SIR PADAMPAT SINGHANIA UNIVERSITY

Udaipur

SCHOOL OF ENGINEERING

Course Curriculum of Ph.D. Degree Programme in Mechanical Engineering (Batch-2020-21)

Credit Structure

Category	Credits
Departmental Major Subjects	6
Minor Subject	5
Total	11

Note: The Research Scholar has to select the courses of minimum 6 credits from the Departmental Major Subjects and two minor courses on "Research Methodology in Science & Engineering" (3 Credits) and "Publication & Research Ethics" (2 Credits) as compulsory courses.

Course Structure: Ph.D. Degree (2020-21)

(Departmental Major Subjects)

S.No.	Course Code	Course Title	L	T	P	Credit(s)
1	ME-6001	Advanced Dynamics and Vibrations	3	0	0	3
2	ME-6002	Theory of Atmospheric Boundary Layer	3	0	0	3
3	ME-6003	Wind Tunnel Design & Testing	3	0	0	3
4	ME-6005	Diagnostic Maintenance of Mechanical Equipment	3	0	0	3
5	ME-6007	Advanced Turbo-machinery	3	0	0	3
6	ME-6008	Principle of Engineering Tribology	3	0	0	3
7	ME-6009	Wind Effects on Structures	3	0	0	3
8	ME-6010	Experimental Stress Analysis.	3	0	0	3
9	ME-6012	Control and Analysis of Dynamic Systems	3	0	0	3
10	ME-6013	Optimization Methods in Design	3	0	0	3
11	ME-6014	Production Scheduling and algorithms	3	0	0	3
12	ME-6015	Chemistry of Lubricants and Additives	3	0	0	3

Course Structure: Ph.D. Degree (2020-21)

(Departmental Minor Subjects)

S.No.	Course Code	Course Title	L	T	P	Credit(s)
1	RM-6001	Research Methodology in Science & Engineering	3	0	0	3
2	RM-6003	Research & Publication Ethics	2	0	0	2

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

Semester - I

(Departmental Major Subject)

ME-6001 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

Module 1: 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.

Module 2: 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.

Module 3: 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.

Module 4: Vibrations Of Continuous Systems

Transverse vibration of strings, Vibration of membranes, longitudinal vibration of rods, Flexural vibration of beams.

Module 5: 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.

Module 6: 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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Mechanical Engineering

Semester - I

(Departmental Major Subject)

ME-6002	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

Module 1:Introduction

General structure of the atmosphere; elements of meteorology - lapse rate of temperature, temperature inversions, isotherms & isobars.

Module 2: Atmospheric Flows

Atmospheric circulation, vertical convection, centrifugal effects, stability of the atmosphere. Effect of earth's rotation, effect of friction.

Module 3: Atmospheric motions

Wind scales. Atmospheric Boundary Layer:Atmospheric boundary layer governing equations; Ekman spiral; logarithmic and power laws; atmospheric turbulence.

Module 4: Similarity Analysis

Basic similarity requirements; dimensional analysis; basic scaling considerations

Module 5: 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-6003	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

Module 1: 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.

Module 2: 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

Module 3: 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.

Module 4: 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.

Module 5: 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-6005 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

Module 1:Maintenance methodology

Introduction, breakdown maintenance, preventive maintenance – time based, condition based maintenance, fault tree analysis.

Module 2: Temperature monitoring

Measurement of temperature: thermometer, thermocouple, pyrometer, thermography. Wear debris monitoring: Filters & chip detectors, ferrography, spectrometric analysis, particle counter.

Module 3: 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.

Module 4: Signal analysis

FFT analysis, wavelet analysis, improvement of signal to noise ratio.

Module 4: 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-6007 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

Module 1: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

Module 2: Compressors

Constructional features, velocity diagrams, incompressible and compressible analysis, pre-whirl, slip, head increase of centrifugal pump, pressure ratio of centrifugal compressor.

Module 3: 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-6008	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

Module 1: Introduction

Review of two-dimensional and three-dimensional stress- strain relationship, principles of measurements, accuracy, sensitivity and range of measurements.

Module 2: Extensometers

Mechanical, optical, acoustical and electrical extensometers, their uses, advantages and disadvantages.

Module 3: 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.

Module 4: Photoelasticity

Two-di,mensional photoelasticity, concept of light - photoelastic effects, stress optic law, interpretation of fringe pattern, compensation and separation techniques, photoelastic materials, introduction to three-dimensional photoelasticity.

Module 5: 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-6009 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

Module 1: Introduction

State of the art in wind engineering, bluff body aerodynamics, boundary layer separation; wake and vortex formations; pressure, lift, drag and moment effect.

Module 2: Structural dynamics

Single degree of freedom linear system; multi–degree of freedom linear system; example of along–wind response.

Module 3: 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.

Module 4: Applications to Design

Tall buildings: Structural response and cladding design. Slender towers and stacks with circular cross-section.

Module 5: 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-6010 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

Module 1: Introduction

Definition and history of tribology, industrial significance, contact between solid surfaces – single asperity contact and real area of contact.

Module 2: Friction

Introduction, laws of sliding friction, mechanism of sliding friction, static friction, stick-slip, rolling friction, interface temperature and thermal analysis.

Module 3: 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.

Module 4: 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.

Module 5: 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-6012 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

Module 1: 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.

Module 2: 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.

Module 3: 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,

Module 4: Graphical methods

Phase plane method, Poincare map, stability analysis and limit cycles.

Module 5: 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-6013 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

Module 1: Optimization problem formulation

Design variables, constraints, objective function and variable bounds, optimization algorithms. Single Variable Optimization Algorithm:

Module 2: Bracketing methods

Exhaustive search method and bounding phase method. Region Elimination Methods: Fibonacci Search method and Golden section search method.

Module 3: 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.

Module 4: 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.

Module 5: 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.

Module 6: 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

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Semester - I

(Departmental Major Subject)

ME-6014	L-T-P-C
Production Scheduling and algorithms	3-0-0-3

Objective: *The course is designed for post-graduate level study of production planning, scheduling and different scheduling algorithms for getting the optimum production efficiency.*

Course content

Module 1: Introduction

Basic concepts and methods in production scheduling; Classifications of scheduling problem;

Module 2: Objective function

Basic complexity; Commonly used objective functions: makespan, flowtime, total tardiness, etc;

Module 3: Different problems

Single machine problems; Parallel machine problems; Job Shop problems;

Module 4: Scheduling

Due-date scheduling; Assignment problems; Dynamic programming techniques;

Heuristics; meta heuristics and scheduling; Genetic algorithm and scheduling.

Text/Reference Books

1. Brucker P (1995) Scheduling algorithm, 1st edn, Springer, Berlin Heidelberg New York
2. Pinedo, M.L. (2005): Planning and scheduling in manufacturing and services. Springer, New York .
3. Lopez P, Roubellat F (2008) Production scheduling. Wiley, Hoboken

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Semester - I

(Departmental Major Subject)

ME-6015 L-T-P-C

Chemistry of Lubricants and Additives 3-0-0-3

Objective: *The course is designed for post-graduate level study of processes of production of petroleum and synthetic oils, their properties, additives to improve performance of lubricants and the impact lubricants to the environment, as well as the processing of used lubricating oils.*

Course content

Module 1: Lubricants and lubrication types

Types and properties, additives and their role; Grease, solid lubricants. Standards, evaluation, testing and selection of lubricants.

Module 2: Hydrodynamic Lubrication

Elasto hydrodynamic lubrication, Boundary Lubrication - Solid Lubrication Hydrostatic Lubrication, Retrieving and re-use of lubricants. Critical environmental problems related to use of lubricants and possible control measures.

Module 3: Lubricant formulation and its importance in effective machinery lubrication

Chemistry of Lubricating oils, Hydraulic fluids, Greases and Additives. Chemistry of lube oil oxidation, effect of oxidation on lubricant properties.

Module 4: Analysis

Indications of oil oxidation. Machine fault detection through lubricant analysis. Tools used in analysis of lubricants.

Text/Reference Books

1. Lubricant additives: chemistry and applications, Chemical Industries, CRC Press; 3 edition.
2. Mortier, Roy M., Fox, Malcolm F., Orszulik, Stefan. Chemistry and Technology of Lubricants, Springer Netherlands.
3. V. Stepina V. Vesely. Lubricants and Special Fluids, 1st Edition, Elsevier Science.

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Semester - I

(Departmental Minor Subject)

RM-6001 L-T-P-C
Research Methodology in Science & Engineering 3-0-0-3

Objective: *This course aims at training the PhD scholars towards acquiring competence in methodologies and methods involved in academic research. The course will expose scholars to various components of a scientific research which includes literature review, framing and testing hypothesis, designing research, data collection and analysis, writing reports and research proposals.*

Course Content

Module 01: Introduction

Introduction of Research Methodology: Approaches to Research: Resources or search engines available for gathering information and literature in related area, Critical review of available literature, Problem Identification & Formulation (finding research gaps), Research Question, Concept of a research proposal

Module 02: Research Design

Research Design: Hypothesis – Qualities of a good Hypothesis, Hypothesis Testing – Logic & Importance Features of a good research design; Concept and Importance of Research Design:–Experimental Design: Concept of Independent & Dependent variables. Qualitative and Quantitative Research.

Module 03: Data Collection, Preparation & Analysis

Data collection/ Sampling: Concepts of Statistical Population, Sample Size, Sampling Error, Probability, Practical considerations in sampling and sample size, Data Preparation and Data Analysis

Module 04: Research Documentation & Presentation

Research documentation and presentation: Structure and components of research report, Seminars and paper presentations

Text/Reference Books

1. Research Methodology and Scientific Writing. Thomas C. G. Ane Books Pvt. Ltd., 2015
2. Research Methodology: Methods and Techniques. Kothari, C. R. New Age International. 418p., 1990.
3. Research Methods: The concise knowledge base. K. Trochim, W. M. K. Atomic Dog Publishing. 270p.
4. Research Methods in Science and Engineering By Scott A. Gold (https://www.crcpress.com/Research-Methods-in-Science-and-Engineering/Gold/p/book/9781482208290)
5. Research Methods for Engineers. David V. Thiel
6. Writing for Science and Engineering: Papers, Presentations and Reports. Heather Silyn-Roberts

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Semester - I

(Departmental Minor Subject)

RM-6003	L-T-P-C
Research & Publication Ethics	2-0-0-2

Objective: *This course provides awareness about the publication ethics and publication misconducts. Hands-on-sessions are designed to identify research misconducts and predatory publications. Indexing and citation databases, open access publications, research metrics and plagiarism tools will be introduced in this course.*

Course Content

Module 01: Philosophy & Ethics

Introduction to philosophy: Definition, nature and scope, concept, branches

Ethics: Definition, moral philosophy, nature of moral judgments and reactions

Module 02: Scientific Conducts

Ethics with respect to science and research, Intellectual honest and research integrity, Scientific Misconducts: Falsification, Fabrication, and Plagiarism (FFP), Redundant Publications: Duplicate and overlapping publications, salami slicing; Selective reporting and misrepresentation of data.

Module 03: Publication Ethics

Publication Ethics: Definition, introduction and importance, Best Practices/Standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest, Publication Misconduct: definition, concept, problems that lead to unethical behavior and vice-versa types, Violation of publication ethics, authorship, and contributor ship, Identification of Publication misconduct, complaints, and appeals, Predatory publishers and journals.

Module 04: Open Access Publishing

Open access publishing and initiatives, SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies, Software tools to identify predatory publications developed by SPPU, Journal finder tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

Module 05: Publication Misconducts

Group Discussions: Subject specific ethical issues, FFP, authorship; Conflicts of interest; Complaints and appeals: examples and fraud from India and abroad.

Software Tools: Use of plagiarism software like Turnitin, Urkund and other open source software tools.

Module 06: Databases and Research Metrics

Databases: Indexing databases; Citation databases: Web of Science, Scopus, etc.

Research Metrics: Impact factor of journal as per Journal citation report, SNIP, SJR, IPP, Cite Score; Metrics: h-index, i10 index, almetrics.

Text/Reference Books

1. The Student's Guide to Research Ethics. Oliver P., Open University Press, 2003.
2. Responsible Conduct of Research. Shamoo A. E., Resnik D. B., Oxford University Press, 2003.
3. Philosophy of Science. Bird, A., Routledge, 2006.
4. A Short History of Ethics. Alasdair M., London, 1967.
5. Ethics in Competitive Research: Do not get scooped; do not get plagiarized. Chaddah P., (2018). ISBN:9789387480865
6. On Being a Scientist: A Guide to Responsible Conduct in Research. National Academy of Science, national Academy of Engineering, and Institute of Medicine. 3rd Ed., national Academies Press, 2009.