Semester III (Second year]
Branch/Course Mechanical Engineering

Semester-3	Code	Course Name	L	T	P	Credits
	ESC-306	Engineering Mechanics	3	1	0	4
	BSC-202	Mathematics III(PDE, Probability & Statistics)	3	1	0	4
	PCC-ME301	Thermodynamics	3	1	0	4
	PCC-ME302	Fluid Mechanics	3	1	2	5
	PCC-ME303	Material Engineering	3	1	0	4
	HSMC-303	Human value& Ethics	3	0	0	3

Engineering Mechanics (ESC -306)

Basic Engineering and Sciences (BES); 4 Credits (3-1-0)

Objective: This course provides knowledge about basic principles of engineering mechanics with emphasis on their analysis and application to practical engineering problems.

Unit	Contents	Contact Hrs.
I	*Systems of Forces:* Basic concepts: Definitions, Basic assumptions, Scalar & Vector quantities, Free, Forced and fixed vectors. Force as a Vector, Composition of forces, Parallelogram Law, Resolution, and Principle of Transmissibility of forces. Moment of a force about a point and axis, Couple and couple moment, addition and subtraction of couples, Moment of a couple about a line, Translation of a force to a parallel position, Coplanar Concurrent force system and Coplanar non Concurrent force systems, Resultant of coplanar force system. *Equations of equilibrium;* Free body diagram, Free bodies involving interior sections, General equations of equilibrium, Problems of equilibrium *Friction:* Laws of Coulomb fraction, Simple contact friction problems, Transmission of power through belt, belt friction	12
II	*Basic Structural Analysis:* Plane Truss, Difference between truss and frame, Perfect and imperfect truss, Assumptions and Analysis of Plane Truss, Method of joints, Method of section, Zero force members. Beams, Types of beams, Statically Determinate Beams, Shear force and bending moment in beams, Shear force and bending moment diagrams, Relationships between load, shear and bending moment.	08
III	*Centroid and Moment of Inertia:* Center of Gravity, Center of Mass and Centroid of curves, areas,	10

	volumes, Determination of centroid by integration, Centroid of composite bodies. Definition of Moment of inertia of area, Perpendicular axis theorem and Polar moment of Inertia, Parallel axis theorem, Moment of inertia of simple areas by integration, Moment of Inertia of Composite Areas, Moment of Inertia of masses.	
IV	*Kinematics and Dynamics:* Method of virtual work and total potential energy, Kinematics and dynamics of particle, Energy methods and methods of momentum, kinematics and dynamics of rigid bodies, Energy and impulse-momentum methods for rigid bodies.	18
	Total	48

Text Book:

[1] "Engineering Mechanics : Statics and Dynamics", Shames, Prentice-Hall

Reference Books

[2] "Engineering Mechanics: Statics" , J.L Meriam , Wiley
[3] "Engineering Mechanics: Dynamics" , J.L Meriam , Wiley
[4] "Engineering Mechanics " , Thimoshenko& Young , 4ed, Tata McGraw Hill

BSC 305	**Mathematics III** **(PDE, Probability & Statistics)**	**3L:1T:0P**	**4 credits**

Objectives:

To introduce the solution methodologies for second order Partial Differential Equations with applications in engineering

To provide an overview of probability and statistics to engineers

Contents:

Definition of Partial Differential Equations, First order partial differential equations, solutions of first order linear PDEs; Solution to homogenous and non-homogenous linear partialdifferential equations of second order by complimentary function and particular integral method. Second-order linear equations and their classification, Initial and boundary conditions, D'Alembert's solution of the wave equation; Duhamel's principle for one dimensional wave equation. Heat diffusion and vibration problems, Separation of variables method to simple problems in Cartesian coordinates. The Laplacian in plane, cylindrical and spherical polar coordinates, solutions with Bessel functions and Legendre functions. One dimensional diffusion equation and its solution by separation of variables. **(14 hours)**

Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality. Continuous random varibales and their properties, distribution functions and densities, normal, exponential and gamma densities.Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.**(12 hours)**

Basic Statistics, Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation. Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, Tests for single mean, difference of means, and difference of standard deviations. Test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.**(12 hours)**

Course Outcomes:

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

Textbooks/References:

Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.

P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).

S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

PCC-ME 301	Thermodynamics	3L:0T:1P	4 credits

Objectives:

To learn about work and heat interactions, and balance of energy between system and its surroundings

To learn about application of I law to various energy conversion devices To evaluate the changes in properties of substances in various processes

To understand the difference between high grade and low grade energies and II law limitations on energy conversion

Contents:

Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work - Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work. **(5)**

Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems-

First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy. **(5)**

Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables and R134a tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart. **(8)**

First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume. **(5)**

Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale. **(5)**

Clausius inequality; Definition of entropy S ; Demonstration that entropy S is a property; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of s from steam tables- Principle of increase of entropy; Illustration of processes in T-s coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles- Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis.**(8)**

Thermodynamic cycles - Basic Rankine cycle; Basic Brayton cycle; Basic vapor compression cycle and comparison with Carnot cycle. **(4)**

Total Hours (40 lectures + 12 tutorials)

Course Outcomes:

After completing this course, the students will be able to apply energy balance to systems and control volumes, in situations involving heat and work interactions

Students can evaluate changes in thermodynamic properties of substances
The students will be able to evaluate the performance of energy conversion devices

The students will be able to differentiate between high grade and low grade energies.

Text Books:

Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, *Fundamentals ofThermodynamics*, John Wiley and Sons.

Jones, J. B. and Duggan, R. E., 1996, *Engineering Thermodynamics*, Prentice-Hall of India

Moran, M. J. and Shapiro, H. N., 1999, *Fundamentals of Engineering Thermodynamics*, John Wiley and Sons.
Nag, P.K, 1995, *Engineering Thermodynamics*, Tata McGraw-Hill Publishing Co. Ltd.

PCC-ME 302	**Fluid Mechanics**	**3L:1T:2P**	**5 credits**
PCC-ME 405	**Fluid Machines**	**3L:1T:2P**	**5 credits**

Objectives:

To learn about the application of mass and momentum conservation laws for fluid flows
To understand the importance of dimensional analysis
To obtain the velocity and pressure variations in various types of simple flows
To analyze the flow in water pumps and turbines.

Contents:

Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications.**(9)**

Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram. **(9)**

Need for dimensional analysis – methods of dimension analysis – Similitude – types of similitude Dimensionless parameters – application of dimensionless parameters – Model analysis. **(6)**

Euler's equation – theory of Rotodynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps- Reciprocating pump – working principle. **(8)**

Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube- Specific speed, unit quantities, performance curves for turbines – governing of Turbines. **(8)**

Course Outcomes:

Upon completion of this course, students will be able to mathematically analyze simple flow situations

They will be able to evaluate the performance of pumps and turbines.

PCC-ME 303	Materials Engineering	3L:1T:0P	4 credits

Objectives:

Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.

To provide a detailed interpretation of equilibrium phase diagrams

Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

Course Contents:

Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress. **(6)**

Mechanical Property measurement: Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength. **(6)**

Static failure theories: Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture mechanics: Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Introduction to non-destructive testing (NDT) **(8)**

Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid andmonotectic reactions. Iron Iron-carbide phase diagram and microstrctural aspects of ledeburite, austenite, ferrite and cementite, cast iron.**(6)**

Heat treatment of Steel: Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening **(6)**

Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titanium alloys.
(8)

Course Outcomes:

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

Text Books:

W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India.

Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.

V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999.

U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.

Human Values and Professional Ethics (Hsmc-303)

Humanities and Social Sciences (HU); 3 Credits (3-0-0)

Objectives:

Faced with major social and economic challenges in our communities the young prospective professionals need to know about human values and their implication in professional context. So t**he main objective of this paper is to:**

Increase ethical **knowledge, sensitivity, and judgment and e**nhance ethical **will-power and** *establish professional business standards that will protect and enhance* professional business standards.

Other objectives are Social and environmental commitment, encouragement to fair competition, innovation and creation of a general goodwill for humanity.

Course Outline

Unit	Contents	Contact hrs.
I	Origin And Definition – Goals Of Ethics – Social Well-being - Care for the Weak – Equality - Political Stability - Higher Productivity - Basic Human Values – Love – Compassion – Honesty	**08**
II	Inquiry into Ethical Issues – Cannibalism - Tax Evasion and Black Money – War – Filial Ingratitude	**08**
III	Professional Ethics – Origin and Definition – Selfishness and Morality – Setting of Priorities – Profit or Welfare	**08**
IV	Case Studies – Rail Mishaps and Minister's Resignation – Political Corruption - Failure to Honor Commitments - Disregard of Company Policy - Deliberate Deception	**12**
	Total	**36**

Reference Books:

1. Common Morality: Deciding What To Do *by Bernard Gert*; Oxford University Press
2. Moral Value and Human Diversity *by Robert Audi*; Oxford University Press
3. Moral Machines Teaching Robots Right from Wrong *by Wendell Wallach Colinallen*; Oxford University Press
4. Ethics: A Very Short Introduction *by Simon Blackburn*; Oxford University Press