Savitribai Phule Pune University, Pune

Maharashtra, India

Faculty of Science and Technology

Curriculum Structure and Syllabus

Master of Engineering (2025 Pattern) in

ME- Mechanical (Design Engineering)

(With effect from Academic Year 2025-26)

Preface by Board of Studies

Dear Students and Teachers,

We, the members of the Board of Studies – Mechanical Engineering, are very happy to present the are very happy to present First Year Master of Computer Engineering syllabus effective from the Academic Year 2025-26 (2025 Pattern).

Mechanical Engineering is a dynamic discipline that integrates principles from core engineering fields and supports innovation across manufacturing, design, energy, materials, and automation. This curriculum is designed to provide students with a comprehensive understanding of the fundamentals, emerging technologies, and practical applications in Mechanical Engineering, while also equipping them to meet the demands of a rapidly evolving industry.

The curriculum revision is mainly focused on knowledge component, skill-based activities, experiential learning and project based activities. The revised syllabus falls in line with the objectives of NEP-2020, Savitribai Phule Pune University, AICTE New Delhi, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

We would like to place on record our gratefulness to the faculty, students, industry experts and stakeholders for having helped us in the formulation of this syllabus

Dr. Pradeep A. Patil

Chairman

Board of Studies - Mechanical Engineering

Program Educational Objectives

Program education objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.

PEO	PEO Statements
PEO1	To develop students' ability to formulate, analyze and solve complex engineering problems.
PEO2	To inculcate the skills and knowledge for addressing real-world engineering challenges through design practices, to contribute effectively to multidisciplinary teams and to adapt to technological advancements.
PEO3	To prepare for advanced studies or research in related fields, fostering a commitment to lifelong learning and professional development

Program Outcomes (PO)

POs are statements that describe what students are expected to know and be able to do upon graduating from the program. These relate to the skills, knowledge, analytical ability attitude and behavior that students acquire through the program. The POs essentially indicate what the students can do from subject-wise knowledge acquired by them during the program. As such, POs define the professional profile of a graduate of PG Engineering Program. NBA has defined the following three POs for a graduate of PG Engineering Program:

PO1	An ability to independently carry out research /investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical Report/document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

General Rules and Guidelines

1. The dissertation stage I and II must result into the publication of at least two research papers (at Stage–I and Stage-II respectively) preferably in the Journal having Citation Index 2.0 and ISSN number; or paper can be published in reputed International Journal recommended by the guide of the Dissertation and the BoS supported PGCON event for paper presentation and participation. The guides certificate covering originality of the work and plagiarism-testing result shall be included in the report along with the Published Journal Papers and. PGCON paper presentation and participation certificates. The comments received by the journal paper reviewers be attached in the Dissertation report and shall be made available during dissertation presentation/viva to the examiners.

2. Assessments consist of A) CCE (Comprehensive continuous evaluation) and B) End-semester Assessment. Both shall have an approximately equal weightage.

3. **Design Engineering Laboratory I and II:**

   This laboratory work will be based on the completion of assignments confined to the courses of that semester.

4. **SEMINAR:**

The student shall deliver the seminar on a topic approved by authorities.

Seminar I : shall be on state of the art topic of student's own choice approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned Guide and head of the department/institute.

Seminar II : shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected by him/her approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned Guide and head of the department/institute.

Seminar III: shall be extension of **seminar II.** The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned Guide and head of the department/institute.

5. **PROJECT WORK:**

The project work shall be based on the knowledge acquired by the student during the coursework and preferably it should meet and contribute towards the needs of the society. The project aims to provide an opportunity of designing and building complete system or subsystems based on area where the student likes to acquire specialized skills.

6. **Project Stage – I**

Project Stage – I is the integral part of the project Work. In this, the student shall complete the partial work of the Project that will consist of problem statement, literature review, project overview, scheme of implementation (UML/ERD/block diagram/ PERT chart, etc.) and Layout & Design of the Set-up. The candidate shall deliver a presentation as a part of the progress report of Project Stage – II, on the advancement in Technology pertaining to the selected dissertation topic.

The student shall submit the progress report of Research Project – I in standard format duly certified

for satisfactory completion of the work by the concerned guide and head of the department/Institute.

Project Stage – II

In Project Stage – II, the student shall complete the balance part of the Project that will consist of fabrication of set up required for the project, conducting experiments and taking results, analysis & validation of results and conclusions.

The student shall prepare the final report of Project work in standard format duly certified for satisfactory completion of the work by the concerned guide and head of the department/Institute.

Note: Institute must submit the list of candidates, guide and project details (title, area, problem definition, and abstract - clearly indicating objectives and scope, sponsorship details, if any) to the university within month of commencement of third semester. The guide must be approved/qualified teacher of the institute. A guide can guide at the most 8 students per year.

Curriculum Structure

Master of Engineering (2025 Pattern) – Mechanical (Design Engineering)

Level 6.0

Semester I

NEP 2020 Compliant Curriculum Structure

M.E. Mechanical –Design Engineering- First Year (2025 Pattern)

Course Code	Course Type	Name of Course	Teaching Scheme		Examination Scheme						Credit		
			L	P	CCE	ESE	TW	PR	OR	Total	L	P	Total
PCC-501-MDE	Programme Core Course	Advanced Stress Analysis	4	-	50	50	-	-	-	100	4	-	4
PCC-502-MDE	Programme Core Course	Advanced Mechanical Vibrations	4	-	50	50	-	-	-	100	4	-	4
PCC-503-MDE	Programme Core Course	Material Science and Mechanical Behavior of Materials	4	-	50	50	-	-	-	100	4	-	4
PCC-504-MDE	Programme Core Course	Optimization Techniques	4	-	50	50	-	-	-	100	4	-	4
PCC-505-MDE	Laboratory-I	Design Engg. Laboratory-I	-	4	-	-	25	-	25	50	-	2	2
PEC-520-MDE	Programme Elective Course	Elective 1	3	-	50	50	-	-	-	100	3	-	3
PEC-521-MDE	Programme Elective Course	Elective 1- Fieldwork Assignments	-	2	-	-	25	-	25	-	-	1	1
Total			**19**	**6**	**250**	**250**	**50**	**0**	**50**	**600**	**19**	**3**	**22**

List of Elective I Courses:

PEC- 520-MDE- A	Engineering Fatigue and Fracture Mechanics
PEC - 520-MDE-B	Reliability Engineering
PEC - 520-MDE-C	Mechanical Behavior and Design of Composite Structures
PEC - 520-MDE-D	Acoustics and Noise Control

Curriculum Structure

Master of Engineering (2025 Pattern) – Mechanical (Design Engineering)

Level 6.0

Semester II

Couse Code	Course Type	Name of Course	Teaching Scheme		Examination Scheme						Credit		
			L	P	CCE	ESE	TW	PR	OR	Total	L	P	P
PCC-551-MDE	Programme Core Course	Analysis and Synthesis of Mechanisms	4	-	50	50	-	-	-	100	4	-	4
PCC-552-MDE	Programme Core Course	Finite Element Method	4	-	50	50	-	-	-	100	4	-	4
PCC-553-MDE	Programme Core Course	Mechanical Measurements and Controls	4	-	50	50	--		-	100	4	-	4
PCC-554-MDE	Programme Core Course	Design Engg. Laboratory-II	-	4	-	-	25	-	25	50	-	2	2
PEC-571-MDE	Programme Elective Course	Elective II	3	-	50	50	-	-	-	100	3	-	3
PEC-572-MDE	Programme Elective Course	Elective III	3	-	50	50	-	-	-	100	3	-	3
SEM-580-MDE	Seminar	Seminar-I	-	4		--	25		25	50	-	2	2
Total			**18**	**8**	**250**	**250**	**50**	**0**	**50**	**600**	**18**	**4**	**22**

List of Elective II Courses:

PEC - 571-MDE-A	Vehicle dynamics
PEC- 571-MDE-B	Robotics
PEC - 571-MDE-C	Material Handling Equipment Design
PEC - 571-MDE-D	Computer-Aided Engineering

List of Elective III Courses:

PEC - 572-MDE-A	Tribology in Design
PEC - 572-MDE-B	Condition Monitoring
PEC - 572-MDE-C	Instrumentation & Automatic Control
PEC - 572-MDE-D	Process Equipment and Piping System Design

Master of Engineering (2025 Pattern) – Mechanical (Design Engineering)

Level 6.5

Semester III

M.E. Mechanical –Design Engineering- Second Year (2025 Pattern)

Couse Code	Course Type	Name of Course	Teaching Scheme		Examination Scheme						Credit		
			L	P	CCE	ESE	TW	PR	OR	Total	L	P	P
RM-601-MDE	Research Methodology	Research Methodology	5	-	50	50	--		-	100	5	-	5
OJT-602-MDE	On Job Training/ Internship	On Job Training/Internship	-	10	-	-	100	-	-	100	-	5	5
SEM-603-MDE	Seminar	Seminar II	-	6	-	-	**25**	-	**25**	50	-	3	3
RPR-604-MDE	Research Project	Project Stage I	-	18	-	-	25	-	25	50	-	9	9
Total			**5**	**34**	**50**	**50**	**150**	**0**	**50**	**300**	**5**	**17**	**22**

Semester IV

Couse Code	Course Type	Name of Course	Teaching Scheme		Examination Scheme						Credit		
			L	P	CCE	ESE	TW	PR	OR	Total	L	P	P
SEM-651-MDE	Seminar	Seminar III	-	8	-	-	50	-	50	100	-	4	4
RPR-652-MDE	Research Project	Project Stage II	-	36	-	-	150	-	50	200	-	18	18
Total			**0**	**44**	**0**	**0**	**200**	**0**	**100**	**300**	**0**	**22**	**22**

Savitribai Phule Pune University, Pune

Maharashtra, India

ME – Mechanical-Design Engineering

Semester I

Semester - I

Advanced Stress Analysis [PCC-501-MDE]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PCC-501-MDE	4	50	50	-	-	100	4

1. **Theory of Elasticity**
   Elasticity problems in two dimensions - stress strain relationship for brittle materials, ductile materials. Compatibility equations in two and three dimensions, free body diagram of complicated structures and stress calculations, stress functions in rectangular and cylindrical coordinate systems, evaluation of stresses in flat rectangular plates with different clamp and load conditions evaluation of the stresses in the flat and circular plate with center hole / holes using stress function.

2. **Theory of Torsion:-**
   Torsion of prismatic bars of solid section and thin walled section. Analogies for torsion, membrane analogy, fluid flow analogy and electrical analogy. Torsion of conical shaft, bar of variable diameter, thin walled members of open cross section in which some sections are prevented from warping, Torsion of non-circular shaft.

3. **Stresses in Beams**
   Concept of shear centre in symmetrical and unsymmetrical bending, stress and deflections in beams subjected to unsymmetrical bending, shear centre for thin wall beam cross section, open section with one axis of symmetry, general open section, and closed section. Curved Beams (Winkler-Bach formula), Combined Bending and torsion, Equivalent Bending Moment, Equivalent Torque, combined bending, torque and internal pressure. Moving loads on Beams.

4. **Contact stresses**
   Geometry of contact surfaces, method of computing contact stresses and deflection of bodies in point contact, Stress for two bodies inline contact with load normal to contact area and load normal and tangent to contact area, gear contacts, contacts between cam and follower, ball bearing contacts.

5. **Experimental stress analysis**
   Dimensional analysis, analysis techniques, strain gauges, types of strain gauges, materials, configuration, instrumentation, characteristics of strain gauge measurement, theory of photo- elasticity, elements of polariscope, simple and circular polariscope, fringes in dark and white field, isoclinic and isochromatic fringe patterns, evaluation of stresses from these fringe patterns.

References-

1. Advanced Mechanics of Materials– Cook and Young, Prentice Hall
2. Advanced Strength and Applied Stress Analysis–Richard G. Budynas, McGrawHill
3. Advanced Mechanics of Materials–Boresi, Schmidt, Sidebottom,Willey
4. Advanced Mechanics of Solids, L S Shrinath, Tata McGrawHill
5. Theory of Elasticity–Timoshenko and Goodier, McGrawHill
6. Advanced Strength of Materials,Vol.1, 2–Timoshenko, CBS
7. Advanced Strength of Materials–Den Hartog
8. Experimental Stress Analysis–Dally & Riley
9. Mechanics of Materials E J Hern, Buttorwoth
10. Strength of Materials, Singer Andrue Pytel, Pearson

Advanced Mechanical Vibrations [PCC-502-MDE]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PCC-502-MDE	4	50	50	-	-	100	4

1. **Multi Degree Freedom System**
   Free vibration equation of motion, influence coefficient i) stiffness coefficient (ii) flexibility coefficient generalized coordinates, coordinate couplings, Lagrange's equations matrix method Eigen values Eigen vector problems, modal analysis, forced vibrations of un-damped system and modal analysis.
   Numerical methods - (i) Rayleigh's Method, (ii) Rayleigh-Ritz Method (iii) Holzer's Method (iv) Methods of Matrix iterations (v) Transfer Matrix Method

2. **Continuous System**
   Transverse vibrations of String, Longitudinal vibration of Rods, Torsional vibrations of Shaft, Lateral vibrations of simply supported and cantilever beams, Forced vibration of beams.

3. **Transient vibrations**
   Laplace transformation, Response to an impulsive input, Response to step input, Response to a pulse input-rectangular pulse and half sinusoidal pulse.
4. **Vibration Control**
   Balancing of rotating machine, in-situ balancing of rotors, control of natural frequency, vibration isolation and vibration absorbers, Passive, active and semi-active control, free layer and constrained layer damping.

5. **Vibration Measurement**
   FFT analyzer, vibration exciters, signal analysis, time domain and frequency domain analysis of signals, experimental modal analysis, machine conditioning and monitoring, fault diagnosis

6. **Random Vibrations**
   Auto and cross correlation function, spectral density, response of linear systems, and analysis of narrow band systems

References:

1. Theory of Vibrations with Applications, W. T. Thomson, Pearson Education, Delhi
2. Mechanical Vibrations, S. S. Rao, Pearson Education, Delhi
3. Mechanical Vibrations, G K Groover, Nem Chand & Bros, Roorkee, India
4. Fundamentals of Vibration, Leonard Meirovitch, McGraw Hill International Edison
5. Principles of Vibration Control: Ashok Kumar Mallik, Affiliated East-West Press, New Delhi.
6. Mechanical Vibrations, A H Church, John Wiley & Sons Inc
7. Mechanical Vibrations & Noise Engineering, A.G.Ambekar, Prentice Hall of India, New-Delhi.

Semester - I

Material Science and Mechanical Behavior of Materials [PCC-503-MDE]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PCC-503-MDE	4	50	50	-	-	100	4

1. **Modern Materials in Design Engineering**
   Dual phase alloy, HSLA, lightweight non-ferrous alloy and their full range stress strain behaviour subjected quasi-static and high strain rate loading, composites and its orthotropic properties, plastics, smart materials, nano-materials – types, applications and its properties, heat treatment and strengthening mechanisms.

2. **Response of metals and alloys to applied load**
   Stress, strain, transformations, Mohr's circle, isotropic elasticity, anisotropic elasticity, anisotropic thermal expansion, octahedral shear stress, yield criteria, yield surface, yield curve.

3. **Material Testing under Complex Loading**
   Tensile testing–uni-axial and biaxial tension test, full range stress-strain curves, true stress-strain curve, Bridgman correction, temperature rise, Bauschinger effect, combined bending and torsion test, three-point bend test, elastic recovery.

4. **Plastic Behavior**
   Experimental studies of plastic deformations under simple and complex loading, strain hardening, power law approximations, isotropic, kinematic and combined hardening models, theory of plastic flow, strain-rate and temperature dependence of flow stress, deformation theory of plasticity, thermo-plasticity, behavior of metals with initial deformations.

5. **Elastic-Plastic Equilibrium**
   Equations of Elastic-Plastic Equilibrium, residual stresses and strains, plastic-rigid body, elastic- plastic bending and torsion, elastic-plastic bodies under variable loading, shake down theorems.

6. **Elasto-Visco-Plasticity**
   Visco-elasticity, rheological models, Maxwell model, Voigt model, Voigt–Maxwell model, damping, natural decay, dependence of damping and elastic modulus on frequency, thermo-elastic effect, low temperature and high temperature visco-plastic deformation models, rubber elasticity, damping, yielding, effect of strain rate, crazing.

References–

1. Fundamentals of Materials Science and Engineering, William D. Callister, Jr., John Wiley & Sons,
2. Mechanical Metallurgy, George E. Dieter, McGraw-Hill Book Company, 1988
3. Theory of Plasticity, J. Chakrabarty, Elsevier, 2006
4. Foundations of Theory of Plasticity, L. M. Kachanov, Dover Publications, 2004
5. Theory of Plasticity and Metal Forming Processes, Sadhu Singh, Khanna Publishers
6. Mechanical Behavior of Materials, W. F. Hosford, Cambridge University Press, 2005
7. Plasticity for Structural Engineers, W.F. Chen, Da-Jian Han, Springer

Semester – I

Optimization Techniques [PCC-504-MDE]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PCC-504-MDE	4	50	50	-	-	100	4

1. **Introduction to Mathematical Modeling**
   Introduction to Mathematical Modeling, Types of Modeling. Objective function; Constraints and Constraint surface; Mathematical modeling characteristics and limitations, Formulation of design problems

2. **Classical Optimization Techniques**
   Engineering applications of optimization, classification of optimization problem, single variable optimization, multi variable optimization with no constraint, equality constraint, in-equality constraint

3. **Linear Programming**
   Simplex algorithm, two phases of the simplex method, Primal-dual simplex method, Sensitivity or post optimality analysis, applications in engineering

4. **Non-Linear Programming**
   One-dimensional minimization - exhaustive search, golden section method, quasi-newton method, random search methods, Powell's method

5. **Modern Methods of Optimization**
   Genetic algorithms, Simulated Annealing, Particle Swarm Optimization, Ant Colony Optimization, Teaching Learning Based Optimization, Introduction to ANN

6. **Topology and Evolutionary Structural Optimization**
   Problem formulation and parameterization of design, solution methods, topology optimization as a design tool, combining topology and shape design, ESO Based on Stress Level, evolutionary methods, two-bar frame, Michell type structure, ESO for stiffness or displacement optimization

References

1. Structural Optimization, Raphael T. Haftka and Zafer Gurdal, Kluwer Academic Publishers
2. Practical Optimization Methods with Mathematical Applications, M. Asghar Bhatti, Springer
3. Topology Optimization – Theory, Methods and Applications, M. P. Bendse, Q. Sigmund
4. Evolutionary Topology Optimization of Continuum Structures, Methods and Applications, X. Huang, Y.M. Xie, Wiley, 2010
5. Engineering Optimization: Theory and Practice, Singiresu S. Rao, John Wiley & Sons
6. Mathematical Modelling, J N Kapur, New age international publication
7. Optimization for engineering design, K. Deb, PHI
8. Optimization concepts and applications in engineering, Belegundu, Chandrupatla, Pearson Education.

Semester - I

Design Engineering Laboratory [PCC–505-MDE]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pract. (Hrs.) /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PCC–505-MDE	4	-	-	25	25	50	2

Design Engineering Laboratory file shall consist of the following assignments/experiments

1. Computer program to find eigenvalues using numerical method
2. Computer program of Fourier and Laplace transforms for an engineering application
3. Measurement of strain in cantilever beam using strain gauges
4. Contact stress analysis using FEM software
5. Elasto-plastic analysis of a tensile test specimen using FEM software
6. Determination of full range stress-strain curve for mild steel and aluminum specimen as per ASTM -E8M
7. Assignment on instrumentation and data collection
8. Assignment on research proposal

Lab. work or Assignments have to be carried out at respective labs as mentioned in the syllabus. Lab work it is to be submitted as term work at the end of the semester after continuous assessment of each by respective teacher. Assessment of term work has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

Semester – I

Elective – I
Engineering Fatigue and Fracture Mechanics
[PEC-520-MDE]-A

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PEC- 520-MDE-A	3	50	50	-	-	100	3

1. Fatigue Mechanics

Time varying uniaxial, biaxial and multiaxial loading of components, load spectra, cycle counting, fatigue damage theories of crack initiation

2. Fatigue Testing

Stress based and strain-based approach **Fatigue Testing,** Data acquisition and instrumentation, classical methods of fatigue testing, ASTM standards - specimen preparation, procedure

3. Advanced Topics in Fatigue

Fatigue analysis in frequency domain, vibration fatigue, fatigue of welded structure, corrosion fatigue, high temperature and low temperature fatigue

4. Linear Elastic Fracture Mechanics

Mechanisms of fracture, initiation of fracture and crack propagation, stress and energy criteria and fracture - effects of geometry, Inglis theory of stress, energy concept – Griffith theory of fracture, energy balance during crack growth, modes of loading, calculation of stress intensity – center crack, single edge crack, double edge crack, round hole with crack, superposition of stress intensity factors, leak before break criterion, experimental determination of stress intensity factor – strain gauge method, optical method of photo elasticity

5. Elastic – Plastic Fracture Mechanics

introduction, crack tip stress state, Irwin's approximation, Dugdale's approximation, crack opening displacement, shape of the plastic zone – von Mises and Tresca yielding criteria, plastic constraint factor

6. Energy Principle

Energy release rate, criteria for crack growth, linear compliance, path independent integrals, J – integral, application of J-integral to cracks and notches, J – integral fracture criterion, experimental determination of the J – integral - single specimen, multiple specimen method

Ref. Books:

1. Metal Fatigue Analysis Handbook, YUNG-LI LEE, Elsevier
2. Design & Analysis of Fatigue Resistant Welded Structure, Dieter Radaj, Woodhead Publishing
3. Fatigue of Structures and Materials, Japp Schijve, Kluwer Academic
4. Fatigue Testing and Analysis – Theory and Practice, YUNG-LI LEE, Elsevier
5. Metal Fatigue in Engineering, Ali Fatemi, Wiley-Interscience
6. Fracture Mechanics Anderson T.L., CRC Press
7. Fracture Mechanics, Nestor Perez, , Kluwer Academic Publishers
8. Fracture Mechanics – An Introduction, Gdoutos E. E., , Springer
9. Nonlinear Fracture Mechanics for Engineers, Ashok Saxena, , CRC Press
10. Elements of Fracture Mechanics, Prashant Kumar, Mc Graw Hill Education
11. Deformation and Fracture Mechanics of Engineering Materials, Hertzberg, R. W., John Wiley & Sons, Inc.
12. Mechanical Metallurgy, George E Dieter and David Bacon, Mc Graw Hill Book Co.

Elective – I
Reliability Engineering [PEC-520-MDE]-B

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PEC- 520-MDE-B	3	50	50	-	-	100	3

1. Fundamental Concepts and Probability Theory: -

Reliability definitions, failure, Failure density, Failure Rate, Hazard Rate, MTTF, MTBF, maintainability, availability, pdf, cdf, safety and reliability, Life characteristic phases, modes of failure, Areas of reliability, Importance of Reliability, laws of probability, total probability theorem, probability distributions- binomial, normal, Poisson, lognormal, Weibull, exponential, standard deviation, variance, skewness coefficient, Chebyshev inequality

2. System reliability and modeling:

Series, parallel, mixed configuration, k- out of n structure, complex systems- enumeration method, conditional probability method, cut set and tie set method, Redundancy, element redundancy, unit redundancy, standby redundancy, Markov analysis.

3. Maintainability and Availability:

Objectives of maintenance, types of maintenance, Maintainability, factors affecting maintainability, system downtime, Availability - Inherent, Achieved and Operational availability, reliability, and maintainability trade-off.

4. System Reliability Analysis:

Reliability allocation or apportionment, Reliability apportionment techniques – equal apportionment, AGREE, ARINC, Reliability block diagrams and models, Reliability predictions from predicted unreliability, minimum effort method.

5. Reliability Testing and Strength-based reliability:

Reliability testing and reliability growth testing, Safety factor, safety margin, Stress strength interaction, Material strengths and loads

6. Failure Mode, Effects and Criticality Analysis-

Failure mode effects analysis, severity/criticality analysis, FMECA examples, RPN, Ishikawa diagram for failure representation, fault tree construction, basic symbols development of functional reliability block diagram, Fau1t tree analysis, fault tree evaluation techniques, minimal cut set method, Monte Carlo evaluation.

Reference Books

1. L.S. Srinath, Concepts of Reliability Engg., Affiliated East-Wast Press (P) Ltd., 1985.
2. A.K. Govil, Reliability Engineering, Tata McGraw-Hill Publishing Co. Ltd., 1983.
3. E. Balagurusmy, Reliability Engineering, Tata McGraw-Hill Publishing Co. Ltd., 1984.
4. B.S. Dhillion, C. Singh, Engineering Reliability, John Wiley & Sons, 1980.
5. M.L. Shooman, Probabilistic, Reliability, McGraw-Hill Book Co., 1968.
6. P.D.T. Conor, Practical Reliability Engg., John Wiley & Sons, 1985.
7. K.C. Kapur, L.R. Lamberson, Reliability in Engineering Design, John Wiley & Sons, 1977.
8. A.Birolini , Reliability Engineering, Theory and Practice, Third Edition, Springer, 1999

Elective – I
Mechanical Behavior and Design of Composites
[PEC-520-MDE]-C

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PEC- 520-MDE-C	3	50	50	-	-	100	3

1. Introduction to Composite Materials

Introduction, types – fibrous, laminate, particulate, combination, polymer matrix composites, metal matrix composites, mechanical behavior of composite material, applications – military, civil, space and automotive.

2. Mechanical Behavior of Lamina

Anisotropy, orthotropy, stiffness, engineering constants, uniaxial and biaxial strength of lamina, failure theories – maximum stress, maximum strain, Tsai-Hill, Hoffman, Tsai-Wu, computational procedure, applicability, mechanics approach to stiffness and strength

3. Mechanical Behavior of Laminate

Classical laminate theory, stress-strain variation in laminate, resultant laminate forces and moments, laminate configurations, laminate stiffness, strength of laminates, interlaminar stresses

4. Bending, Buckling and Vibration of Laminated Plates

Governing equations, simply supported laminated plates – deflection under distributed transverse load, buckling under in-plane load, vibration

5. Testing of Composite Materials

Characterization of constituent materials, physical characterization of composite material, determination of tensile, compressive and shear properties, determination of inter-laminar fracture toughness, bi-axial testing, characterization of composites with stress concentration

6. Design of Composite Structures

Structural design procedure, configuration selection, joints, design requirements, failure criteria, design analysis, optimization

Reference Books

1. Mechanics of Composite Materials, Robert M. Jones, Taylor & Francis
2. Engineering Mechanics of Composite Materials, Isaac M. Daniel and Ori Ishai, Oxford University Press
3. Mechanics of Composite Materials, Autar K. Kaw, CRC Press
4. Mechanics and Analysis of Composite Materials, Valery V. Vasiliev and Evgeny V. Morozov, Elsevier

Elective – I
Acoustics and Noise Control
[PEC-520-MDE]-D

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PEC- 520-MDE-D	3	50	50	-	-	100	3

1. Basics of acoustics

Speed of sound, wavelength, frequency, and wave number, acoustic pressure and particle velocity, acoustic intensity and acoustic energy density, spherical wave, directivity factor and directivity index, levels and the decibel, combination of sound sources, octave bands, weighted sound levels.

2. Acoustic measurement

Sound level meters, intensity level meters, octave band filters, acoustic analyzers, dosimeters, measurement of sound power, sound power measurement in a reverberant room, sound power measurement in an anechoic, sound power survey measurements, measurement of the directivity factor, noise measurement procedures.

3. Transmission of sound

The wave equation, complex number notation, wave equation solution, solution for spherical waves, changes in media with normal incidence, changes in media with oblique incidence, sound transmission through a wall, transmission loss for walls - stiffness-controlled region- mass-controlled region - damping-controlled region, method for estimating the transmission loss, transmission loss for composite walls, sound transmission class, absorption of sound, attenuation coefficient.

4. Acoustic criteria and Room acoustics

The human ear, hearing loss, industrial noise criteria, speech interference level, noise criteria for interior spaces, surface absorption coefficients, steady-state sound level in a room, reverberation time, effect of energy absorption in the air, noise from an adjacent room, acoustic enclosures, acoustic barriers.

5. Noise control

Noise sources, vibration isolation for noise control- undamped single-degree-of-freedom (SDOF) system - damped single-degree-of-freedom (SDOF) system, damping factors, forced vibration, mechanical impedance and mobility, transmissibility, rotating unbalance, displacement excitation, dynamic vibration isolator, vibration isolation materials.

6. Silencer design

Silencer design requirements, lumped parameter analysis, Helmholtz resonator, side branch mufflers, expansion chamber mufflers, dissipative mufflers, evaluation of the attenuation coefficient, and commercial silencers.

Reference Books:

1. Vibration and Noise for Engineers, Kewal Pujara, Dhanpat Rai and Co.
2. Industrial Noise Control Fundamentals and Applications, Lewis H. Bell, Douglas H. Bell, Marcel Dekker, Inc.
3. Fundamentals of Noise & Vibration analysis for Engineers: M. P. Norton, D. G. Karczub, Cambridge University Press
4. Engineering Noise Control, Bies D. A. and Hansen C. H, Spon 5) Fundamentals of Acoustics, Kinsler L. E. et al, Wiley. Mechanical Vibrations, S. S. Rao, Addison-Wesley Publishing Co.

Semester - I

Elective I Fieldwork Assignments
Engineering Fatigue and Fracture Mechanics Field Work Assignments
[PEC-521-MDE]-A

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pract. (Hrs.) /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PEC-521-MDE-A	2	-	-	25	25	50	1

The Engineering Fatigue and Fracture Mechanics field work file shall consist of the following assignments

1. Title: Analysis of Fatigue Loading and Damage Accumulation in Engineering Components

   Objectives:

   To understand time-varying uniaxial, biaxial, and multiaxial loading.

   To apply fatigue damage theories to estimate the life until crack initiation.
2. Title: Fatigue Testing and Standards Compliance

   Objectives:

   To perform fatigue testing following ASTM standards.

   To compare stress-based and strain-based approaches.

   To familiarize with instrumentation and data acquisition techniques.
3. Title: Advanced Fatigue Behavior under Special Conditions

   Objectives:

   To analyze fatigue in the frequency domain and under vibration loading.

   To study the fatigue performance of welded structures and corrosion fatigue.
4. Title: Experimental Determination of Stress Intensity Factor in LEFM

   Objectives:

   To understand the principles of Linear Elastic Fracture Mechanics (LEFM).

   To experimentally determine the Stress Intensity Factor (K) for a cracked specimen.
5. Title: Elastic–Plastic Fracture Mechanics and J-Integral Application

   Objectives:

   To study plastic zone formation and measure crack tip parameters in EPFM.

   To determine the J-integral experimentally for a notched specimen.

The filed work is to be submitted as term work at the end of semester after continuous assessment by respective teacher. Assessment of term work has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

Semester – I

Elective I Fieldwork Assignments
Reliability Engineering Field Work Assignments
[PEC-521-MDE]-B

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pract. (Hrs.) /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PEC-521-MED-B	2	-	-	25	25	50	1

The Reliability Engineering field work file shall consist of the following assignments

1. Title: Reliability Fundamentals and Probability Analysis in Engineering Systems

   Objectives:

   To understand and apply the basic concepts of reliability engineering.

   To model failure behavior using probability theory.

   To compute measures such as MTTF, MTBF, failure density, and hazard rate from real or simulated
2. Title: System Reliability Modeling for Industrial Equipment

   Objectives:

   To model and evaluate system reliability for various configurations.
3. Title: Maintainability and Availability Assessment in Real Systems

   Objectives:

   To analyze maintainability and availability characteristics of an operational system.
4. Title: Reliability Apportionment and Block Diagram Analysis

   Objectives:

   To allocate reliability requirements to subsystems based on system-level targets.

   To use apportionment techniques and reliability block diagrams for design.
5. Title: Reliability Testing and Failure Analysis using FMECA

   Objectives:

   To conduct reliability testing or use test data for evaluating system safety.

   To perform FMECA and develop fault tree for critical failures.

The filed work is to be submitted as term work at the end of semester after continuous assessment by respective teacher. Assessment of term work has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

Semester – I

Elective I Fieldwork Assignments
Mechanical Behavior and Design of Composites Field Work Assignments
[PEC-521-MDE]-C

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pract. (Hrs.) /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PEC-521-MDE-C	2	-	-	25	25	50	1

The Mechanical Behavior and Design of Composites field work file shall consist of the following assignments

1. Title: Identification, Classification, and Application Study of Composite Materials

   Objectives:

   To identify different types of composite materials and classify them by structure and matrix type.

   To understand the mechanical behavior and application potential of various composites.

2. Title: Mechanical Behavior and Failure Theories for a Composite Lamina

   Objectives:

   To experimentally determine engineering constants for a unidirectional lamina.

   To verify anisotropic and orthotropic behavior.

   To apply different failure theories and compare predictions.

3. Title: Classical Laminate Theory and Strength Analysis of Laminates

   Objectives:

   To analyze stress–strain distribution in multi-layer laminates.

   To determine laminate stiffness, resultant forces, and moments.

4. Title: Bending, Buckling, and Vibration Analysis of Laminated Plates

   Objectives:

   To experimentally determine deflection under transverse loading, buckling load, and natural frequency of laminated plates.

5. Title: Testing and Design of Composite Structures

   Objectives:

   To characterize composite materials and apply test results to design a structural component.

The filed work is to be submitted as term work at the end of semester after continuous assessment by respective teacher. Assessment of term work has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

Semester – I

Elective I Fieldwork Assignments
Acoustics and Noise Control Field Work Assignments
[PEC-521-MDE]-D

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pract. (Hrs.) /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PEC-521-MDE-D	2	-	-	25	25	50	1

The Acoustics and Noise Control field work file shall consist of the following assignments

1. Title: Measurement and Analysis of Basic Acoustic Parameters

   Objectives:

   To measure and calculate fundamental acoustic quantities such as speed of sound, wavelength, frequency, acoustic pressure, and intensity.

   To understand the decibel scale, a combination of sources, octave bands, and weighted sound levels.

2. Title: Acoustic Measurement and Sound Power Determination

   Objectives:

   To operate different acoustic measurement instruments.

   To determine the sound power level of a source in reverberant and anechoic environments.

3. Title: Transmission Loss and Sound Propagation through Barriers

   Objectives:

   To study sound transmission and determine transmission loss for different wall types.

   To verify stiffness, mass, and damping control regions in TL curves.

4. Title: Room Acoustics and Reverberation Time Measurement

   Objectives:

   To measure reverberation time (RT) and assess acoustic quality of an enclosed space.

   To evaluate compliance with noise criteria for industrial and interior spaces.

5. Title: Noise Control and Silencer Performance Evaluation

   Objectives:

   To study vibration isolation and evaluate the performance of different silencer designs.

   To measure attenuation provided by silencers and vibration isolators.

The filed work is to be submitted as term work at the end of semester after continuous assessment by respective teacher. Assessment of term work has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

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Savitribai Phule Pune University, Pune

Maharashtra, India

ME – Mechanical-Design Engineering

Semester II

Semester - II

Analysis and Synthesis of Mechanisms [PCC-551-MDE]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PCC-551-MDE	4	50	50	-	-	100	4

1. Introduction to Kinematics

Review of concepts related to kinematic analysis of mechanisms, degree of freedom, Grashoff's and Grubler's criteria, Transmission and deviation angles, mechanical advantage

2. Complex Mechanisms

Types of complex Mechanisms, velocity-acceleration analysis of complex mechanisms by the Normal Acceleration method and Auxiliary Point Method, Introduction to Goodman's Method.

3. Curvature theory

Fixed and moving centrodes, inflection circle, Euler-Savary equation, Bobillier constructions, cubic of stationary curvature

4. Synthesis of Planar Mechanisms

Types, number and dimensional synthesis, function generation, path generation, and rigid body guidance problems, accuracy(precision)points, Chebychev spacing, types of errors, graphical synthesis for function generation and rigid body guidance with two and three accuracy points using Relative pole method & Inversion method.

5. Analytical synthesis of Planar Mechanisms

Freudenstein's equation, synthesis for four accuracy points, compatibility condition, Introduction to complex numbers method of synthesis, Robert Chebychev theorem, Cognate linkages.

6. Kinematics of Spatial Mechanisms

Transformations describing planar finite displacements, planar finite transformations, identity transformation, rigid-body transformations, spatial transformations Denavit-Hartenberg parameters, matrix method of analysis of spatial mechanisms

References:

1. Theory of Machines and Mechanisms, A. Ghosh and A.K. Mallik, Affiliated East-West Press.
2. Kinematic Synthesis of Linkages, R.S. Hartenberg and J. Denavit, McGraw-Hill.
3. Theory of Machines and Mechanisms, J. E. Shigley and J. J. Uicker,2nd Ed. McGraw-Hill.
4. Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, Robert L. Norton, Tata McGraw-Hill,3rd Edition.
5. Theory of machines – S. S. Rattan McGraw-Hill Publications.
6. Mechanisms and Machine Theory- A.G. Ambekar. PHI Learning Pvt. Ltd.
7. Mechanism Design- Analysis and Synthesis (Vol.1and 2), A.G. Erdman and G.N. Sandor, Prentice Hall.

Semester - II

Finite Element Method [PCC-552-MDE]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PCC-552-MDE	4	50	50	-	-	100	4

1. Introduction

Finite element method, brief history, basic steps, advantages and disadvantages, weak formulation, variational methods of approximation – Rayleigh-Ritz methods, Galerkin method of Weighted Residuals.

2. One dimensional problem

Variational formulation of 1D bar and beam elements (Euler Bernoulli and Timoshenko beam) – governing equation, domain discretization, elemental equations, assembly and element connectivity, application of boundary condition, solution of equations, post-processing of the results.

3. Two-Dimensional Isoperimetric Formulation

Introduction, types of 2D elements (CST, LST, QST, Isoparametric), shape functions – linear & quadratic, displacement function – criteria for the choice of the displacement function, polynomial displacement functions, displacement function in terms of nodal parameters, strain-nodal parameter relationship, stress-strain relationship, element stiffness matrix, convergence of isoparametric elements, rate of convergence, plane elasticity problems – plane stress, plane stain and axisymmetric problems

Numerical Integration – Trapezoidal rule, Simpson's 1/3 rule, Newton-Cotes Formula, Gauss Quadrature formula, Gauss Quadrature in two and three dimensions, reduced and selective integration

4. 3D Problems in stress analysis

Introduction, Finite element formulation, stress calculations, mesh preparation, hexhedral and tetrahedral elements, modeling problems [Only theoretical treatment]

5. Plate Bending Problems – Plate and Shell Elements

Introduction, thin and thick plates – Kirchhoff theory, Mindlin plate element, triangular and rectangular, conforming and nonconforming elements, degenerated shell elements, shear locking and hour glass phenomenon

6. Nonlinear Problems – Geometric, Material and Contact Problems

Introduction to non-linear analysis, formulation for geometrical, material and contact

nonlinear problems, Nonlinear equation solving procedure - direct iteration, Newton-Raphson method, modified Newton-Raphson method, incremental techniques

7. Dynamic Problems – Eigen value and Time Dependent Problems

Formulation of dynamic problems, consistent and lumped mass matrices Solution of eigenvalue problems – transformation methods, Jacobi method, Vector Iteration methods, subspace iteration method

Forced vibration – steady state and transient vibration analysis, modeling of damping, the mode superposition scheme, direct integration methods – implicit and explicit numerical integration

8. Special Topics

Algorithmic approach for Finite element formulation of element characteristics, Assembly and incorporation of boundary conditions, Guidelines for code development, Automatic mesh generation techniques, Mesh quality checks, h & p refinements, symmetry – mirror/plane, axial, cyclic & repetitive, Node Numbering scheme, Computer implementation: Pre-processor, Processor, Post-processor

References

1. Seshu P., "Text book of Finite Element Analysis", PHI Learning Private Ltd., New Delhi, 2010.
2. Mukhopadhyay M and Sheikh A. H., "Matrix and Finite Element Analyses of Structures", Ane Books Pvt. Ltd., 2009.
3. Bathe K. J., "Finite Element Procedures", Prentice-Hall of India (P) Ltd., New Delhi.
4. Cook R. D., "Finite Element Modeling for Stress Analysis", John Wiley and Sons Inc, 1995
5. Chandrupatla T. R. and Belegunda A. D., "Introduction to Finite Elements in Engineering", Prentice Hall India.
6. Liu G. R. and Quek S. S. "The Finite Element Method – A Practical Course", Butterworth Heinemann, 2003.
7. Reddy, J. N., "An Introduction to The Finite Element Method", Tata McGraw Hill, 2003.

Semester – II

Mechanical Measurements and Control [PCCC-553-MDE]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PCC-553-MDE	4	50	50	-	-	100	4

1. **Fundamentals of Measurements:**
   Characteristics of Measurement system: Static and Dynamic Sensors and Transducers: Force, Speed Measurement, Strain Stress Measurement, FFT (Fast Fourier Transform): Vibration and Noise Measurement, Laser Doppler Vibrometer, Temperature, pressure, flow rate, velocity, humidity.

2. **Fundamentals of interfacing of sensors with Microcontroller/computer**
   Analog and Digital Signals, ADC, DAC, Bit width, Sampling theorem, Noise Filters: Low Pass, Band Pass and High Pass.

3. **Modeling of Mechatronic Systems:**
   Mathematical Modeling of Mechatronics System. Representation of mechatronics system into transfer function blocks, block reduction fundamentals, State space representation, only second order mechanical, electro-mechanical. System Stability analysis using Poles and Zeros of System.

4. **Control using time domain:**
   Transient response of electromechanical and mechanical system, Routh Hurwitz criterion to determine Poles and Zeros of system, PID control system design and tuning PID parameters based on transient response.

5. **Control using Frequency Domain:**
   Frequency response of electromechanical and mechanical system, Bode plot to determine Phase margin and gain margin, PID control system design and tuning PID parameters based on frequency response.

Reference Books:

1. Measurement Systems-Application and Design, Doebelin E.O, McGraw Hill Publication
2. Measurement and Instrumentation – Theory and Application, Alan Morris, Reza Langari, Elsevier
3. Instrumentation for Engineering Measurements, James Dally, William riley and Kenneth McConnell, Wiley.
4. Mechanical Measurements, S.P. Venkateshan, Ane Books Pvt. Ltd.
5. Control System Engineering, Norman Nise, 6th Edition, John Wiley and Sons

6. Engineering Metrology and Measurement, N V Raghavendra and Krishnamurthy, Oxford University Press,
7. Engineering Metrology and Measurements, Bentley, Pearson Education
8. Theory and Design for Mechanical Measurements, 3rd Edition, Richard S Figliola, Donald E Beasley, Wiley India
9. Doebelin's Measurement Systems Ernest Doebelin, Dhanesh Manik McGraw-Hill
10. Instrumentation, Measurement and Analysis, B.C. Nakra, K.K. Chaudhry McGraw-Hill
11. A Text book of Engineering Metrology, I C Gupta, Dhanpat Rai Publications
12. A course in Mechanical Measurements and Instrumentation, A K Sawhney, Dhanpat Rai Publications
13. Mechanical Measurements and Instrumentations, Er. R K Rajput, Kataria Publication (KATSON)

Semester - II

Design Engineering Laboratory-II [PCC–554-MDE]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pract. (Hrs.) /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PCC–554-MDE	4	-	-	25	25	50	2

Design Engineering Laboratory- II file shall consist of the following assignments/experiments

1. Analysis of inertia forces in slider crank mechanism using computer software
2. Coupler curve synthesis for a mechanism using computer software
3. Determination of natural frequencies & modal analysis of a machine component using FFT Analyzer
4. Stress and deflection analysis of short and long beams with different end conditions and cross-sections subjected to different loading conditions (i.e., point load – force & moment, distributed load etc) using FEA software
5. Stress and deflection analysis of thin and thick rectangular and circular plates/shells with different end conditions subjected to different loading conditions (i.e., point load – force & moment, distributed load etc) using FEA software
6. Stress analysis of rotating disc (solid and hollow discs) using FEA software
7. Buckling mode analysis of a thin shell cylinder using FEA software
8. Direct/Modal frequency response analysis of a beam/plate under a single-point cyclic load/base excitation with and without damping using FEA software

Lab. work or Assignments have to be carried out at respective labs as mentioned in the syllabus of respective. It is to be submitted as term work at the end of semester after continuous assessment of each by respective teacher. Assessment of term work has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

Semester – II

Elective – II
Vehicle Dynamics [PEC-571-MDE]-A

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PEC-571-MDE-A	3	50	50	-	-	100	3

1. **Tire Characteristics -** Tire – types, axis system, mechanics of pneumatic tires - tire forces and moments, rolling resistance of tires, tractive (braking) effort and longitudinal slip (skid), cornering properties of tires, slip angle and cornering force, slip angle and aligning torque, camber and camber thrust, characterization of cornering behavior of tires, performance of tires on wet surfaces, ride properties of tires
2. **Performance characteristics of road vehicles -** Equation of motion and maximum tractive effort, aerodynamic forces and moments, vehicle power plant and transmission characteristics, acceleration time and distance, gradability, engine and transmission matching, Electronic Stability Control (ESC), Braking characteristics of a two-axle vehicle, braking efficiency and stopping distance, antilock brake systems, traction control systems, Electronic Brakeforce Distribution (EBD), Electronic Brake assist System (EBS)
3. **Suspension Kinematics -** Terminology, definitions – reference frame, toe-in, toe-out, wheel camber, caster and kingpin angle, steering offset, types of dependent and independent suspensions, equivalent mechanisms (front view / side view), anti-dive and squat geometry, roll center analysis, steering geometry, error, steering force and moments
4. **Handling characteristics of vehicle -** Steady-state handling characteristics of a two-axle vehicle, steady-state response to steering input, testing of handling characteristics, transient response characteristics, directional stability, steering of tracked vehicles
5. **Vehicle ride characteristics -** Calculation of spectral densities, RMS values, relation to ride comfort, vehicle ride models - two-degree-of-freedom vehicle model for sprung and un-sprung mass, numerical methods for determining the response of a quarter-car model to irregular surface profile excitation, two-degree-of-freedom vehicle model for pitch and bounce, active and semi-active suspension
6. **Road and Suspension modeling -** Road – modeling aspects, deterministic profile, random profile, auto-correlation function, spectral density, relation between input and output spectral densities, effect of wheelbase, modeling of springs, anti-roll bars, torsion bar, air springs, dampers, bump stop

Reference Books:

1. Road Vehicle Dynamics – Problems & Solutions, Rao & Dukkipati, SAE,
2. Theory of Ground Vehicles, J.Y. Wong, John Wiley & Sons,
3. Fundamentals of Vehicle Dynamics, T.D. Gillespie, SAE

Elective – II

Robotics [PEC-571-MDE]-B

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PEC-571-MDE-B	3	50	50	-	-	100	3

1. Manipulator Kinematics

Matrix algebra, inverse of matrices, rotational groups, matrix representations of coordinate, transformation, transformation about reference frame and moving frame, forward and inverse kinematics

2. Robotics Dynamics

Velocity kinematics, acceleration of rigid body, mass distribution Newton's equation, Euler's equation, iterative newton – Euler's dynamic formulation, closed dynamic, Lagrangian formulation of manipulator dynamics, dynamic simulation, and computational consideration

3. Trajectory planning

Introduction, general considerations in path description and generation, joint space schemes, cartesian space schemes, path generation in runtime, planning path using dynamic model, point to point and continuous trajectory

4. Robot Sensors: -

Internal and external sensors, position- potentiometric, optical sensors, encoders - absolute, incremental, touch and slip sensors velocity and acceleration sensors, proximity sensors, force & torque sensors, laser range finder, camera. Micro-controllers, DSP, centralized controllers, real-time operating systems.

5. Robot Controllers

Essential components-Drive for Hydraulic and Pneumatic actuators, H-bridge drives for Dc motor Overload over current and stall detection methods, the example of a micro-controller/microprocessor-based robot Controller.

6. Robot Vision and Programming languages

Introduction, Image acquisition, Illumination Techniques, Image conversion, Cameras, sensors, Camera and system interface, Frame buffers and Grabbers, Image processing, low level & high-level machine vision systems.

Introduction the three level of robot programming, requirements of a robot programming language, problems peculiar to robot programming languages.

Reference Books:

1. S. R. Deb, "Robotics Technology and Flexible Automation ", Tata Mc Graw Hill 1994.
2. M. P. Groover, M. Weiss R.N. Nagel, N.G. Odrey "Industrial Robotics (Technology, Programming and application s), McGraw, Hill 1996
3. K. S. Fu, R. C. Gonzalez, and C. S. G. Lee, "Robotics: Control, sensors, vision and intelligence ", MCGraw-Hill.1987.
4. J. J. Craig, Introduction to Robotics, Addison-Wesley 1989.
5. K lafter, Richard D., et al "Robotics Engineering", PhI,1996.
6. Zuech, Nello," Applying Machine Vision ", John Wiley and Sons, 1988.

Elective – II

Material Handling Equipment Design

[PEC-571-MDE]-C

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PEC-571-MDE-C	3	50	50	-	-	100	3

1. **Material handling system -** principles and features of material handling system, importance, terminology, objectives and benefits of better material handling, classification of material handling equipment

2. **Selection of material handling equipment -** choice of material handling equipment, factors affecting for selection, general analysis procedures, basic analytical techniques, the unit load concept

3. **Design of cranes -** hand-propelled and traveling mechanisms of cantilever and monorail cranes, design considerations for structures of rotary cranes with fixed radius, fixed post and overhead traveling cranes, stability of stationary rotary and traveling rotary cranes, electric overhead travelling crane - essential parts, design parameters, structural considerations, end carriages, long and cross travel mechanisms, brakes, motor selection, safety arrangements, electrical control system

4. **Load lifting attachments -** load chains and types of ropes used in material handling system, forged, standard and Ramshorn hooks, crane grabs and clamps; grab buckets; electromagnet; design consideration for conveyor belts; drums, sheaves, sprockets

5. **Study of bulk material handling systems -** objectives of storage; bulk material handling; gravity flow of solids through slides and chutes; storage in bins and hoppers; screw conveyor, vibratory conveyor, pneumatic & hydraulic conveyor (classification, types, principles of operation)

6. **Automation in material handling -** control of hoisting & conveying machinery, material handling in direct-line production and automated lines, safety and design; safety regulations and discipline

Reference Books

1. N. Rudenko, 'Material Handling Equipment', Peace Publishers
2. James M. Apple, 'Material Handling System Design', John-Wiley and Sons
3. John R. Immer, 'Material Handling' McGraw Hill
4. Colin Hardi, 'Material Handling in Machine Shops'. Machinery Publication Co. Ltd.,

5. M .P. Nexandrn, ‘Material Handling Equipment’, MIR Publication,
6. C. R. Cock and J. Mason, ‘Bulk Solid Handling’, Leonard Hill Publication Co. Ltd.,
7. Spivakovsy, A.O. and Dyachkov, V.K., ‘Conveying Machines’, Volumes I and II, MIR Publishers,
8. Kulwiac R. A., ‘Material Handling Hand Book’, John Wiley Publication

Elective – II

Computer-Aided Engineering (CAE)

[PEC-571-MDE]-C

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PEC-571-MDE-C	3	50	50	-	-	100	3

1. CAE Driven Design Process

Analysis types, geometry clean-up, meshing techniques, 1-D, 2-D, and 3-D mesh, element selection, special elements, solution convergence, element quality checks, material information, boundary conditions, and loads.

2. Static Analysis

Externally applied forces and pressures, steady-state inertial forces (such as gravity or rotational velocity), imposed (nonzero) displacements, temperatures (for thermal strain), non-linear structural analysis, model verification

3. Normal Modes and Buckling analysis

Real eigenvalue analysis, governing equations, methods of computations, normal modes analysis, Block Lanczos and QR damped methods of modes extraction, linear buckling analysis

4. Harmonic Response Analysis

Definition, applications, methods – full, reduced, and mode superposition, pre-stressed harmonic response analysis

5. Transient dynamic analysis

Dynamic modeling input, normal mode analysis, reduction in dynamic analysis, rigid body modes, damping, transient response analysis, frequency response analysis, direct matrix input, dynamic equations of motion, residual vector methods, enforced motion, shock and response spectrum analysis, random response analysis, complex eigenvalue analysis

6. Advanced topics in FEA

Complex eigenvalue analysis, normal mode analysis using parts super-element, transfer functions, normal modes of preloaded structures, dynamic design optimization, test-analysis correlation

Reference Books:

1. Strukturdynamik, R. Gasch, K. Knothe, Springer
2. Dynamics of Structures, W. C. Hurty and M. F. Rubinstein, Prentice-Hall
3. Dynamics of Structures, R. W. Clough and J. Penzien, McGraw-Hill
4. S. Timoshenko, D. H. Young, and W. Weaver, Jr., Vibration Problems in Engineering, John Wiley & Sons
5. K. J. Bathe and E. L. Wilson, Numerical Methods in Finite Element Analysis, Prentice-Hall
6. Theory of Matrix Structural Analysis, J.S. Przemieniecki, McGraw-Hill
7. Structural Dynamics: An Introduction to Computer Methods, R. R. Craig, John Wiley & Sons

Semester – II

Elective – III
Tribology in Design [PEC-572-MDE]-A

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PEC-572-MDE-A	3	50	50	-	-	100	3

1. Friction and Wear: -

Friction Control and Wear prevention, Boundary Lubrication, Tribological properties of Bearing Materials and Lubricants, Theories of friction and wear, instabilities and stick-slip motion.

2. Lubrication of Bearings: -

Mechanics of Fluid Flow, Reynold's Equation and its limitations, idealized bearings, infinitely long plane pivoted and fixed show sliders, infinitely long and infinitely short (narrow) journal bearings, lightly loaded infinitely long journal bearing (Petroff's solution).

3. Finite Bearings and Air lubricated bearings: -

Finite Bearings: Hydrostatic, Hydrodynamic, and thrust oil bearings, heat in bearings,
Air Lubricated Bearings: Tilting pad bearings, hydrostatic, hydrodynamic, and thrust bearings with air lubrication.

4. Hydrostatic squeeze film: -

Circular and rectangular flat plates, variable and alternating loads, piston pin lubrications, and application to journal bearings.

5. Elasto-hydrodynamic Lubrication: -

Pressure-viscosity term in Reynold's Equation, Hertz theory, Ertel-Grubin Equation, lubrication of spheres.

6. Tribological aspects of rolling motion: -

The mechanics of tyre-road interaction, road grip, and rolling resistance, Tribological aspects of wheel on rail contact, Tribological aspects of metal rolling, drawing, and extrusion.

Reference Books

1. Basic Lubrication Theory- A Camaron
2. Principles of Lubrication – A Camaron, Longman's Green Co. Ltd.
3. Fundamentals of Tribology, S. K. Basu, S. N.Sengupatha and D. B.Ahuja, PHI.
4. Theory and Practice for Engineers – D. D. Fuller, John Wiley and sons.
5. Fundamental of Friction and Wear of Metals – ASM
6. The Design of Aerostatic Bearings – J. W. Powell
7. Gas Bearings – Grassam and Powell
8. Theory Hydrodynamic Lubrication Pinkush and Sterrolicht
9. Tribology in Machine Design – T. A. Stolarski

Elective – III

Condition Monitoring
[PEC-572-MDE]-B

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PEC-572-MDE-B	3	50	50	-	-	100	3

1. Vibrations

System response to vibration, nature of vibration, harmonics, limits and standards of vibration

2. Predictive maintenance techniques

Predictive maintenance basics, maintenance philosophies, evolution of maintenance philosophies, plant machinery classification and recommendations, principles of predictive maintenance, predictive maintenance techniques, and vibration analysis – a key to predictive maintenance

3. Data acquisition

Introduction, collection of vibration signal – vibration transducers, characteristics and mountings, conversion of vibrations to electrical signal

4. Signal processing - applications and representation

The Fast Fourier transform (FFT) analysis, time waveform analysis, phase signal analysis, spectral signal processes.

5. Machinery fault diagnosis using vibration analysis

Commonly witnessed machinery faults diagnosed by vibration analysis, correcting faults that cause vibration, balancing, alignment, resonance vibration control with dynamic absorbers

6. Oil and particle analysis

Condition-based maintenance and oil analysis, setting up an oil analysis program, oil analysis – sampling methods, oil analysis – lubricant properties, oil analysis – contaminants in lubricants, particle analysis techniques, alarm limits for various machines

Reference Books:

1. Theory of Vibration with Applications, Thomson, W. T., CBS Publishers and Distributors, New Delhi
2. Introductory Course on Theory and Practice of Mechanical Vibrations, Gupta K., New Age International Ltd.
3. Vibratory Condition Monitoring of Machines, J. S. Rao, Narosa Publishing House, New Delhi 3) Shock and Vibration Handbook, Cyril M. Harris, Allan G. Piersol, McGraw-Hill Publishing Co.,
4. Practical Machinery Vibration Analysis and Predictive Maintenance, C. Scheffer, Paresh Girdhar, Elsevier

Elective – III
Instrumentation and Automatic Control
[PEC-572-MDE]-C

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PEC-572-MDE-C	3	50	50	-	-	100	3

1. **Introduction to measurements**
   Measurements for scientific and engineering applications need and a goal. A broad category of methods for measuring field and derived quantities.

2. **Principles of measurement**
   Parameter Estimation, Regression Analysis, Correlations, Error Estimation, and Data Presentation, Analysis of Data, Problems on Data Analysis, and Errors Estimation

3. **Measurement of field quantities**
   Thermometry, Heat Flux Measurement, Measurement of Force, Pressure, Flow Rate, Velocity, Humidity, Noise, Vibration, Measurement Of The Above By Probe And Non-Instructive Techniques, Calibration of Pressure gauges, Computer-aided experimentation for temperature measurement

4. **Measurement of derived quantities**
   Torque, Power, Thermo-Physical Properties, Radiation, and Surface Properties.

5. **Analytical methods and pollution monitoring**
   Mass Spectrometry, Chromatography, Spectroscopy

6. **Basics of P, PI, PID controllers**
   Pneumatic and Hydraulic Controllers, Electronic Controllers, Applications to Machine Tools, Furnaces, Material Handling, Etc, Design of control system for boiler/compressor/pumps/turbines

Reference Books

1. Doebelin E.O: Measurement Systems-Application and Design, McGraw Hill Publication Co.
2. Beckwith TG. N. Lewis Buck and Marangoni R.D: Mechanical Measurements, Narosa Publishing House,New Delhi
3. Liptak B.G. Instrument Engineers' Handbook
4. Bolton W, Mechatronics-Electronics Control Systems in Mechanical and Electrical Engg.
5. Modern Electronic Instrumentation and Measurement Technique by A.D. Helfrick and W.D. Cooper
6. Johnson C.D., Process Control Instrumentation
7. J.P.Holman: Experimental Methods For Engineers, McGraw Hill International Edition, Seventh Edition

Elective – III

Process Equipment Design

[PEC-572-MDE]-D

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
PEC-572-MDE-D	3	50	50	-	-	100	3

1. **Process Design Parameters:**

   Basic concepts in process design, block diagrams for flow of processes, material flow balance. Design pressures -–temperatures, design stresses, factory of safety, minimum shell thickness and corrosion allowance, weld joints efficiency, design loading, stress concentration and thermal stresses, failure criteria, cost and profitability estimation. Introduction to design codes like IS-2825, ASME-SECT, EIGHT-DIV-II TEMA.API-650, BS-1500 & 1515.

2. **Design of Cylindrical and Spherical Vessels:**

   Thin and thick-walled cylinder analysis, design of end closers, local stresses due to discontinuity or change of shape of the vessel, vessel opening compensation, design of standard and non-standard flanges, design of vessels and pipes under external pressure, design of supports for process vessels.

3. **Design of Tall Vessels and Large Storage Tanks:**

   Determination of equivalent stress under combined loadings including seismic and wind loads application of it to vertical equipment like distillation column.

4. **Design of Thick-Walled High-Pressure Vessels:**

   Design by various theories of failure, construction of these vessels with high strength steel and other special methods.

5. **Process Equipment Design:**

   Storage vessels, reaction vessels, agitation and mixers, heat exchangers, filters and driers, centrifuges. Code practices, selection and specification procedures used in design. Selection of pumps, compressors, electrical equipments and auxiliary services, safety, etc.

6. **Process Piping Design:**

   Flow diagrams and pipe work symbols, design of layout of water, steam and compressed air pipes work, pipe fitting, linings and flanged connections. Types of valves used on pipe line. Fabrication of pipe lines, expansion joints and pipe support.

   Planning, manufacture, inspection and erection of process equipment like pressure vessels, chimneys, ducting, heat exchangers, pulverizing equipment, etc. protective coatings, lining of vessels.

Reference Books

1. Process Equipment Design: By Dr. M.V. Joshi, Mc-Millan.
2. Process Equipment Design: By Browell and Young, John Wiley.
3. Plant Design and Economics: Max and Timasulaus Kalus – McGraw Hill.
4. Industrial Instrumentation servicing Hand Book: Cannel Grady, McGraw Hill.
5. Chemical Engineering Handbook: Perry John, McGraw Hill.

6. Chemical Equipment Design: B.C. Bhattacharya.
7. Industrial Pipe Work: D.N.W. Kentish, McGraw Hill.
8. Chemical Engineering: J.M. Coulson, Richardson, Sinnott Vol. VII, Maxwell, McMillan.
9. Pressure Vessel Design Hand Book: H. Bedna.
10. Dryden's outlines of Chemical Technology for the 2 : By Roa M. Gopala, Sitting M., East West Press Pvt. Ltd., New Delhi.
11. Applied Process Design for Chemical and Petrochemical, Vol. I, II and III : By E.E. Ludwig, Gulf Publication Co., Houston.
12. Chemical Process Control: An Introduction to Theory and Practice: By Stephanopoulos G., Prentice Hall of India, New Delhi.
13. Chemical Process Equipment Selection and Design: By Stanley M. Walas, Butterworth- Heinemann Series in Chemical Engineering.
14. Process System Analysis and Control: By D.R. Coughanowr, McGraw Hill, New York.
15. Optimization of Chemical Processes: By Edgar T.F., Himmelblau D.M., McGraw Hill Book Co., New York.

Seminar – I, II, and III
[SEM-580-MDE, SEM-603-MDE, SEM-650-MDE]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pr. Hrs/Week	Paper		TW	Oral/Presentation	Total	
		CCE*	End Semester Assessment				
SEM- 580-MDE	4	-	-	25	25	50	2
SEM - 603-MDE	6	-	-	25	25	50	3
SEM - 650-MDE	8	-	-	50	50	100	4

Assessment of the Seminar has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

INSTRUCTIONS FOR SEMINAR REPORT WRITING

It is important that the procedures listed below be carefully followed by all the students of M.E. (Mechanical Engineering).

1. Prepare 3 **COPIES** of your manuscript.
2. Limit your project report to preferably
   a) 15-20 manuscript pages for Seminar I
   b) 20-25 manuscript pages for Seminar II
   c) 25-30 manuscript pages for Research Project Based Seminar
3. The footer must include the following:
   Institute Name, M. E. (Mechanical) (Design Engineering) Times New Roman 10 pt. and centrally aligned.
4. Page number as second line of footer, Times New Roman 10 Pt, centrally aligned.
5. Print the manuscript using
   a) Letter quality computer printing.
   b) The main part of manuscript should be Times New Roman 12 pt. and justified**.**
   c) Use 1.5 line spacing.
   d) Entire report shall be one chapter. No chapters for Seminar I, II and III.
   e) Seminar I shall not have last section as Conclusions, it will be summary only.
6. Use the paper size **8.5" × 11"** or **A4 (210 × 197 mm).** Please follow the margins given below.

Margin Location	Paper 8.5" × 11"	Paper A4 (210 × 197 mm)
Top	1"	25.4 mm
Left	1.5"	37 mm
Bottom	1.25"	32 mm
Right	1"	25.4 mm

7. All paragraphs will be 1.5 line spaced with a one blank line between each paragraph. Each paragraph will begin without any indentation.
8. Section titles should be bold with 14 pt typed in all capital letters and should be left aligned.

9. Sub-Section headings should be aligning at the left with 12 pt, bold and Title Case (the first letter of each word is to be capitalized).
10. Illustrations (charts, drawings, photographs, figures) are to be in the text. Use only illustrations really pertinent to the text. Illustrations must be sharp, clear, **black and white. Illustrations downloaded from internet are not acceptable.**
    a) Illustrations should not be more than **two** per page. One could be ideal
    b) Figure No. and Title at bottom with **12 pt**
    c) Legends below the title in **10 pt**
    d) Leave proper margin in all sides
    e) Illustrations as far as possible should not be xeroxed.

11. **Photographs** if any should be of glossy prints
12. Please use **SI** system of units. If students would like to add the equivalent in inch-pound (British) units, they must be stated in parenthesis after the **SI** units. In case the final result comes out in any other units (say due to empirical formula etc.) covert the unit to **SI** unit.
13. Please **number the pages** on the front side, centrally below the footer
14. **References** should be either in order as they appear in the thesis or in alphabetical order by last name of first author
15. **Symbols** and **notations** if any should be included in nomenclature section only
16. Following will be the order of report
    i. **Cover page** and **Front page** as per the specimen on separate sheet
    ii. **Certificate** from the Institute as per the specimen on separate sheet
    iii. **Acknowledgement**
    iv. **List of Figures**
    v. **List of Tables**
    vi. **Nomenclature**
    vii. **Contents**
    viii. **Abstract** (A brief abstract of the report not more than **150 words**. The heading of abstract i.e. word "Abstract" should be **bold, Times New Roman, 12 pt** and should be typed at the **centre.** The contents of abstract should be typed on new line without space between heading and contents. Try to include one or two sentences each on **motive, method, key-results** and **conclusions** in the Abstract)
    ix. Section: Introduction
    x. References
17. All section headings and subheadings should be numbered. For sections use numbers **1, 2, 3, ...** and for subheadings **1.1**, **1.2**, **....** etc and section subheadings **2.1.1**, **2.1.2, ...** etc.
18. **References** should be given in the body of the text and well spread. No verbatim copy or excessive text from only one or two references. If **figures** and **tables** are taken from any reference then indicate source of it. Please follow the following procedure for references

Reference Books

Collier, G. J. and Thome, J. R., Convective boiling and condensation, 3rd ed., Oxford University Press, UK, 1996, pp. 110 – 112.

Papers from Journal or Transactions

Jung, D. S. and Radermacher, R., Transport properties and surface tension of pure and mixed refrigerants, *ASHRAE Trans*, 1991, 97 (1), pp. 90 – 98.

Bansal, P. K., Rupasinghe, A. S. and Jain, A. S., An empirical correction for sizing capillary tubes, *Int. Journal of Refrigeration*, 1996, 19 (8), pp.497 – 505.

Papers from Conference Proceedings
Colbourne, D. and Ritter, T. J., *Quantitative assessment of flammable refrigerants in room air conditioners*, Proc. of the Sixteenth International Compressor Engineering Conference and Ninth International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, Indiana, USA, 2002, pp. 34 – 40.

Reports, Handbooks etc.
United Nations Environmental Programme, Report of the Refrigeration, Air Conditioning and Heat Pumps, Technical Option Committee, 2002, Assessment - 2002.

ASHRAE Handbook: Refrigeration, 1994 (Chapter 44)

Patent
Patent no, Country (in parenthesis), date of application, title, year.

Internet
www.(Site) [Give full length URL]

Format for front page and Certificate

A Seminar I / II / III (TNR, 16pt, centrally aligned)

Title (TNR, 27pt, Bold, Centrally Aligned, Title Case)

By (TNR, 16pt, Centrally Aligned)

Mr. Student's Name (TNR, 16pt, Centrally Aligned)

Guide (TNR, 16pt, Centrally Aligned)

Guide's Name (TNR, 16pt, Centrally Aligned)

Institute

Logo

Department of Mechanical Engineering

Name of the Institute

[2025-26] (TNR, 22pt, Title Case Centrally Aligned)

Name of the Institute

Logo

C E R T I F I C A T E

This is to certify that *Mr. ……..*, has successfully completed the seminar-I/II/III entitled “Performance analysis of……..” under my supervision, in the partial fulfillment of Master of Engineering (Mechanical) (Design Engineering) of Savitribai Phule Pune University, Pune.

Date:

Place:

Guide’s Name
Guide

Head
Department
and Institute
Name

External Examiner

Seal

Principal,
Institute
Name

Savitribai Phule Pune University, Pune

Maharashtra, India

ME – Mechanical-Design Engineering

Semester III

Semester – III

Research Methodology [RM-601-MDE]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
RM-601-MDE	5	50	50	-	-	100	5

1. **Introduction**
   Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Criteria of Good Research

2. **Research Problem and Research Design:**

   Definition of good research problem, Feasibility study of research problem, Importance of research problem, Sources of research problem, Criteria of good research problem, Meaning of Hypothesis, Characteristics of Hypothesis, Errors in selecting a research problem, Concept & need of research design, Meaning of variable, Selection of variables

3. **Mathematical Modelling and prediction of performance:**
   Steps in Setting up a computer model to predict performance of experimental system, Validation of results, Multi-scale modelling and verifying performance of process system, Nonlinear analysis of system and asymptotic analysis, verifying if assumptions hold true for a given apparatus setup, Plotting family of performance curves to study trends and tendencies, Sensitivity analysis.

4. **Basic instrumentation:**
   Instrumentation schemes, Static and dynamic characteristics of instruments used in experimental set up, Performance under flow or motion conditions, Data collection using a digital computer system, Linear scaling for receiver and fidelity of instrument, Role of DSP in data collection in noisy environment, Good measurement practice.

5. **Applied statistics:**

   Regression analysis, curve fitting and developing Correlation, Parameter estimation, Multivariate statistics, Principal component analysis, Moments and response curve methods, State vector machines and uncertainty analysis, Probable errors in the research, Error analysis and methods to reduce errors in research process.

6. **Research report writing and Publication**

   Research Report: Dissemination of research findings, outline and structure of research report, different steps and precautions while writing research report, methods and significance of referencing

Publishing Research work: Selection of suitable journal for publishing research work, Open access Vs Subscription Journals, identifying indexing of selected journals, Impact factor of the journal, structure of research paper, Check for plagiarism of the article, Research paper submission and review process.

Lab Practice:

1. Write Sample research proposal of the planned research topic giving details of topic, significance, funding required etc.
2. Write a research paper on review of at least 5 research papers for a research topic (Language, formatting and authors guidelines to be strictly followed from standard Springer or Elsevier Journals and referred journal details to be mentioned in the Lab practice file) and verify the research article for plagiarism and attach the plagiarism report.

Reference Books:

1. Research methodology: An Introduction for Science & Engineering students, by Stuart Melville and Wayne Goddard
2. Research Methodology: Methods and Trends, by Dr. C. R. Kothari
3. Research Methodology: An Introduction by Wayne Goddard and Stuart Melville
4. Research Methodology: A Step by Step Guide for Beginners, by Ranjit Kumar, 2nd Edition
5. Operational Research by Dr. S.D. Sharma, Kedar Nath Ram Nath & Co.
6. Software Engineering by Pressman

Semester - III

On Job Training/ Internship [OJT-602-MDE]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pract. (Hrs.) /Week	Paper		TW	Oral/ Presentation	Total	
		CCE*	End Semester Assessment				
OJT-602-MDE	10	-	-	100	--	100	5

Course objectives:

1. To put theory into practice and expand thinking and broaden the knowledge and skills acquired through coursework in the field.
2. To relate to, interact with, and learn from current professionals in the field.
3. To understand and adhere to professional standards in the field.
4. To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
5. To develop the initiative and motivation to be a self-starter and work independently.

Course Outcomes: Upon successful completion of this course, students will be able to:

- **Gain** practical experience within industry in which the internship is done.
- **Acquire** knowledge of the industry in which the internship is done.
- **Apply** knowledge and skills learned to classroom work.
- **Develop** and refine oral and written communication skills.
- **Acquire** the knowledge of administration, marketing, finance and economics.

Course Description:

1. Internship/On Job Training provide students the opportunity of hands-on experience that includes personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc.
2. An internship is the phase of time for students when they are trained for their skills, they are good at, and it gives them a chance to apply their knowledge practically in industries
3. The internship can be carried out in any industry/R&D Organization/Research Institute/Institute of national repute/R&D Centre of Parent Institute.
4. The Department/college shall nominate a faculty to facilitate, guide and supervise students under internship.

Guidelines

- **Purpose**

  Internships are designed to bridge the gap between academic learning and industry practice. They aim to provide hands-on experience, expose students to the industrial environment, develop technical and soft skills (communication, teamwork, problem-solving), and help in career exploration.

- **Internship Duration and Academic Credentials**

  - Students can take internship work in the form of Online/Offline mode from any of the Industry / Government Organization Internship Programmes approved by SPPU/AICTE/UGC portals
  - An intern is expected to spend 10 - 12 hours per week on the Internship. Training will result in about 160-170 hours of total internship duration.
  - The minimum requirement regarding Internship duration should not be below 8 weeks

- **Type of Internship**

  - Industry/Government Organization Internship: Working directly with a company or government body.
  - Research Internship: Focused on research projects, often in collaboration with academic institutions or R&D labs.
  - Innovation/Entrepreneurship: Working on developing new products, processes, or even starting a venture.
  - Social Internship: Engaging in community-based projects.

- **Assessment Details (TW and Practical)**

  - Term work for 100 marks
  - A daily log submitted by the student and a work log signed by the office HoDs where the student has interned will be considered towards the TW marking.

- **Indicative list of areas for OJT**

  - Trade and Agriculture
  - Economy & Banking Financial Services and Insurance
  - Logistics, Automotive & Capital Goods
  - Fast Moving Consumer Goods & Retail
  - Information Technology/Information Technology Enabled Services & Electronics
  - Handcraft, Art, Design & Music
  - Healthcare & Life Science

- Sports, Wellness and Physical Education
- Tourism & Hospitality
- Digitization & Emerging Technologies (Internet of Things / Artificial Intelligence / Machine
- Learning / Deep Learning / Augmented Reality / Virtual Reality etc.)
- Humanitarian, Public Policy and Legal Services
- Communication
- Education
- Sustainable Development
- Environment
- Commerce, Medium and Small-Scale Industries

- **Faculty Supervision:** Students are usually assigned an internal faculty guide/mentor who supervises their internship activities. This faculty member acts as a teacher, mentor, and critic, and ensures the internship aligns with academic goals. External Supervision: In many cases, an external expert from the host organization also guides the student.

- **Documentation and Reporting:**
  - Joining Report: To be submitted within a specified time frame (e.g., one week from joining).
  - Daily/Periodical Diary: Students are often required to maintain a daily or weekly record of their observations, work, and learning.
  - Internship Report: A comprehensive report detailing the work done, learning outcomes, and achievements during the internship. This report needs to be duly signed by the company official and the faculty mentor.
  - Completion Certificate: Issued by the host organization upon successful completion.

- **Evaluation:**
  - Evaluation is typically done by the institute, often within a short period after the internship ends.
  - It may involve presentations, viva-voce examinations, and assessment of the internship report and daily diary.
  - Performance-based feedback from the industry mentor is usually a key component.

Project Stage – I and II [RPR-604-MDE, RPR-652-MDE]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	RP Hrs. / Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
RPR-604-MDE	18	-	-	25	25	50	9
RPR-652-MDE	36	-	-	150	50	200	18

Assessment of Project Stage-I/II has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

INSTRUCTIONS FOR DISSERTATION WRITING

It is important that the procedures listed below be carefully followed by all the students of M.E. (Mechanical Engineering).

1. Prepare **Three Hard Bound Copies** of your manuscript.
2. Limit your Dissertation report to 80 – 120 pages (preferably)
3. The footer must include the following:
   Institute Name, M.E. (Mechanical) (Design Engineering) Times New Roman 10 pt. and centrally aligned.
4. Page number as second line of footer, Times New Roman 10 Pt, centrally aligned.
5. Print the manuscript using
   a. Letter quality computer printing.
   b. The main part of manuscript should be Times New Roman 12 pt. with alignment - justified**.**
   c. Use 1.5 line spacing.
   d. Entire report shall be of 5- 7 chapters.
6. Use the paper size **8.5" × 11"** or **A4 (210 × 197 mm).** Please follow the margins given below.

Margin Location	Paper 8.5" × 11"	Paper A4 (210 × 197 mm)
Top	1"	25.4 mm
Left	1.5"	37 mm
Bottom	1.25"	32 mm
Right	1"	25.4 mm

7. All paragraphs will be 1.5 line spaced with a one blank line between each paragraph. Each paragraph will begin with without any indentation.
8. Section titles should be bold with 14 pt typed in all capital letters and should be left aligned.
9. Sub-Section headings should be aligning at the left with 12 pt, bold and Title Case (the first letter of each word is to be capitalized).
10. Illustrations (charts, drawings, photographs, figures) are to be in the text. Use only illustrations really pertinent to the text. Illustrations must be sharp, clear, **black and white. Illustrations downloaded from internet are not acceptable.**
    a. Illustrations should not be more than **two** per page. One could be ideal
    b. Figure No. and Title at bottom with **12 pt**
    c. Legends below the title in **10 pt**
    d. Leave proper margin in all sides
    e. Illustrations as far as possible should not be photo copied.

11. **Photographs** if any should of glossy prints
12. Please use **SI** system of units only.
13. Please **number the pages** on the front side, centrally below the footer
14. **References** should be either in order as they appear in the thesis or in alphabetical order by last name of first author
15. **Symbols** and **notations** if any should be included in nomenclature section only
16. Following will be the order of report
    i. **Cover page** and **Front page** as per the specimen on separate sheet
    ii. **Certificate** from the Institute as per the specimen on separate sheet
    iii. **Acknowledgements**
    iv. **List of Figures**
    v. **List of Tables**
    vi. **Nomenclature**
    vii. **Contents**
    viii. **Abstract** (A brief abstract of the report not more than **150 words**. The heading of abstract i.e. word "Abstract" should be **bold, Times New Roman, 12 pt** and should be typed at the **centre.** The contents of abstract should be typed on new line without space between heading and contents. Try to include one or two sentences each on **motive, method, key-results** and **conclusions** in Abstract

    1 Introduction (2-3 pages) (TNR – 14 Bold)
    1.1 Problem statement (TNR – 12)
    1.2 Objectives
    1.3 Scope
    1.4 Methodology
    1.5 Organization of Dissertation

    2 Literature Review (20-30 pages)
    Discuss the work done so far by researchers in the domain area and their significant conclusions. No derivations, figures, tables, graphs are expected.

    3 This chapter shall be based on your own simulation work (Analytical/ Numerical/FEM/CFD) (15- 20 pages)

    4 Experimental Validation - This chapter shall be based on your own experimental work (15-20 pages)

    5 Concluding Remarks and Scope for the Future Work (2-3 pages)

    References

    ANNEXURE (if any)
    (Put all mathematical derivations, Simulation program as Annexure)
17. All section headings and subheadings should be numbered. For sections use numbers **1, 2, 3, ...** and for subheadings **1.1**, **1.2**, **....** etc and section subheadings **2.1.1**, **2.1.2, ...** etc.
18. **References** should be given in the body of the text and well spread. No verbatim copy or excessive text from only one or two references. If **figures** and **tables** are taken from any reference then indicate source of it. Please follow the following procedure for references

    Reference Books

    Collier, G. J. and Thome, J. R., Convective boiling and condensation, 3rd ed., Oxford University Press, UK, 1996, pp. 110 – 112.

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Jung, D. S. and Radermacher, R., Transport properties and surface tension of pure and mixed refrigerants, *ASHRAE Trans*, 1991, 97 (1), pp. 90 – 98.

Bansal, P. K., Rupasinghe, A. S. and Jain, A. S., An empirical correction for sizing capillary tubes, *Int. Journal of Refrigeration*, 1996, 19 (8), pp.497 – 505.

Papers from Conference Proceedings

Colbourne, D. and Ritter, T. J., *Quantitative assessment of flammable refrigerants in room air conditioners*, Proc. of the Sixteenth International Compressor Engineering Conference and Ninth International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, Indiana, USA, 2002, pp. 34 – 40.

Reports, Handbooks etc.

United Nations Environmental Programme, Report of the Refrigeration, Air Conditioning and Heat Pumps, Technical Option Committee, 2002, Assessment - 2002.

ASHRAE Handbook: Refrigeration, 1994 (Chapter 44)

Patent

Patent no, Country (in parenthesis), date of application, title, year.

Internet

www.(Site) [Give full length URL]

A Project Stage -I Report on (TNR, 16pt, centrally aligned)

Title (TNR, 27pt, Bold, Centrally Aligned, Title Case)

By (TNR, 16pt, Centrally Aligned)

Mr. Student's Name (TNR, 16pt, Centrally Aligned)

Guide

Guide's Name (TNR, 16pt, Centrally Aligned)

Institute

Logo

Department of Mechanical Engineering

Name of the Institute

[2025-26](TNR, 22pt, Title Case Centrally Aligned)

Name of the Institute
Institute
Logo

C E R T I F I C A T E

This is to certify that *Mr. ……*, has successfully completed the Project Stage -I entitled "Performance analysis of……." under my supervision, in the partial fulfillment of the Master of Engineering (Mechanical) (Design Engineering) of Savitribai Phule Pune University, Pune.

Date :

Place :

Guide's Name
Guide

Head
Department
and Institute
Name

External Examiner

Seal

Principal,
Institute
Name

A Dissertation on (TNR, 16pt, centrally aligned)

Title (TNR, 27pt, Bold, Centrally Aligned, Title Case)

By (TNR, 16pt, Centrally Aligned)

Mr. Student's Name (TNR, 16pt, Centrally Aligned)

Guide

Guide's Name (TNR, 16pt, Centrally Aligned)

Institute

Logo

Department of Mechanical Engineering

Name of the Institute

[2026-27] (TNR, 22pt, Title Case Centrally Aligned)

Name of the Institute

Institute Logo

C E R T I F I C A T E

This is to certify that ……., has successfully completed the Dissertation entitled “Performance analysis of…” under my supervision, in the partial fulfillment of the Master of Engineering (Mechanical) (Design Engineering) of Savitribai Phule Pune University, Pune.

Date :

Place:

Guide’s Name
Guide

_____
Head
Department and Institute Name

External Examiner

Seal

_____
Principal, Institute Name

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