SIR PADAMPAT SINGHANIA UNIVERSITY

Udaipur

SCHOOL OF ENGINEERING

Course Curriculum of Ph.D. Degree Programme in Mechanical Engineering (Batch: 2018-19)

Credit Structure

Category	Credits
Departmental Major Subjects	6
Minor Subject	2
Total	8

Course Structure: Ph.D. Degree(2018-19)

(Departmental Major Subjects)

S.No.	Course Code	Course Title	L	T	P	Credit(s)
1	ME-601	Advanced Dynamics and Vibrations	3	0	0	3
2	ME-602	Theory of Atmospheric Boundary Layer	3	0	0	3
3	ME-603	Wind Tunnel Design & Testing	3	0	0	3
4	ME-605	Diagnostic Maintenance of Mechanical Equipment	3	0	0	3
5	ME-607	Advanced Turbo-machinery	3	0	0	3
6	ME-608	Principle of Engineering Tribology	3	0	0	3
7	ME-609	Wind Effects on Structures	3	0	0	3
8	ME-610	Experimental Stress Analysis.	3	0	0	3
9	ME-612	Control and Analysis of Dynamic Systems	3	0	0	3
10	ME-613	Optimization Methods in Design	3	0	0	3

Detailed Syllabus for Ph.D. Degree Programme in Mechanical Engineering

Semester - I

(Departmental Major Subject)

ME-601 L-T-P-C
Advanced Dynamics & Vibrations 3-0-0-3

Objective: *This course is designed for post-graduate level study of advanced theories of vibration and dynamics of machinery*

Course Content

Single DOF Systems: Review of free and forced vibration with harmonic excitation, response under periodic force, vibration due to non-periodic forces, convolution integral, impulse response, parametric excitation. Two DOF Systems: Free Vibration – General solution and method of influence coefficient, Damped –free vibration, forced vibrations with application to dynamic vibration Absorber, Technical applications. Multi DOF Systems: Generalized coordinates, Derivation of Lagrange's equations, Largrange's equation for non-conservative systems, Undamped free vibration, Determination of natural frequencies and mode shapes by numerical methods - Matrix iteration Method, Transfer matrix Method, Dunkerley's method, Stodola's Method, Holzer's Method, Forced vibration due to harmonic and non-harmonic forces. Vibrations Of Continuous Systems: Transverse vibration of strings, Vibration of membranes, longitudinal vibration of rods, Flexural vibration of beams. Non-linear Vibration: Examples of non-linear systems, phase plane method, perturbation method, Forced vibration – jump phenomena. Random Vibration: Random variables and random processes, Probability distribution, Mean value and standard deviation, Correlation functions of a random process, Stationary random process. Balancing: Field balancing of rotors, Dynamic balancing machines

Text/Reference Books

1. Mechanical Vibration. Rao S.S. Pearson Education
2. Theories of Vibration with Applications. Thomson W.T. Prentice Hall
3. Vibration Problems in Engineering. Timoshenko S.P. Young D.H. and Weaver W. John Wiley & Sons.
4. Fundamentals of Vibration. Meirovitch L. Mc-Graw Hill

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Semester - I

(Departmental Major Subject)

ME-602 L-T-P-C
Theory of Atmospheric Boundary Layer 3-0-0-3

Objective: *This course is designed for post-graduate level study of dynamics of wind within the atmospheric boundary layer.*

Course Content

Introduction; General structure of the atmosphere; elements of meteorology - lapse rate of temperature, temperature inversions, isotherms & isobars. Atmospheric Flows: Atmospheric circulation, vertical convection, centrifugal effects, stability of the atmosphere. Effect of earth's rotation, effect of friction. Atmospheric motions; wind scales. Atmospheric Boundary Layer: Atmospheric boundary layer governing equations; Ekman spiral; logarithmic and power laws; atmospheric turbulence. Similarity Analysis: Basic similarity requirements; dimensional analysis; basic scaling considerations Diffusion: General considerations, the statistical theory of diffusion, K-theory models, Gaussian models, Higher order closure models, Monte Carlo methods

Text/Reference Books

1. Wind Effects on Structures. Simiu E. & Scanlan R. H.
2. Structure of the Atmospheric Boundary Layer. Sorbjan Z.

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Mechanical Engineering

Semester - I

(Departmental Major Subject)

ME-603	L-T-P-C
Wind Tunnel Design and Testing	3-0-0-3

Objective: *This course is designed for post-graduate level study of design and testing procedures of aerodynamic and atmospheric boundary layer wind tunnels.*

Course Content

Introduction: Important testing parameters, types of wind tunnels. Wind Tunnel Design: Design of different parts: test section, diffuser, corners, fan section, fan design, return passage or second diffuser, contraction cone, cooling, honeycombs and screens, tunnel flow improvement, drive systems, energy ratio, power losses, test section inserts. Instrumentation and Calibration of Test Section: Manometers; pitot-static, pitot and long static tubes; flow direction measurement techniques, rakes; pressure tube; modern instruments and techniques; speed setting; turbulence sphere. Model Force, Moment and Pressure Measurements : Balances, types of balances: platform balances, yoke balances, pyramidal balances, balance measuring devices, internal strain gauge balances, profile drag by momentum method, lift and drag by pressure distribution. Testing Procedures:

Planning the test; testing of two-dimensional and three-dimensional wings. Boundary Corrections: The method of images, wall corrections for two-dimensional testing, buoyancy, solid blockage, wake blockage, summary of two-dimensional blockage corrections, three-dimensional blockage corrections, scale effects. ABL Wind Tunnels: Generation of atmospheric boundary layer within wind tunnels, static and dynamic testing of buildings and other earth-fixed structures.

Text/Reference Books:

1. Low Speed Wind Tunnel Testing – W.H. Rae & A. Pope

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Semester - I

(Departmental Major Subject)

ME-605 L-T-P-C
Diagnostic Maintenance of Mechanical Equipment 3-0-0-3

Objective: *This course is designed for post-graduate level study of condition monitoring and condition-based maintenance of mechanical equipments*

Course Content

Maintenance methodology: Introduction, breakdown maintenance, preventive maintenance – time based, condition based maintenance, fault tree analysis. Temperature monitoring: Measurement of temperature: thermometer, thermocouple, pyrometer, thermography. Wear debris monitoring: Filters & chip detectors, ferrography, spectrometric analysis, particle counter. Vibration monitoring: Review of SDOF vibration; vibration instrumentation – proximity type and seismic type; Vibration data – rms, peak, peak to peak, linear and logarithmic scale, decibel level; vibration analysis – time domain and frequency domain; permissible levels of vibration. Signal analysis: FFT analysis, wavelet analysis, improvement of signal to noise ratio. Non destructive testing: liquid penetrant, magnetic particle testing, ultrasonic testing, acoustic emission, radiography.

Text/Reference Books:

1. Mechanical Fault Diagnosis and Condition Monitoring. Collacott R.A. John Wiley & Sons (ISBN: 0470990953)
2. Vibration Measurement & Analysis. Nakra B.C. Yadcava G.S. & Thuested L. National Productivity Council, Lodhi Road, New Delhi – 3
3. Instrumentation, Measurements and Analysis. Nakra B.C. & Chaudhry K.K. Tata McGraw Hill Education

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Semester - I

(Departmental Major Subject)

ME-607 L-T-P-C
Advanced Turbo- Machinery 3-0-0-3

Objective: *This course is designed for post-graduate level study of design, analysis and performance of turbomachines, with a special emphasis on radial flow turbomachines.*

Course Content

Three Dimensional Flow in Axial Turbomachines: Theory of radial equilibrium, the indirect and direct problem, compressible flow through a fixed blade row. Centrifugal Pumps, Fans, Compressors: Constructional features, velocity diagrams, incompressible and compressible analysis, pre-whirl, slip, head increase of centrifugal pump, pressure ratio of centrifugal compressor. Radial Flow Turbines: Classifications, thermodynamics of 90 deg IFR turbine, design point efficiency, Mach number relations, loss coefficients, criterion for minimum number of blades, specific speed, clearance and windage losses, pressure ratio limits.

Text/Reference Books:

1. Fluid Mechanics Thermodynamics of Turbomachinery Dixon S L & Hall C.A. 6th Ed. Elsevier Publication 2010
2. Principles of Turbomachinery. Shepherd D. G. Macmillan 1956

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Semester - I

(Departmental Major Subject)

ME-608	L-T-P-C
Experimental Stress Analysis	3-0-0-3

Objective: *This course is designed for post-graduate level study and discusses various techniques of experimental stress analysis.*

Course Content

Introduction: Review of two-dimensional and three-dimensional stress- strain relationship, principles of measurements, accuracy, sensitivity and range of measurements. Extensometers: Mechanical, optical, acoustical and electrical extensometers, their uses, advantages and disadvantages. Electrical Resistance Strain Gauges: Principles of operation, types and their uses, materials for strain gauges, calibration and temperature compensation, cross sensitivity, rosette analysis, Wheastone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators. Photo elasticity: Two-dimensional photo elasticity, concept of light – photo elastic effects, stress optic law, interpretation of fringe pattern, compensation and separation techniques, photoelastic materials, introduction to three-dimensional photo elasticity. Other techniques: Ultrasonic testing, acoustic emission technique, fundamentals of brittle coating method, introduction to Moire techniques, holography, fiber-optic sensor

Text/References Books:

1. Experimental stress analysis: L.S. Srinath, M.R. Raghavan, K. Lingaiah, G. Gargesh, K. Ramachandara & B. Pant, Tata McGraw Hill publication 2000.
2. Experimental stress analysis by Dally & Riley, Tata McGraw Hill Publication 2001

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Semester - I

(Departmental Major Subject)

ME-609 L-T-P-C
Wind Effects on Structures 3-0-0-3

Objective: *This course is designed for post-graduate level study of dynamic effects of wind on various earth-fixed structures.*

Course Content

Introduction: State of the art in wind engineering, bluff body aerodynamics, boundary layer separation; wake and vortex formations; pressure, lift, drag and moment effect. Structural dynamics: Single degree of freedom linear system; multi–degree of freedom linear system; example of along–wind response. Aeroelastic phenomena: Vortex shedding and lock–in phenomena; models of vortex–induced response; across wind galloping; wake galloping; flutter; torsional divergence. Wind tunnel simulation of aerodynamic and aero–elastic behaviour of bluff bodies. Applications to Design: Tall buildings: Structural response and cladding design. Slender towers and stacks with circular cross-section. Tornado Effects: Wind pressures, atmospheric pressure change loading, tornado-borne missile speeds. Effects of wind on low-rise buildings under general and extreme conditions. Codes of practices on analysis and design of wind sensitive structures.

Text/Reference Books:

1. Wind Effects on Structures. Simiu E. & Scanlan R. H.
2. Wind Loading of Structures. Holmes J. D.

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Semester - I

(Departmental Major Subject)

ME-610 L-T-P-C
Principles of Engineering Tribology 3-0-0-3

Objective: *This course is designed for post-graduate level study of various aspects of tribology such as friction, wear and lubrication*

Course Content

Introduction: Definition and history of tribology, industrial significance, contact between solid surfaces – single asperity contact and real area of contact. Friction: Introduction, laws of sliding friction, mechanism of sliding friction, static friction, stick-slip, rolling friction, interface temperature and thermal analysis. Wear: Introduction, types of wear mechanism, adhesive wear, abrasive wear, fatigue wear, impact wear, chemical (corrosive) wear, fretting and fretting corrosion, wear of materials – metals, alloys, ceramics and polymers. Lubrication: Introduction, viscous flow, Reynold's equation and simplifying assumptions, hydrostatic lubrication, hydrodynamic lubrication – thrust bearings, journal bearings, squeeze film bearings, elasto-hydrodynamic lubrication, boundary lubrication. Lubricants: Introduction, liquid lubricants – principal classes, physical and chemical properties of lubricants, temperature and pressure dependence of viscosity, additives, greases, solid lubricants. Micro/ nanotribology: Introduction, basic concepts.

Text/Reference Books

1. Principles and Applications of Tribology. Bhusan B. John Wiley & Sons
2. Engineering Tribology. Williams J Cambridge University Press

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Semester - I

(Departmental Major Subject)

ME-612 L-T-P-C
Control and Analysis of Dynamic System 3-0-0-3

Objective: *This course is designed for post-graduate level. It involves study of theories of automatic control of mechanical systems as well as procedures to analyze dynamic systems with non-linear elements and random excitations.*

Course Content

Introduction: Introduction, types of control systems, mathematical modeling, block diagram representations and signal flow graphs of control systems with feedback elements, proportional control, derivative control and integral control, typical examples in Mechanical engineering. Transient and steady state response: Time domain representation, Laplace transform representation, Systems with proportional control, PD and PI control, Closed and open loop transfer functions. Stability of control systems: Characteristic equation, Routh's criterion, Nyquist criterion and Root locus method Non-linear dynamic systems: Introduction, examples of non-linear dynamic systems, approximate analytical methods, graphical methods: phase plane method, Poincare map, stability analysis and limit cycles. Dynamic systems with random excitations: Random variables and random processes, probability distribution, correlation functions of random processes, stationary random process, wide-band and narrow-band processes, power spectral density, response due to stationary random excitations.

Text/References Books:

1. Theory and Applications of Automatic Controls. Nakra B.C. New Age International Ltd.

2. Modern Control Engineering. Ogata K. Prentice Hall
3. Mechanical Vibrations. Rao S.S. Pearson Education
4. An Introduction to Random Vibration and Spectral Analysis. Newland D.E. Longman

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Semester - I

(Departmental Major Subject)

ME-613 L-T-P-C
Optimization Methods in Engineering Design 3-0-0-3

Objective: *Optimization is a subject that deals with the problem of minimizing or maximizing a certain function. Optimization, is a powerful modeling and problem solving methodology, has a broad range of applications in engineering, management, science, and industry.*

Course Content

Optimization problem formulation: Design variables, constraints, objective function and variable bounds, optimization algorithms. Single Variable Optimization Algorithm: Bracketing methods: Exhaustive search method and bounding phase method. Region Elimination Methods: Fibonacci Search method and Golden section search method. Gradient based methods: Newton-Raphson method, Bisection Method, Secant Method, and Cubic Search Method. Computer programs for bounding phase method and golden section search method. Multivariable Optimization Algorithms: Direct search methods: Simplex search method and Hooke-Jeeves pattern search method. Gradient-based methods: Cauchy's (steepest descent) method and Newton's method. Constrained Optimization Algorithms: Kuhn- Tucker conditions, penalty function Method, method of multipliers, cutting plane method, Generalized Reduced Gradient method, computer program for penalty function method. Specialized Algorithms: Integer programming: penalty function method. Non Traditional Optimization Algorithms: Global optimization using the steepest descent method, Genetic algorithms and simulated annealing.

Text/Reference Books

1. Optimization for Engineering Design Deb K. PHI 2004
2. Optimization methods. Rao S. S. New Age International Publishers, 2010.
3. Optimization Techniques. Jain and Rawat CBC, 2007