/ **una**/ **unos**/ **unas**
Quantifiers: **muy**, **mucho** / **mucha**/ **muchos**/ **muchas**
qué, **cuál**/ **cuáles**, **cuántos**/ **cuántas**, **dónde**, **cómo**
Identifying objects
Expressing needs
Shopping: asking for items, asking about prices, etc.
Talking about preferences
The numbers over 100
The colours, clothes, everyday objects
Demonstratives: **este**/ **esta**/ **estos**/ **estas**, **esto**
e l/ **la** / **los**/ **las** + adjective
qué+ noun, **cuál**/ **cuáles**
tener que + infinitive
The verb **ir**
The verb **preferir**

Module IV – 9L
The verb **gustar**
Quantifiers (**muy**, **bastante**, **unpoco**)
Possessives
también/ tampoco
The **presente de indicativo**and some irregular verbs
Reflexive verbs
Yotambién/ Yotampoco/ Yosí/ Yo no
Primero / **Después/ Luego**
Quantifiers (**algún**, **ningún**, **muchos**)
Prepositions and adverbs of place (**a**, **en**, **al lado de**, **lejos**, **cerca**...)
Ordering and giving information about food
Speaking about different culinary habits
Describing districts, towns and cities
Adjectives to describe a district

Evaluation:
Internal: 30 Marks
End Semester: 70 Marks

Suggested Reading

Corpas, Jaime**.** *Cuadernos de gramáticaespañola A1*. Difusion,2010. Print.

Hanssler, William Beginners' Spanish. Forgotten Books,2016.

Jagger, Lucas. *Learn Spanish Step by Step: Spanish Language Practical Guide for Beginners*.

Ibarra, Juan Kattan. Complete Spanish Book.

MECH 4211: ADVANCED MANUFACTURING LAB

Contacts: 3P **Credits: 2**

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

- Set and operate a CNC lathe using control panel.
- Program a CNC Lathe based on a component drawing, test the program and produce the component in automatic cycle.
- Set and operate a EDM machine using control panel.
- Program a EDM machine based on a component drawing and produce the component in automatic cycle.
- Run and teach a robot in manual mode.
- Write a program and run the robot on automatic mode for performing specified task.

Sl. No.	List of Experiments	Contact Hrs.
Expt 1	Study of CNC Lathe and its subsystems.	3
Expt 2	Basic Operations of CNC Lathe like homing, slide movements, spindle rotation, turret indexing, coolant on-off, tool offset, program editing and dry run.	3
Expt 3	CNC programming for operations like Facing, Chamfering & Turning.	3
Expt 4	CNC programming for Stock Removal, Radius Turning and Thread cutting.	3
Expt 5	Study of EDM machine and its subsystems.	3
Expt 6	Basic operations of EDM machine like tool setting, job setting and setting machining parameters.	3
Expt 7	Machining of a component in EDM and calculate its material removal rate.	3
Expt 8	Study of robot and its subsystems.	3
Expt 9	Basic Robot operations like homing, arm movement and gripper operation.	3
Expt 10	Programming a robot for autonomous pick and place operation.	3
	Viva-voce	

N.B: A minimum of six experiments must be performed in the semester, covering at least two for each of the three machines.

MECH 4221: DESIGN OF AN INDUSTRIAL PRODUCT

Contacts: 4 P **Credits: 2**

This is a sessional course work. Students in a group of around 10 will undertake this course under one faculty guide. Each group will be asked to design a mechanical equipment/system. The group has to work out the design of the unit and then make proper engineering drawing for the same. The drawings should include GA drawing with BOM and detailed drawings for parts/components.

The course work will be examined by a group of faculty members in which the design guide will be a member.

MECH 4231: COMPREHENSIVE VIVA VOCE

Credits: 3

This viva voce examination will be conducted at the later part of 8th semester. Each student will appear in the test at the prefixed time and date.
This will be an evaluation of the student's overall mechanical engineering concept and grasp of all the 8 semester courses undertaken by the student.

MECH 4291: PROJECT -II

Contacts: 12 P **Credits: 8**

This is continuation of the project -I undertaken by the groups of students in 7th semester.

In this semester, depending on the nature of the project, fabrication/manufacturing/analytical model has to be completed; experimentation/analysis to be done, results to be obtained and conclusion to be drawn. At the end of the project, the final project report as per specified format has to be submitted to the project guide. The project will be evaluated by a team of faculty members & at least one outside academic/industry expert.

Free Electives offered by ME dept. for other departments

MECH 4281: MECHANICAL HANDLING OF MATERIALS

Contacts: 3L **Credit: 3**

Course Objectives:
Students will be able to:

- Appreciate the importance of materials handling.
- Identify the application of different types of material handling systems and equipment.
- Understand the concept of maximizing productivity through effective materials handling.
- Select & specify suitable materials handling equipment for specific applications.

Module	Syllabus	Contact Hrs.
1	**Introduction :** Definition, importance and scope of materials handling (MH); Objectives of Material Handling; classification of materials; utility of following principles of MH – (i) materials flow, (ii) simplification, (iii) gravity, (iv) space utilization, (v) unit size, (vi) safety, (vii) standardization, (viii) dead-weight, (ix) idle time (x) motion. **Load Unitization:** Definition; advantages & disadvantages of unitization; unitization by use of platform, container, rack, sheet, bag and self contained unit load; descriptive specification and use of pallets, skids, containers, boxes, crates and cartons; shrink and stretch wrapping. **Classification of MH Equipment :** Types of equipment – (i) industrial trucks & vehicles, (ii) conveyors, (iii) hoisting equipment, (iv) auxiliary equipment; Independent equipment wise sub classification of each of above type of equipment.	9
2	**Conveyors :** Use and characteristics of belt conveyor, constructional features of flat and troughed belt conveyor; Use and constructional features of Flg. types of chain conveyors – apron, car and trolley type; Construction of link-plate chains; Dynamic phenomena in chain drive; Use and constructional features of roller conveyors; Gravity and powered roller conveyor; Pneumatic conveyor-use and advantages; Positive, negative and combination system of pneumatic conveyors; constructional feature, application and conveying capacity of screw conveyor, bucket elevator.	10
3	**Hoisting Equipment:** Advantage of using steel wire rope over chain; constructional features of wire ropes; Rope drum design; Pulley system-simple vs. multiple pulley; Load handling attachments : hooks, grabs, tongs, grab bucket; Use and constructional features of (i) hand operated trolley hoist, (ii) winch; (iii) Jib crane, (iv) overhead traveling crane and (v)	8

	wharf crane; Level luffing system of a wharf crane; Utility of truck mounted and crawler crane.	
4	**Ttrucks & Vehicles:** Constructional features and use of the equipment: (i) wheeled hand truck, (ii) hand pallet truck, (iii) fork lift truck; Major specifications, capacity rating and attachments of fork lift truck ; FLT batteries. **Auxiliary Handling Equipment :** Descriptive specification and use of – (i) Slide and trough gates, (ii) belt, screw and vibratory feeders, (iii) Chutes, (iv) positioners like elevating platform, ramps, universal vise; (v) ball table.	9
	Total Classes	**36**

Books Recommended:

5. Introduction to Materials Handling- S. Ray, New Age Int. Pub.
6. Materials Handling: Principles and Practices- T.H. Allegri, CBS Publishers and Distributors.
7. Mechanical Handling of Materials- T. K. Ray, Asian Books Pvt. Ltd.

MECH 4282: AERODYNAMICS

Contacts: 3L **Credits: 3**

Course Objectives:

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

- Learn fundamental physical and analytical principles of aerodynamics.
- Use the fundamental laws to solve problems in aerodynamic applications.
- Solve standard bench mark problems like vortex flow, Stokes theory etc.
- Analyze the effect of drag and lift force on submerged bodies.
- Apply the knowledge of aerodynamics in design of turbo-machine blades, vehicles 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.	9
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.	9
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.	9
	Total	**36**

Text Books:

3. Fundamentals of Aerodynamics, John D. Anderson, Jr., Mc-Graw Hill, 3e.
4. 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.

MECH 4283: MODERN MANUFACTURING TECHNOLOGY

Contacts: 3L **Credits: 3**

Course objectives:

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

- Acquire basic idea about conventional manufacturing processes
- Learn about different engineering materials and their properties
- Form knowledge on modern manufacturing technologies.
- Acquire working knowledge on Computer Integration in manufacturing.
- Learn various Non-traditional Machining process and their application.
- Understand the manufacturing processes for polymer, composites and ceramics.

Module No.	Syllabus	Contact Hrs.
Module 1	What is manufacturing. Introduction to conventional manufacturing processes: casting, forming, welding, machining, rolling, extrusion, presswork, heat treatment and surface finishing processes. Mechanical properties of materials: elasticity, hardness, effect of temperature on properties. Engineering materials: metals and alloys, polymers, ceramics, composites.	9
Module 2	CNC machines; Cellular manufacturing, flexible manufacturing system (FMS); Group Technology concept (GT); Computer Integrated Manufacturing; Robots in manufacturing; Rapid prototyping.	9
Module 3	Non-Traditional Machining (NTM) Processes: USM, AJM, EDM, ECM, and EBM; NTM application considerations; Powder Metallurgy Process and Products.	9
Module 4	Plastic Fabrication Processes: Injection molding, Blow molding, Thermoforming; Polymer Composite Fabrication Process; Processing of Ceramics	9
	Total	**36**

Text Books:

1. Principles of Modern Manufacturing, M.P. Grover, Wiley
2. Manufacturing Technology, Kalpakjian, Pearsons Publications.
4. Non-conventional Machining, P.K.Mishra, Narosa Publishers

Reference Books:

1. Manufacturing Technology, Vol-I & II, P. N. Rao, TMH
2. Manufacturing Technology, Radhakrishnan, Scitech
3. Manufacturing Science, Ghosh & Mallik, Affiliated East-West Press Pvt. Ltd.