CURRICULUM FOR B.SC. MECHANICAL ENGINEERING (SESSION 2015 ONWARD)

Course No. and Title		Contact Hrs		Credit Hrs		Pre-requisite
		Th	Lab	Th	Lab	
1.	**Knowledge Area-Humanities (10 Credit Hours)**					
IS 101	Islamic & Pakistan Studies-I	3 + 0		3 + 0		None
HU 101	Ethics & Pakistan Studies-I					None
IS 201	Islamic & Pakistan Studies-II	3 + 0		3 + 0		IS 101
HU 201	Ethics & Pakistan Studies-II					HU 101
HU 111	Communication Skills	0 + 3		0 + 1		None
HU 221	Technical Writing & Presentation Skills	3 + 0		3 + 0		None
2.	**Knowledge Area-Management (3 Credit Hours)**					
MGT 316	Project Management and Economics	3 + 0		3 + 0		None
3.	**Knowledge Area-Natural Sciences (19 Credit Hours)**					
Phy 119 & Phy 119L	Engineering Physics	2 + 3		2 + 1		None
MA 113	Calculus and Analytic Geometry	3 + 0		3 + 0		None
MA 129	Vector and Complex Analysis	3 + 0		3 + 0		None
MA 225	Differential Equations and Transforms	3 + 0		3 + 0		None
MA 242	Engineering Statistics	3 + 0		3 + 0		None
MA 345 & MA 345L	Numerical Methods in Computing	3 + 3		3 + 1		None
4.	**Knowledge Area-Computing (3 Credit Hours)**					
CS 101 & CS 101L	Computing Fundamentals	2 + 3		2 + 1		None
5.	**Knowledge Area-Engineering Foundation (38 Credit Hours)**					
ME 100L	Workshop Practice	0 + 3		0 + 1		None
ME 111 & ME 111L	Thermodynamics-I	3 + 3		3 + 1		None
ME 121	Engineering Statics	2 + 0		2 + 0		None
ME 122	Engineering Graphics	2 + 0		2 + 0		None
ME 122L	Engineering Drawing	0 + 6		0 + 2		None
ME 123 & ME 123L	Engineering Dynamics	3 + 3		3 + 1		MA 113, ME 121
ME 131	Industrial Materials	2 + 0		2 + 0		None
ME 211	Fluid Mechanics-I	2 + 0		2 + 0		ME 123
ME 212 & ME 212L	Thermodynamics-II	3 + 3		3 + 1		ME 111, ME 211
ME 213 & ME 213L	Fluid Mechanics-II	2 + 3		2 + 1		MA 225, ME 211
ME 221 & ME 221L	Mechanics of Materials-I	3 + 3		3 + 1		ME 121
ME 222 & ME 222L	Mechanics of Materials-II	3 + 3		3 + 1		ME 221
ME 231 & ME 231L	Manufacturing Processes	3 + 3		3 + 1		ME 131

6.	**Knowledge Area-Major Based Core (54 Credit Hours)**			
ME 311 & ME 311L	Hydraulic Machines	2 + 3	2 + 1	ME 213
ME 312 & ME 312L	Heat and Mass Transfer	3 + 3	3 + 1	ME 212, ME 213
ME 321	Theory of Machines-I	3 + 0	3 + 0	ME 123
ME 322 & ME 322L	Machine Design and CAD-I	3 + 3	3 + 1	ME 122L, ME 22
ME 323 & ME 323L	Machine Design and CAD-II	3 + 3	3 + 1	ME 322
ME 324 & ME 324L	Theory of Machines-II	3 + 3	3 + 1	ME 321
ME 331 & ME 331L	Machine Tools and Machining	2 + 3	2 + 1	ME 100L, ME 13
ME 332 & ME 332L	Metrology and Quality Assurance	2 + 3	2 + 1	MA 242
ME 411 & ME 411L	IC Engines	2 + 3	2 + 1	ME 312
ME 412 & ME 412L	Refrigeration and Air Conditioning	3 + 3	3 + 1	ME 312
ME 413 & ME 413L	Power Plants	3 + 3	3 + 1	ME 312
ME 414	Energy Resources and Utilization	2 + 0	2 + 0	ME 312
ME 421	Mechanical Vibrations	2 + 0	2 + 0	ME 324
ME 422 & ME 422L	Mechanics of Material-III	2 + 3	2 + 1	MA 225, ME 222
ME 431	Production and Operations Management	2 + 0	2 + 0	None
ME 441 & ME 441L	Instrumentation and Control	2 + 3	2 + 1	EE 201, MA 242
ME 451 & ME 451L	Finite Element Analysis	2 + 3	2 + 1	MA 345
7.	**Interdisciplinary Engineering Breadth (3 Credit Hours)**			
EE 201 & EE 201L	Electrical Engineering and Electronics	2 + 3	2 + 1	None
8.	**Senior Design Project (6 Credit Hours)**			
ME 498L	Project I	0 + 9	0 + 3	HU 221
ME 499L	Project II	0 + 9	0 + 3	ME 498L

SAMPLE SEMESTER WISE SCHEME OF STUDIES FOR B.SC. MECHANICAL ENGINEERING (SESSION 2015 ONWARD)

1st Semester

Course No.	Title	Credit Hrs		Contact Hrs		Pre-requisites
		Th	Lb	Th	Lb	
HU 111	Communication Skills	0	1	0	3	
MA 113	Calculus and Analytic Geometry	3	0	3	0	
Phy 119 & Phy 119L	Engineering Physics	2	1	2	3	
ME 100L	Workshop Practice	0	1	0	3	
ME 111 & ME 111L	Thermodynamics-I	3	1	3	3	
ME 121	Engineering Statics	2	0	2	0	
ME 131	Industrial Materials	2	0	2	0	
	Total:	**12**	**4**	**12**	**12**	

2nd Semester

Course No.	Title	Credit Hrs		Contact Hrs		Pre-requisites
		Th	Lb	Th	Lb	
CS 101 & CS 101L	Computing Fundamentals	2	1	2	3	
IS 101	Islamic & Pakistan Studies-I	3	0	3	0	
MA 129	Vector and Complex Analysis	3	0	3	0	
ME 122	Engineering Graphics	2	0	2	0	
ME 122L	Engineering Drawing	0	2	0	6	
ME 123 & ME 123L	Engineering Dynamics	3	1	3	3	MA 113, ME 121
	Total:	**13**	**4**	**13**	**12**	

3rd Semester

Course No.	Title	Credit Hrs		Contact Hrs		Pre-requisites
		Th	Lb	Th	Lb	
EE 201 & EE 201L	Electrical Engineering and Electronics	2	1	2	3	
IS 201	Islamic & Pakistan Studies-II	3	0	3	0	IS 101
MA 225	Differential Equations and Transforms	3	0	3	0	
ME 211	Fluid Mechanics-I	2	0	2	0	ME 123
ME 221 & ME 221L	Mechanics of Materials-I	3	1	3	3	ME 121
ME 231 & ME 231L	Manufacturing Processes	3	1	3	3	ME 131
	Total:	**16**	**3**	**16**	**9**	

4th Semester

Course No.	Title	Credit Hrs		Contact Hrs		Pre-requisites
		Th	Lb	Th	Lb	
HU 221	Technical Writing & Presentation Skills	3	0	3	0	
MA 242	Engineering Statistics	3	0	3	0	
ME 212 & ME 212L	Thermodynamics-II	3	1	3	3	ME 111, ME 211
ME 213 & ME 213L	Fluid Mechanics-II	2	1	2	3	MA 225, ME 211
ME 222 & ME 222L	Mechanics of Materials-II	3	1	3	3	ME 221
	Total:	**14**	**3**	**14**	**9**	

5th Semester

Course No.	Title	Credit Hrs		Contact Hrs		Pre-requisites
		Th	Lb	Th	Lb	
ME 311 & ME 311L	Hydraulic Machines	2	1	2	3	ME 213
ME 312 & ME 312L	Heat and Mass Transfer	3	1	3	3	ME 212, ME 213
ME 321	Theory of Machines-I	3	0	3	0	ME 123
ME 322 & ME 322L	Machine Design and CAD-I	3	1	3	3	ME 122L, ME 222
ME 331 & ME 331L	Machine Tools and Machining	2	1	2	3	ME 100L, ME131
	Total:	**13**	**4**	**13**	**12**	

6th Semester

Course No.	Title	Credit Hrs		Contact Hrs		Pre-requisites
		Th	Lb	Th	Lb	
MGT 316	Project Management and Economics	3	0	3	0	
MA 345 & MA 345L	Numerical Methods in Computing	3	1	3	3	
ME 323 & ME 323L	Machine Design and CAD-II	3	1	3	3	ME 322
ME 324 & ME 324L	Theory of Machines-II	3	1	3	3	ME 321
ME 332 & ME 332L	Metrology and Quality Assurance	2	1	2	3	MA 242
	Total:	**14**	**4**	**14**	**12**	

7th Semester

Course No.	Title	Credit Hrs		Contact Hrs		Pre-requisites
		Th	Lb	Th	Lb	
ME 411 & ME 411L	IC Engines	2	1	2	3	ME 312
ME 412 & ME 412L	Refrigeration and Air Conditioning	3	1	3	3	ME 312
ME 421	Mechanical Vibrations	2	0	2	0	ME 324
ME 422 & ME 422L	Mechanics of Material-III	2	1	2	3	MA 225, ME 222
ME 441 & ME 441L	Instrumentation and Control	2	1	2	3	EE 201, MA 242
ME 498L	Project I	0	3	0	9	HU 221
	Total:	**11**	**7**	**11**	**21**	

8th Semester

Course No.	Title	Credit Hrs		Contact Hrs		Pre-requisites
		Th	Lb	Th	Lb	
ME 413 & ME 413L	Power Plants	3	1	3	3	ME 312
ME 414	Energy Resources and Utilization	2	0	2	0	ME 312
ME 431	Production and Operations Management	2	0	2	0	
ME 451 & ME 451L	Finite Element Analysis	2	1	2	3	MA 345
ME 499L	Project II	0	3	0	9	ME 498L
	Total:	**9**	**5**	**9**	**15**	
	Grand Total:	**102**	**34**	**102**	**102**	
		136		**204**		

DETAIL OF COURSES FOR B.SC. MECHANICAL ENGINEERING(SESSION 2015 ONWARD)

IS 101 Islamic & Pakistan Studies-I 3(3,0)
Prerequisite: None

It is a university level course. The contents are designed by the Department of Islamic Studies.

HU 101 Ethics & Pakistan Studies-I 3(3,0)
Prerequisite: None

It is a university level course. The contents are designed by the Department of Islamic Studies.

IS 201 Islamic & Pakistan Studies-II 3(3,0)
Prerequisite: IS 101: Islamic and Pakistan Studies-I

It is a university level course. The contents are designed by the Department of Islamic Studies.

HU 201 Ethics & Pakistan Studies-II 3(3,0)
Prerequisite: HU 101: Ethics and Pakistan Studies-I

It is a university level course. The contents are designed by the Department of Islamic Studies.

HU 111 Communication Skills 1(0,1)
Prerequisite: None

It is a university level course. The contents are designed by the Department of Humanities.

HU 221 Technical Writing & Presentation Skills 3(3,0)
Prerequisite: None

It is a university level course. The contents are designed by the Department of Humanities.

MGT 316 Project Management and Economics 3(3,0)
Prerequisite: None

Introduction to project management, Project life cycle; Types of projects, Project appraisal, Project planning, Conflicts and negotiation, Project implementation., Budgeting and cost estimation, Scheduling; Resource allocation, Monitoring and information systems, Project control., Project feasibility study (Project appraisal tools), Environmental Impact analysis, Cost benefit analysis, Earned value analysis, How to prepare project feasibility study, Project networking & scheduling (PERT/CPM).

Recommended books

1. Jack R. Meredith & Samuel J. Mantel, Jr.: Project Management – A Managerial Approach, Aug 2011.
2. Harold Kerzner Project Management – A Systems Approach to Planning, Scheduling and Controlling, Feb 2013.
3. Project management body of knowledge "PMBOK" 5th edition, Jan 2013.

Phy 119 & Phy 119L Engineering Physics 3(2,1)
Prerequisite: None

Introduction: Scientific notation and significant figures. Units in different systems.
Vectors: Review of vectors, Vector derivatives, Line and surface integrals, Gradient of scalar.
Mechanics: Coordinate systems. Motion under constant acceleration, Newton laws and their applications, Uniform circular motion. Vortex Motion, Frictional forces. Work and energy. Potential energy, energy conservation, energy and our environment.
Electrostatic and magnetism: Coulomb's law, Gauss's law, Electric field around conductors, Dielectrics. Magnetic fields. Magnetic force on current.

Semiconductor Physics: Energy levels in a semiconductor, Hole concept, Intrinsic and extrinsic regions, Law of mass action, P-N junction, Transistor.

Waves and Oscillation: Free oscillation of systems with one degree of freedom, Classical wave equation. Transverse modes for continuous string. Standing waves. Dispersion relation for waves.

Optics and Laser: Basic introduction to Optics and Laser. Diffraction grating. Lasers, Population inversion. Resonant cavities. Quantum efficiency. He-Ne, Ruby and CO_2 lasers.

Modern Physics: Photoelectric effect, Compton Effect, Bohr theory of hydrogen atom, atomic spectra, reduce mass, De-Broglie hypothesis Braggs law, Electron microscope, Zeeman effect, Atomic nucleus, Mass energy relation, Binding energy, Nuclear forces and fundamental forces, Exponential decay and half life.

Recommended Books:

1. Fundamentals of Physics by Halliday, Resnick and Walkers 9th Edition.
2. Applied Physics (University Physics) by Zears, Zemansky and Young 7th Edition
3. Physics for scientist and Engineers with Modren Physics, by Dougles C. Giancol, 4th Edition

MA 113 Calculus and Analytic Geometry 3(3,0)
Prerequisite: None

Pre-requisite: Derivative of a function; Differentiation; Rules of differentiation; Differentiation of algebraic, trigonometric, inverse trigonometric, exponential and logarithmic functions; Differentiation of implicit functions; Anti-derivatives; Integration; Basic techniques of integration; Algebra of vectors; Scalar and vector products; Determinants and their properties.

Contents: A review of differentiation: Geometrical interpretation of a derivative; Infinitesimal; Differential coefficient; Derivatives of higher order; Indeterminate forms and L. Hopital's rule; Asymptotes; Curvature; Increasing and decreasing functions; Maxima and minima of a function. Approximation and error estimates.

Further techniques of Integration; Integration by reduction formula; Fundamental Theorem of Integral Calculus; Definite integral and its properties ; Area enclosed between curves; Arc length; Volume of a solid; Volume of a solid of revolution; Area of surface of revolution; Moments; Centroids.

Cartesian, cylindrical and spherical coordinates; The ratio formula; Equations of a straight line in R^3; Direction ratios and direction cosines; Angle between two straight lines, Distance of a point from a line; Equations of a plane; Angle between two planes; Shortest distance between two skew lines; The sphere; Directional derivatives.

The concept of limit, continuity and differentiation in functions of several variables; Geometric interpretation of partial derivatives; Total differential; Chain rule; Implicit differentiation; Maxima and minima of functions of two independent variables. Taylor's and Maclaurin's series for functions of two variables.

Double Integration; Fubini's Theorems; Change of order; Geometrical Interpretation of double integral; Applications to find volumes and areas.

Recommended Books:

1. "Mathematics for Engineers and Scientists" by Muhammad Iqbal Bhatti and Muhammad Nasir Ch., published by Allied Book Centre, Urdu Bazar Lahore.
2. "Calculus" by Thomas & Finny published by Addison Wesley
3. "Advanced Engineering Mathematics" by E. Kreyszig, published by John Wiley & Sons,
4. "Calculus" by Howard Anton.
5. "Calculus" by Swokowski.

MA 129 Vector and Complex Analysis 3(3,0)
Prerequisite: None

Pre-requisite: Algebra of vectors; Scalar and vector products, Complex numbers and their conjugates , Absolute value of a complex number and properties, Algebra of complex numbers; Polar form of a complex number.

Contents: A review of vector algebra, scalar and vector products: Scalar triple product, Vector triple product; Scalar and vector point functions; Differentiation and integration of vector point functions; Gradient of a function; Divergence, curl and their physical interpretations; Green's theorem in the plane; Gauss' divergence theorem and Stock's theorem; Cartesian tensors.
Polar and exponential forms of complex numbers; Product and quotient of complex numbers in polar form; Properties of complex numbers; Lograthim of a complex number; De Moivres Theorem, The nth roots of a number; Solution of equations; Circular and hyperbolic functions; Inverse hyperbolic functions; Limit, continuity and differentiability of complex functions; Analytic functions, Harmonic functions; Cauchy fundamental theorem and its consequences; Cauchy Integral formula; Derivatives of an analytic function; Singularities and calculus of residues; Contour integration.

Recommended Books:

1. "Mathematics for Engineers and Scientists" by Muhammad Iqbal Bhatti and Muhammad Nasir Ch, published by Allied Book Centre, Urdu Bazar Lahore.
2. "Advanced Engineering Mathematics" by E. Kreyszig, published by John Wiley & Sons,
3. "Vector Analysis" by M.R. Spiegel, McGraw – Hill Book Company.
4. "Elements of Complex Variables" by Pennisi, L. L. Holt, Rinehart and Winston, U.S.A.
5. "Vector and Tensor Analysis" by N.A. Shah, A–One Publishers, Urdu Bazar, Lahore.

MA 225 Differential Equations and Transforms 3(3,0)
Prerequisite: None

Pre-requisite: Rules and formulas of differentiation and integration,

Contents: Formation of differential equations; Solution of various types of first order differential equations; Orthogonal trajectories, Application in physical problems. Linear differential equations of second order, Complementary function and particular integral. Solution of non-homogeneous linear differential equations of second order and higher by (i) the method of undetermined coefficients (ii) the method of variation of parameters and (iii) the method of power series; Application of second order differential equations; System of differential equations.
Formation of partial differential equations; Equations reducible to ordinary differential equations; Equations of the form $Pp + Qq = R$; Solution by the method of separation of variables. Wave, heat and Laplace equations.
Introduction to Laplace transform: Laplace transform of elementary functions, Laplace transform theorems, Inverse Laplace transform, applications to the solutions of initial value problems, Convolution theorem and applications.
Periodic functions. Even and odd functions. Fourier series of functions of period 2π and arbitrary period; Half range series; Complex Fourier series, Fourier transform and applications

Recommended Books:

1. "Mathematics for Engineers and Scientists" by Muhammad Iqbal Bhatti and Muhammad Nasir Ch, published by Allied Book Centre, Urdu Bazar Lahore.
2. "Advanced Engineering Mathematics" by E. Kreyszig, published by John Wiley & Sons,
3. Elementary Differential Equations and Boundary Value Problems, by Boyce and Diprima, 10th Edition, Wiley, 2012
4. "Advanced Engineering Mathematics" by H.K. Dass, published by S. Chand & Company, New Dehli.
5. "Ordinary Differential Equations" by N.A. Shah, A-one publishers, Urdu Bazar, Lahore.

MA 242 Engineering Statistics 3(3,0)
Prerequisite: None

Introduction & role of statistics in engineering.
Population & samples, Variables, Methods of displaying data sets, Stem & leaf display, Histogram, Histogram shapes, Boxplot, Bar chart, Pareto diagram, Dot diagram, Frequency distributions & their graphs, Outlier.
Mean, Median, Quartile, Percentile, Range, Deviation from mean, Sample variance, Sample standard deviation, Coefficient of variation.
Probability, Concepts & definitions, Basic theorems of probability, Law of total probability, Bayes theorem, Discrete and continuous random variables and their probability distributions, Density and distribution functions; Expectation.
Mean & variance of discrete & continuous random variables, Binomial distribution, Poisson distribution, Normal distribution, t-distribution, Chi- square distribution, F-distribution.
Sampling techniques and sampling distribution; Point estimation and interval estimation of parameters, Least square linear & polynomial regression, Linearization of nonlinear models, Correlation, Design of experiments, Analysis of variance.

Recommended Books:

1. Applied Statistics for Engineers & Scientists by Devore/Farnum, 3rd Ed. Thomas.
2. Probability and Statistics for Engineers and Scientists, Ronald E. Walpole, 8th Ed. Pearson Educational International, 2007.
3. Probability and Statistics for Engineering and Sciences, 8th Ed. CENGAGE Learning.
4. Advanced Engineering Mathematics by Erwin Kreyszig, 11th Ed. John and Viley and Sons.
5. Applied Statistics and Probability for Engineers by Montgomery, Runger, 3rd Ed. John and Viley and Sons.
6. Probability and Random Variables and Stochastic Processes, Papoulis Athanasios, 3rd Ed. McGraw-Hill Inc.
7. Introduction to Statistical Theory by Muhammad Shehzad and Sher Muhammad, Ilmi Kitab Khana Urdu Bazar Lahore.

MA 345 & MA 345L Numerical Methods in Computing 4(3,1)
Prerequisite: None

Basic concepts: round-off errors, floating point arithmetic, Convergence
Solution of non-linear equations: Open methods, bracketing methods for locating roots, initial approximation and convergence criteria, Newton Raphson and Secant methods.
Solution of linear simultaneous equations: Jacobi's method; Gauss-Seidle method;
Finite differences: Difference operators and tables; Differences of polynomials;
Interpolation and polynomial approximation: Taylor series approximation, introduction to interpolation, Newton's polynomials, Newton's divided difference table and interpolation, Lagrange's interpolation, Chebyshev polynomials.
Curve fitting: Least squares line, curve fitting, Interpolation by spline functions.
Numerical differentiation: approximating the derivative.
Numerical integration: Introduction to quadrature, trapezoidal, composite trapezoidal and Simpson's rules.
Solution of differential equations: Taylor series method, Euler's method, Runge Kutta methods.
Solution of partial differential equations: Hyperbolic Equations, Parabolic Equations, Elliptic equations.
Computations: Numerical techniques in context of engineering applications and solutions of problems by using Matlab.

Recommended Books:

1. "Numerical Methods for Engineers" by S. C Chapra & R. P Canale, McGraw-Hill.
2. "Numerical Methods using MATLAB" by John H. Mathews, Pearson Education.

3. "Applied Numerical Methods for Engineers using MATLAB" by Robert J. Schilling & Sandra L. Harris, Brooks/Cole.
4. "Numerical Methods for Engineers and Scientists" by D. Joe Hoffman.
5. "A First Course in Numerical Analysis with FORTRAN and C." by Saeed Akhtar Bhatti.

CS 101 & CS 101L **Computing Fundamentals** **3(2,1)**
Prerequisite: None

Introduction to Hardware, Software Engineering, Networking, Operating System and Database Concepts.
Business Applications: Data acquisition, storage and presentation using MS Office.
Pseudo Code, Problem solving techniques and Flow Charts.
Introduction to Visual Basic/C++.
Class Project: Solving Specific Engineering Problem.
Good understanding of the world wide and internet applications.

Recommended Books

1. Computer Science and Overview by J. Glenn Brook Shear
2. Simple Program Design by Lesley Anne Robertson
3. Schaum Series, Visual Basic and Tutorials
4. Discovering Computers by Shelly Vermaat

ME 100L **Workshop Practice** **1(0,1)**
Prerequisite: None

1. Machine Shop: Detailed study of centre lathe and accessories. Plain and Taper turning. Basic lath operations including turning, facing, simple screw cutting/treading, knurling, Grooving (Drilling and Boring), cutting tools and their grinding. Brief Introduction of shaper, milling Sharing and Surface Grinding Machine. Assigning of Practical Jobs.
2. Fitting and Fabrication Shop: The use and care of fitter's tools. Marking out of job. Practice in Metal filing. Sawing, Drilling, dieing, Tapping and reaming. Brief introduction and use of power Hack Saw, Arbor Press, Sheet Sharing Machine, Sheet Rolling Machine, Punching Machine and Drilling Machine. Assigning of practical Jobs.
3. Carpentry Shop: The use and care of tools. Type of Timber, its defects and preservation methods practice in planning and sawing. Different types of wood joints. Study of sawing, planning, turning mortise and tenon machines. Assigning of Practical Jobs.
4. Electrical Shop: Electric shocks and treatment. The use and care of tools used by Electrician. Types and uses of cable and electrical accessories for house wiring, practice in simple house wiring, testing methods. Switch gear used on domestic installation and DB system. Earthing System. Assigning of Wiring arrangements practical.

Books recommended:

1. Workshop Technology part-1 by W.A.J Chapman.
2. Electrical Wring by Richter and Schwan
3. Wiring Manual by Pak Cables Limited.

ME 111 & ME 111L **Thermodynamics-I** **4(3, 1)**
Prerequisite: None

Thermodynamics, system, continuum, properties, state, thermodynamic equilibrium, state postulate and its conclusions, process, cycle, zeroth law of thermodynamics, forms of energy, energy transfer by heat, energy transfer by work, moving boundary work and other forms of work, properties of pure substances, phase change processes of pure substance, critical and triple point, property diagrams for phase change processes, use of property tables, ideal gas equation, specific heats, Joule's law, internal energy, enthalpy and specific heats of perfect gases, liquids and solids, first law of thermodynamics, first law of thermodynamics applied to non – flow processes, continuity equation, first law of thermodynamics applied to flow processes, steady flow energy equation and steady flow engineering devices, uniform state and uniform flow processes, second law of thermodynamics, statements,

corollaries, thermodynamic temperature scale, reversible and irreversible processes, entropy and its application to non-flow and flow processes, temperature-entropy and enthalpy-entropy diagrams, generation of steam through boilers, classification, configurations and applications of boilers, boiler efficiencies, energy analysis of boilers, boiler Draughts, concept of steam condenser and its types, thermodynamic cycles, Carnot cycle, gas power cycles, vapour power cycles, vapour compression cycle

Recommended Books

1. Thermodynamics, An Engineering Approach by Y. A. Cengel and M. A. Boles
2. Fundamentals of Engineering Thermodynamics by Moran, Shapiro
3. Basic Engineering Thermodynamic by Rayner Joel
4. Applied Thermodynamics for Engineering Technologists by T.D. Eastop, A. McConkey

ME 121 Engineering Statics 2(2, 0)

Prerequisite: None

Force System, force, rectangular components, moment, couples, resultant of forces, moments and couples (two and three dimensional systems), equilibrium, mechanical systems, isolation and equilibrium equations for two and three-dimensional systems. Free body diagram, two force and three force members, plane trusses, method of joints, method of sections, frames and machine analysis, distributed forces, flexible cables, friction, types of friction, dry friction, applications of friction.

Recommended Books:

1. Engineering Mechanics, Statics by J.L. Meriam and L.G. Kraige
2. Engineering Mechanics, Statics by R.C. Hibbeler and S.C. Fan
3. Vector Mechanics for Engineers, Statics by Ferdinand P. Beer and E.Russell Johnston Jr.

ME 122 Engineering Graphics 2(2, 0)

Prerequisite: None

Introduction, types of lines, projections, types of projections, orthographic projections, plane of projections, four quadrants, projection of points, projection of straight lines, examples with different quadrants, traces of a line, true length of a line, inclination to both the planes, projection of oblique and auxiliary planes, loci of points and generated curves, Loci of points and straight lines, cycloid, epicycloid, involute, Archimedean spiral, development of solids, types of solids, polyhedra, solids of revolution, prism, pyramid, cylinder, cone, sphere, intersection of surfaces, Intersection of cylinder and cylinder, cone and cylinder, cone and cone, cone and prism, projection of solids, projection of various solids in simple position and inclined positions, section of solids, true shape of section on auxiliary plane of various solids.

Recommended Books

1. Technical Graphics Communication by Bertoline Wiebe, Miller Mohler, Irwin
2. Practical Geometry and Engineering Graphics by Abbot.
3. Engineering Graphics by Craft, Meyers and Boyer

ME 122L Engineering Drawing 2(0, 2)

Prerequisite: None

Introduction, types of lines, lettering, dimensioning, use of pencil and drawing instruments, planning of drawing sheet, projections, types of projections, orthographic projections, plane of projections, four quadrants, Isometric and pictorial projections of solids/machine parts, making of freehand sketches from solid objects and from orthographic projections, sections of joints, screw thread systems, nuts and bolts, keys and cotter, coupling and simple bearings, pipe connections and engine details, preparation of assembly drawings.

Recommended Book

1. Engineering Drawing by A. C. Parkinson

ME 123 & ME 123L **Engineering Dynamics** **4(3, 1)**

Prerequisite: MA 113: Calculus and Analytic Geometry, ME 121: Engineering Statics

Kinematics of Particles, rectilinear motion, plane curvilinear motion, rectangular coordinates, normal and tangential coordinates, polar coordinates, space curvilinear motion, kinetics of particles: force, mass, and acceleration, Newton's second law of motion, equation of motion and solution of problems, kinetic diagrams, rectilinear motion, curvilinear motion, work and energy, potential energy, impulse and momentum, conservation of momentum, kinetics of systems of particles plane kinematics of rigid bodies, angular motion relations, absolute motion, relative velocity, instantaneous centre of zero velocity, relative acceleration, kinematic analysis using rotating frames of references, plane kinetics of rigid bodies, force, mass, and acceleration, equation of motion, translation, fixed axis rotation, general plane motion, work and energy relationship, impulse and momentum equations.

Recommended Books

1. Engineering Mechanics, Dynamics by J.L. Meriam and L.G. Kraige
2. Engineering Mechanics, Dynamics by R.C. Hibbeler and S.C. Fan
3. Vector Mechanics for Engineers, Dynamics by Ferdinand P. Beer and E.Russell Johnston Jr.

ME 131 **Industrial Materials** **2(2, 0)**

Prerequisite: None

Metals and their structure, crystalline, polymorphism or allotropy. crystallographic planes, mechanisms in metals, slip and slip systems, types of dislocation, twinning, yield phenomenon and strain aging, metals and alloy systems, production of iron, wrought iron, cast iron, production of steel and its classification, ferrite, austenite, S-iron, cementite, pearlite, martensite, bainite, etc., iron-iron carbide phase diagram, alloying elements and their effect on the properties of alloy steel, refining of copper, aluminum and zinc, aluminum alloys, structure, properties, applications and selection of aluminum alloys, zinc alloys, structure, properties, applications and selection of zinc alloys, copper alloys, structure, properties, applications and selection of copper alloys, brass and bronzes, metals and alloys for special application, corrosion of metals anti-corrosive coatings and paints, material forms and designation, heat treatment critical temperature transformation on heating/cooling, annealing, normalizing, tempering, quenching, austempering, hardening, rolling processes and production of various steel sections such a billet, bar, rod, channel, Roll pressure calculation, British standards and ASTM standard specification on iron / steel, Non Metals: Properties, Composition, structure of plastics, rubber, ceramic, fiberglass and composite materials. Polymers: Molecular structure, properties, bonding and classification of polymers Compounding, forming of thermosetting or thermoplastic polymer. Ceramics and Refractory: Mechanical and thermal properties of Ceramics, Ceramic materials, structure, properties, applications and selection of ceramics, introduction to composite materials

Recommended books

1. Material Sciences and Engineering by William D. Callister
2. Introduction to Physical Metallurgy by Avner
3. Process and Materials of Manufacturing by Lindberg
4. Materials and Processes in Manufacturing by E.P Degarmo

ME 211 **Fluid Mechanics-I** **2(2, 0)**

Prerequisite: ME 123: Engineering Dynamics

Introduction, continuum concept of fluid, properties of fluids, no-slip condition, no-temperature jump condition, Newton's law of viscosity, Newtonian and Non-Newtonian fluids, surface tension and capillarity, no-slip condition, no-temperature jump condition, normal stress at a point in shear free fluid, pressure, basic equation for variation of pressure in non-viscous flow or with fluid in rigid body motion and its reduction to the case of static fluid, Pascal's law, absolute and gauge pressure,

hydrostatic paradox, manometry, barometer and atmospheric pressure, hydrostatic forces on submerged plane surfaces, hydrostatic forces on submerged curved surfaces, buoyancy (Archimedes principle), stability of immersed and floating bodies, types of fluid flow, Lagrangian and Eulerian descriptions, acceleration field, material derivative , flow lines, flow rates, Reynolds transport theorem **,**integral conservation equations of mass, linear momentum, angular momentum, energy equations and their applications, Bernoulli's equation, impact of jets on curved surfaces, dimensional analysis, similitude and its applications, viscous flow in ducts, steady, quasi-steady and unsteady flow, underdeveloped and fully developed, laminar and turbulent flow, flow between parallel plates, flow in tubes, losses in pipes, Moody's chart and pumping power, flow meters

Recommended Books

1. Fluid Mechanics, Fundamentals and Applications by Yunus A. Cengel, John M. Cimbala
2. Engineering Fluid Mechanics by Clayton T. Crowe, Donald F. Elger, John A. Roberson
3. Fluid Mechanics by John F. Douglas, Janusz M. Gasiorek, John A. Swaffield
4. Fundamentals of Fluid Mechanics by Munson, Young and Okiishi
5. Fluid Mechanics by F.M. White
6. Fluid Mechanics by Irving H. Shames

ME 212 & ME 212L **Thermodynamics-II** **4(3, 1)**
Prerequisite: ME 111: Thermodynamics-I,
ME 211: Fluid Mechanics-I

Non reacting gas mixtures: Dalton's law and the Gibb's Dalton law, Exergy, Amagat's law, properties of ideal gas mixtures, adiabatic mixture of perfect gases. Fuel and Mixture with chemical reaction: Fuels and types of fuels, combustion, calorimeter, simple reaction equation, stoichiometric chemical reaction, rich and lean air-fuel ratio mixture, enthalpy of formation and combustion reaction, adiabatic flame temperature. combustion in engineering systems, third law of thermodynamics, Introduction to IC Engines: IC & EC Engines, types of IC Engines, powers and efficiencies of IC Engines, PV diagram, power and pumping loop, dynamometers, calculation of heat supply and indicated power, introduction to Fuel Injection Systems and Ignition Systems. Compressors: classification and working principles, single stage and multistage rotary and reciprocating compressors, inter-cooling, efficiencies and P-V diagrams of reciprocating compressors, velocity diagrams of centrifugal compressors, performance characteristics and working regimes. Centrifugal and axial compressors, analysis, design considerations and selection. Nozzles: Introduction to air/gas nozzles, flow through steam nozzle, their classification, working principles and efficiencies, jet propulsion. Turbines: Steam turbine, their classification and working principles, comparison of reaction & impulse steam turbines, velocity diagrams, multi row and multi stage turbines, blade height, efficiencies of turbine, compounding, gas turbines, analysis, design considerations and selection.

Recommended Books

1. Thermodynamics, An Engineering Approach by Y.A. Cengel and M.A. Boles
2. Fundamentals of Engineering Thermodynamics by Moran, Shapiro
3. Fundamentals of Thermodynamics by Sonntag, Borgnakke, Van Wylen
4. Fluid Mechanics and Thermodynamics of Turbomachinery by S.L. Dixon
5. Power Plant Technology by M. M. El –Wakil
6. Applied Thermodynamics for Engineering Technologists by T.D. Eastop, A. McConkey
7. Engineering Fundamentals of the Internal Combustion Engine by Willard W. Pulkrabek

ME 213 & ME 213L **Fluid Mechanics-II** **3(2, 1)**
Prerequisite: MA 225: Differential Equations and Transforms,
ME 211: Fluid Mechanics-I

Differential equations of mass conservation, linear momentum, angular momentum and energy conservation, introduction to Navier-Stokes equations, potential flow theory, stream function, two dimensional irrotational flows, boundary layer theory, flow over bodies, flow over flat plate, cylinder and sphere, flow over airfoil, compressible flow

Recommended Books

1. Fluid Mechanics, Fundamentals and Applications by Yunus A. Cengel, John M. Cimbala
2. Engineering Fluid Mechanics by Clayton T. Crowe, Donald F. Elger, John A. Roberson
3. Fluid Mechanics by John F. Douglas, Janusz M. Gasiorek, John A. Swaffield
4. Fundamentals of Fluid Mechanics by Munson, Young and Okiishi
5. Fluid Mechanics by F.M. White
6. Fluid Mechanics by Irving H. Shames

ME 221 & ME 221L **Mechanics of Materials-I** **4(3, 1)**

Prerequisite: ME 121: Engineering Statics

Mechanical properties of materials, tensile and compressive loads and stresses, Hooke's law, modulus of elasticity, permissible and yield stresses and factor of safety, thermal stresses, cross-section of beams, moments of inertia, beam loading, pointed and evenly distributed loads, pure bending of beams ,cantilever and simply supported beams, shearing force and bending moment diagrams, shear load and shear stresses in beams, deflection of beams, modulus of rigidity, torsion of circular bars, hollow and compound shafts, strain energy, theory of columns.

Recommended Books

1. Mechanics of Materials by F. P. Beer and E.R. Johnston
2. Mechanics of Engineering Materials by P.P. Benham and R.J. Crawford
3. Mechanics of Materials by R.C.Hibbeler
4. Mechanics of Materials by J M Gere, S.P Timoshenko
5. Strength of Materials by Andrew Pytel, Ferdinand L.Singer

ME 222 & ME 222L **Mechanics of Materials-II** **4(3, 1)**

Prerequisite: ME 221: Mechanics of Materials-I

Stresses in combined loading, Plane stress and strain, principal stresses and strains, Mohr's circle for stress and strain. Analysis of statically indeterminate beams, double integration with Macaulay's method, superposition method. Virtual work principle, energy methods, Castiglione's theorem. Thin and thick curved bars. Theories of failure, Yield criteria. Thin walled pressure vessels. Introduction to stress concentration and critical stress intensity factor, fatigue, creep, hardness, toughness, ductility, malleability, and fracture mechanics.

Recommended Books

1. Mechanics of Materials by F.P. Beer, E.R. Johnston.
2. Mechanics of Engineering Materials by P.P. Benham and R.J. Crawford.
3. Advanced Theory and Applications by J. Alexander and J.S. Gunasekra.

ME 231 & ME 231L **Manufacturing Processes** **4(3, 1)**

Prerequisite: ME 131: Industrial Materials

Introduction to manufacturing processes, types, casting, types of molds, heating and pouring, fluidity, solidification, shrinkage, expandable mold casting, sand casting, patterns and cores, shell molding, expanded polystyrene casting process, investment casting, slush casting, die casting, hot chamber and cold chamber die casting, centrifugal casting, casting quality, product design considerations, bulk deformation processes, rolling, rolling mills, thread rolling, gear rolling, ring rolling, roll piercing, forging, open die and impression die forging, forging dies, hammers and presses, upsetting and heading, extrusion, types of extrusion, drawing, joining processes, welding, types of welding, types of weld joints, types of welds, features of welded joint, arc welding, SMAW,GMAW, GTAW, resistance welding, resistance spot and seam welding, oxyfuel gas welding, weld quality, defects, inspecting and testing of welds ,brazing, soldering, sheet metalworking, cutting operations, bending operations, drawing, presses, roll bending and forming, mechanical assembly, threaded fasteners, washers, rivets and eyelets, press fitting, shrink and expansion fits, snap fits, retaining rings, cotter pins, shaping

processes for plastics, extrusion, injection molding, compression molding, blow molding, thermoforming, introduction to rapid prototyping

Recommended Books

1. Manufacturing Engineering and Technology by Kalpakjian, Shmid
2. Processes and Materials of Manufacture by Lindberg
3. Materials and Processes in Manufacturing by Degarmo, Black, Kohser
4. Fundamentals of Modern Manufacturing, Materials, Processes and Systems by Groover
5. Manufacturing Engineering by Ostwald

ME 311 & ME 311L **Hydraulic Machines** **3(2, 1)**

Prerequisite: ME 213: Fluid Mechanics-II

Classification of fluid machines, basic equations related to turbomachines,Euler's turbomachine equation, Bernoulli and energy equation relative to rotating frame of reference, rotodynamic pumps , flow through rotodynamic pumps, cavitation in pumps, performance characteristics, application of dimensional analysis, design considerations and selection,fans,positive displacement pumps, performance characteristics, design considerations and selection, hydraulic turbines , impulse turbines, reaction turbines, flow through hydraulic turbines, performance characteristics, application of dimensional analysis, design considerations and selection, cavitation in turbines,
introduction to hydraulic systems, hydraulic fluids, hydraulic circuits, actuators, hydraulic pumps and motors, their performance characteristics, hydraulic presses, lifts and jacks, hydraulic cranes, accumulators, and intensifiers, hydraulic couplings, rams

Recommended Books

1. Basic Concepts in Turbomachinery by Grant Ingram
2. Fluid Mechanics and Thermodynamics of Turbomachinery by S.L. Dixon
3. Fluid Power With Applications by Anthony Esposito
4. Fluid Mechanics, Fundamentals and Applications by Yunus A. Cengel, John M. Cimbala
5. Engineering Fluid Mechanics by Clayton T. Crowe, Donald F. Elger, John A. Roberson
6. Fluid Mechanics by John F. Douglas, Janusz M. Gasiorek, John A. Swaffield

ME 312 & ME 312L **Heat and Mass Transfer** **4(3, 1)**

Prerequisite: ME 212: Thermodynamics-II,
ME 213: Fluid Mechanics-II

Introduction to conduction, convection and radiation heat transfer, Fourier's law, Newton's law of cooling, Stefan Boltzmann's law, Thermal conductivity, heat diffusion equation in Cartesian, Cylindrical and Spherical coordinates; one dimensional steady state heat conduction through plane composite walls, cylinders and spheres with and without heat generation sources, Insulation, critical radius/thickness of insulation, The overall heat transfer co-efficient, Fins, heat transfer through extended surfaces, Thermal contact resistance; Unsteady-state conduction, Lumped-heat-capacity system; Principles of convection, Viscous flow, Laminar boundary layer on a flat plate, The thermal boundary layer, Relation between fluid friction and heat transfer, Heat transfer in laminar tube flow, Bulk temperature, Turbulent flow in a tube, non-dimensional parameters related to convective heat transfer and their applications, shear stress; Empirical and practical relations for forced convection heat transfer, empirical relations for pipe and tube flow, flow over cylinders and spheres; Radiation heat transfer – Radiation properties, black body radiation, absorptivity, reflectivity, transmissivity, Wien's law, Kirchoff's law, Grey body radiation, Radiation shape factor and relations between shape factors, Heat exchange between non-blackbodies, Infinite parallel planes, Radiation shields, Heat exchangers - overall heat transfer co-efficient, fouling factors, types of heat exchangers, Log mean temperature difference (LMTD) and Effective-NTU methods, Compact heat exchanger, Heat exchanger design considerations; Mass transfer - Fick's law of diffusion, diffusion in gases, liquids and solids, analogy between momentum, heat and mass transfer; simultaneous heat and mass transfer, Evaporation processes in the atmosphere.

Recommended books

1. Heat Transfer by J. P. Holman
2. Engineering Heat Transfer by William S. Janna
3. Fundamentals of Heat and Mass Transfer by Incropera and Dewitt

ME 321 Theory of Machines-I 3(3, 0)

Prerequisite: ME 123: Engineering Dynamics

Friction between un-lubricated surfaces, motion on inclined plane, screw threads and efficiency, friction of pivot and collar, journal and thrust bearings, Belts and rope drives , cone, plate and centrifugal clutch, mechanisms, link, lower and higher pair joints, kinematic chain, frame, linkage, kinematically equivalent mechanisms, degree of freedom, connectivity and mobility, inversion, Grashof rules, motion limit for slider crank mechanism, graphical and analytical position, velocity and acceleration analysis of four bar and slider crank mechanism, relative velocity and relative acceleration analysis (linkages with rotating sliding joints, quick return mechanism analysis, rolling contact analysis, cam contact analysis), gears (spur gears, condition for constant velocity, involutes, gear terminology and standards, contact ratio, rack and pinion, internal gears, interference, helical, bevel and worm gears), gear trains (simple, compound, concentric and planetary gear trains)

Recommended Books

1. Mechanics of Machines, Elementary theory and Examples by John Hannah and R.C Stephens
2. Mechanics of Machines, Advanced theory and Examples by John Hannah and R.C Stephens
3. Kinematics, Dynamics and Design of Machinery by Kenneth J. Waldron/ Gary L Kinzal
4. Mechanics of Machines by W.L Cleghorn
5. Theory of Machines and Mechanisms by John J. Uicker, Gordon R. Pennock, Joseph E. Shigley
6. Kinematics and Dynamics of Machinery by Charles E. Wilson, J.Peter Sadler

ME 322 & ME 322L Machine Design and CAD-I 4(3, 1)

Prerequisite: ME 122L: Engineering Drawing,
ME 222: Mechanics of Materials-II

Basic criteria of design of machine parts, design of simple elements, design of keys, cotters, design of shaft and couplings, design of welded, design of screws and fasteners, design of belts and pulleys, design of flywheel, design of brakes, metal fits and tolerances, standards of fits and tolerances, surface finish.

Recommended Books

1. Mechanical Engineering Design by J.E. Shigley
2. Mechanical Design, An Integrated Approach by R L Norton
3. Fundamentals of Machine elements by Hamrock, Shmid, Jacobson
4. Design of Machine Elements by M.F. Spotts

ME 323 & ME 323L Machine Design and CAD-II 4(3, 1)

Prerequisite: ME 322: Machine Design and CAD-I

Design of spur gear, helical, bevel and worm gears, design of rolling contact bearings, design of journal bearings, Design of helical extension, helical compression and torsion springs, design of clutches, international design standards BS, ANSI, JIS, DIN, ISO standards, design of mechanical components assembly and dimensioning.

Recommended Books

1. Mechanical Design, an Integrated Approach by R L Norton
2. Mechanical Engineering Design by J.E. Shigley
3. Fundamentals of Machine elements by Hamrock, Shmid, Jacobson
4. Design of Machine Elements by M.F. Spotts

ME 324 & ME 324L Theory of Machines-II 4(3, 1)

Prerequisite: ME 321: Theory of Machines-I

Chains and sprockets, bands and shoe brakes. dead weight and spring loaded governors, effort and power, sensitivity, controlling force and stability, crank effort diagram, flywheels , profile cam design , Hook's joint, steering mechanism, Geneva mechanism, gyroscope, gyroscopic stabilization, theory and applications of dynamometers), force analysis of mechanisms (slider crank mechanism, spur, helical, bevel and worm gears, cam), torques on gear trains, balancing, balancing of rotating and reciprocating masses, balancing of in-line engines, V-engines and radial engines, balancing machines

Recommended Books

1. Mechanics of Machines, Elementary theory and Examples by John Hannah and R.C Stephens
2. Mechanics of Machines, Advanced theory and Examples by John Hannah and R.C Stephens
3. Kinematics, Dynamics and design of Machinery by Kenneth J. Waldron/ Gary L. Kinzal
4. Mechanics of Machines by W.L Cleghorn
5. Theory of Machines and Mechanisms by John J. Uicker, Gordon R. Pennock, Joseph E. Shigley
6. Kinematics and Dynamics of Machinery by Charles E. Wilson, J.Peter Sadler

ME 331 & ME 331L Machine Tools and Machining 3(2, 1)

Prerequisite: ME 100L: Workshop Practice,
ME 131: Industrial Materials

Introduction to rotary and linear and rotary cum linear machine tools; lath machine tools, working principle of machines, conventional and non-conventional machining processes, machines related statics and dynamics, different lathe processes, calculation of area, volume and power; cutting tools nomenclature, geometry and materials, and their effects on machining, cutting speed, feed and depth; Types of drilling machine and drills, speed, feed and power calculations; Milling machine classifications, milling processes, milling cutters and related mechanics, speed, feed, depth of cut, calculations; grinder, and its types, grinding processes, grinding wheel structure; working principles configuration and their related mechanics , shaper, planer, slotter; working principle, configuration and related mechanics, introduction to CNC Machining, EDM, ECM, Water jet cutting, Plasma arc cutting, Chemical milling,

Recommended Books

1. Machine Tools Practice by Kibbe, Meyer, Neely, White
2. Technology of Machine Tools by Krar, Gill, Smid
3. Manufacturing and Machine Tool operation by: Pollack
4. Workshop Technology (Vol- I, II and III; SI Versions) by: Chapman
5. Fundamentals of Modern Manufacturing, Materials, Processes and Systems by Groover

ME 332 & ME 322L Metrology and Quality Assurance 3(2, 1)

Prerequisite: MA 242: Engineering Statistics

Introduction to the line and end standards, linear measurement, errors, Interferometry ,comparators, Taylor's Theory of Gauging Systems, Limits and Fits, B.S 4500, Design of Limit Gauges Angular Measurements. Sine bar, Angle gauges, Measurement of internal taper Alignment and perpendicularity measurement, Autocollimators, Measurement of roundness. Gear Measurement and Testing, Measurement of Surface Texture. Control charts for variables and attributes. Acceptance Sampling, Operating characteristic curves, Introduction to Quality Management Systems, Introduction to ISO-9000

Recommended Books

1. Fundamentals of Dimensional Metrology by Dotson, Harlow,Thompson
2. Quality Control by Besterfield

ME 411 & ME 411L IC Engines 3(2, 1)
Prerequisite: ME 312: Heat and Mass Transfer

Introduction and historical perspective, classifications, operating cycles, components and operations of IC engines, working principle of S I and C I engines; Engine design and operating parameters – Geometrical properties and performance parameters, performance characteristics of SI and CI engines under variable conditions of load and speed; Cooling Systems, Lubricants and lubrication of the Engines, Ideal models of engine cycles – Processes and thermodynamic relations, analysis of ideal gas and fuel-air cycles, comparison with real engine cycles; Fuel metering, carburetion and injection in SI engines, octane number and rating; Combustion in SI engines – Thermodynamics analysis, abnormal combustion (knock) in SI engines; Combustion in CI engines – Essential features, types of combustion systems, flow visualization and diagnostics, combustion in DI multi-spray systems, analysis of cylinder pressure data, heat release analysis, fuel spray behavior, ignition delay, cetane number and ratings; Supercharging – working principle of turbo-charged engine, its performance characteristics and comparison with naturally aspirated (NA) engine of equal power; Engine testing and control, exhaust gas analysis, regulated and unregulated emissions, controlling of emissions using in-cylinder and out-cylinder (after treatment) techniques, implications of exhaust gas recirculation (EGR) system, thermal reactor and catalytic converters, Diesel NOx and particulate trade off, selective catalytic reduction (SCR), diesel oxidation catalyst (DOC) and diesel particulate filter (DPF); Conventional and alternative fuels, fuel additives, engine lubrication and lubricants, engine cooling systems and coolants.

Recommended Books

1. Internal Combustion Engine Fundamentals by J.B. Heywood
2. Introduction to I. C. Engines by Richard Stone
3. Internal combustion Engines by C. R. Ferguson and A. T. Kirkpatrick

ME 412 & ME 412L Refrigeration and Air Conditioning 4(3, 1)
Prerequisite: ME 312: Heat and Mass Transfer

Introduction, History of refrigeration, Application of refrigeration; Scope, classification and application of air-conditioning, The vapor compression cycle – Carnot refrigeration cycle, coefficient of performance (COP) and condition for highest COP, temperature limitations, Carnot heat pump, revision of the Carnot cycle, standard vapor-compression cycle and its performance, pressure-enthalpy chart, Actual vapor compression cycle; Refrigerants – types of refrigerants, their characteristics and thermodynamic comparison, Absorption refrigeration – vapor absorption cycle and COP, Thermal analysis of simple absorption system and system with heat exchanger, commercial absorption units, Aqua-ammonia system; Thermo-electric, vortex-tube and steam-jet water vapor refrigerating systems; Ultra-low temperature refrigeration, cryogenics, properties of cryogenic fluids, methods of low temperature cooling; Psychrometry and wetted surface heat transfer – Psychrometric chart, properties of moist air, Psychrometric processes, Heating and cooling load calculations – health and comfort criteria, air quality, estimation of heat loss and gain, infiltration and ventilation loads, internal loads and solar loads; Air conditioning systems – thermal distribution systems, single zone system and its design calculations, terminal-reheat system, dual duct or multizone system, variable air volume (VAV) system, Cooling towers and evaporative condensers – range and approach of a cooling tower, analysis of a counter-flow cooling tower, cross flow cooling towers, evaporative condensers and coolers.

Recommended Books

1. Refrigeration and Air conditioning by W.F. Stoecker, J.W. Jones
2. Refrigeration and Air conditioning by Ahmadul Ameen
3. Principles of Refrigeration by Roy J. Dossat

ME 413 & ME 413L **Power Plants** **4(3, 1)**
Prerequisite: ME 312: Heat and Mass Transfer

Introduction to conventional and non-conventional power plants, Rankine cycle, steam power plants, heat balance sheet, concepts of heat regeneration and co-generation, combined heat and power (CHP) systems, binary power plants; Brayton cycle, gas turbine power plants, with and without exhaust gas heat recovery, cooling of combustion chamber and gas turbine blades, Application of gas turbines in aircraft industry, flow through air intakes duct and nozzles, nozzle choking, and critical pressure ratio, ram jets, jet propulsion, propulsive thrust, turbojet engines, turboprop engines, and their performance characteristics, Introduction to nuclear power plants, environmental hazards, power plant site selection power plants economics.

Recommended Books

1. Power Plant Technology by M. M. El –Wakil
2. Power Plant Engineering by P.K Nag
3. Modern power plant engineering by J. Weisman and R. Eckart
4. Power plant system deign by K.W. Li and A.P.Priddy
5. Power plant by F.T. Morse
6. Standard Handbook of Powerplant Engineering by Thomas C.Elliott, Kao Chen, Robert C.Swanekamp

ME 414 **Energy Resources and Utilization** **2(2, 0)**
Prerequisite: ME 312: Heat and Mass Transfer

Mineral Energy resources, Fossil Fuels in solid, liquid and gaseous state, Hydroelectric power, Fuel cells, Wind power, wind turbines, compatible power generators, wind turbine design issues, Tidal power, Geothermal energy, Biomass energy, Modern renewable energy plants, Operations and maintenance problems, Energy conservation techniques, Energy audit, energy management systems

Recommended Readings:

1. Energy Resources, Utilization and Technologies by Anjaneyulu Yerramilli and Francis Tuluri
2. Renewable Energy: Power for a Sustainable Future by Godfrey Boyle
3. Renewable Energy Resources Paperback by John Twidell, Tony Weir.

ME 421 **Mechanical Vibrations** **2(2, 0)**
Prerequisite: ME 324: Theory of Machines-II

Oscillatory motion, elements of vibrating system, harmonic motion, periodic motion, vibration terminology, single degree of freedom systems, equation of motion, Newton's method, energy method, undamped free vibration, viscously damped free vibration, logarithmic decrement, harmonically excited vibration, vibration isolation, vibration measuring instruments, finding natural frequencies, modal analysis, Vibration measurement, Vibration diagnosis and control, Machinery health monitoring software Case studies.

Recommended Books

1. Mechanical Vibrations: Theory and Applications by W.T. Thompson
2. Mechanical Vibrations by S. S. Rao.
3. Elements of Vibration Analysis by L. Meirovitch, McGraw Hill
4. Vibration for Engineers by Endrew Dimargonas, Prentice Hall

ME 422 & ME 422L **Mechanics of Materials-III** **3(2, 1)**
Prerequisite: MA 225: Differential Equations and Transforms,
ME 222: Mechanics of Materials-II

Three dimensional stress at a point, stress equation of equilibrium, laws of stress transformation, principal stresses, displacement and strain, equations of strain transformation, principal strains, compatibility. inelastic bending and torsion, Thick cylinders, axial stresses in thick cylinders,

compound cylinders, plastic deformation of thick cylinders, thin circular plates, beams on elastic foundation.

Recommended Books

1. Mechanics of Engineering Materials by R.J. Crawford and P.P. Benham.
2. Advanced Mechanics of Materials by Arthur P. Boresi, Richard J. Schmidt

ME-431 Production and Operations Management (2, 0)
Prerequisite: None

Functions of management, production systems and factors affecting industrial development in Pakistan. Productivity and factors contributing to productivity of organizations. Work Study motion economy, efficiency, ergonomics and throughput. Inventory management; economic order quantities, coverage analysis. Demand Forecasting, Production planning and scheduling and capacity planning, Just in time and Lean Operations, HR management, Process Analysis and Design, Cost concepts and economic environments, cost terminology, general economic environment etc. Principals of money time relationship, simple interest, compound interest, present and future and uniform series cash flows etc, Money time relationships; determining minimum ROR, present, future annual worth methods, internal and external ROR, Comparing Alternatives, capitalized worth methods, mutually exclusive investment etc.

Recommended Readings:

1. Operations Management by Jay Heizer, Barry Render, Jagdesh Rajashekhar
2. Work Systems: The Methods, Measurement and Management of by Mikell P. Groover
3. Production and Operations Management by Martin Starr.

ME-441 & ME 441L Instrumentation and Control 3(2, 1)
Prerequisite: EE 201: Electrical Engineering and Electronics, MA 242: Engineering Statistics

Instrumentation, Basic concepts of instrumentation system, Static and dynamic characteristics of measuring instruments. Different transducers for measuring and indicating, temperature, pressure, flow and level. Measurement errors. Calibration of measuring instruments. Control, Introduction. Examples of control systems. Open loop and close loop control systems. Block diagrams of control systems, Block diagrams and Transfer function, Reduction of Block diagrams, Signal flow graphs, gain formula, state diagrams, state diagram to state equation and vice versa. Modeling of mechanical systems in transfer function and state equation and instate equation. Stability of control systems, methods of determining stability, Routh Hurwitz criteria. Time domain analysis of control systems, Steady state error for different types of control systems, Root locus, properties of root loci, Introduction to P, PI, PD and PID control. Introduction to state feedback control, optimal control and adaptive control.

Recommended Books

1. Measurement and Instrumentation Principles by Alan S. Moris
2. Mechanical measurement by Bechwith
3. Automatic Control Systems by Farid Golnaraghi and B.C Kuo 8th edition
4. Modern Control Systems by Dorf and Bishop
5. Control Systems engineering by Norman S Nise 5th edition

ME 451 & ME 451L Finite Element Analysis 3(2, 1)
Prerequisite: MA 345: Numerical Methods in Computing

Introduction to Finite Element Methods, Basic steps in FEM, energy, variational principles and Ritz's methods; co-ordinate transformation, iso-parametric formulation, solution of eigen value problems, boundary value problems, modeling, discretized time dependant problems, connectivity of elements,

Solutions and post processing applications of heat transfer. fluid mechanics and solid mechanics problems, finite element error analysis

Recommended books

1. The Finite Element Method: Principles and Applications by P.E.Lewis, J.P. Ward. Addison-Wesley
2. Advanced Finite Element Procedures by K.J. Bathee
3. Finite Element Analysis-Theory and Application by Saeed Moaveni, Prentice Hall

EE 201 & EE 201L **Electrical Engineering and Electronics** **3(2,1)**
Prerequisite: None

Introduction to DC circuits, series and parallel circuits and analysis, AC current, resistance, inductance and capacitance in AC circuits, power factor, single and polyphase circuits, power and power factor measurement, current and voltage relationship in phase and line circuits, introduction to AC/DC motors and generators, transformers, losses and efficiency, introduction to semiconductors, diode, power amplifiers, transistors, relays, signal conditioning, operational amplifier.

Recommended books

1. Electrical Power Technology by Theodore Wildi
2. Electric Machinery Fundamentals by S. Chapman
3. Electric Circuits, Basic Electricity by Schaum's Series
4. Electronic Devices, by Floyd, Prentice Hall
5. Electronic Principles by Malvino, A.Paul McGraw Hill

ME 498L **Project I** **3(0, 3)**
Prerequisite: HU 221: Technical Writing & Presentation Skills

ME 499L **Project II** **3(0, 3)**
Prerequisite: ME 498L: Project I