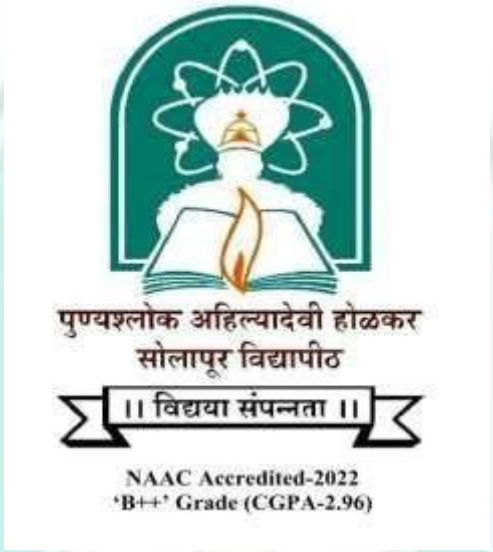

PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

FACULTY OF SCIENCE & TECHNOLOGY
NEP 2020

Syllabus of

Second Year B.Tech Mechanical and Rail Engineering
w.e.f. Academic Year 2026-27

A. Multidisciplinary Minor

in "Material Science and Energy Engineering"

Semester	Course Code	Course Title
III	MERLMDM-01A	**Fundamentals of Material Science in Mechanical and Rail Systems**
IV	MERLMDM-02A	**Materials for Technology Development**

B. Multidisciplinary Minor

in "Industrial and Project Management"

Semester	Course Code	Course Title
III	MERLMDM-01B	**Industrial and Railway Management**
IV	MERLMDM-02B	**Production and Operation Management**

A. Honors in Robotics Engineering

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
III	MerlHon-01A	Industrial Robotics	3	-	2	4	70	30	25	-	125
IV	MerlHon - 02A	Machine Vision	3	-	2	4	70	30	25	-	125
		Total	6	-	4	**8**	**140**	**60**	**50**	-	**250**

Honors Course will be for the students of same Program

B. Honors in Electric Vehicle Engineering

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
III	MerlHon - 01B	Introduction to Automobile Engineering	3	-	2	4	70	30	25	-	125
IV	MerlHon - 02B	Introduction to Electric and Hybrid Vehicles	3	-	2	4	70	30	25	-	125
		Total	6	-	4	**8**	**140**	**60**	**50**	-	**250**

Honors Course will be for the students of same Program

These Courses are open for students of all the UG Engineering Program.

Semester: III List of Open Elective - I

Sr. No.	List of Open Electives
1.	OE-01A: Advanced Mathematics and Statistics
2.	OE-01B Digital Marketing and E- Commerce
3.	OE-01C Humanities and Social Sciences
4.	OE-01D Industrial and Quality Management
5.	OE-01E Mathematics for Software and Hardware
6.	OE-01F Soft Skills and Personality Development
7.	OE-01G High-Speed Rail and Metro Systems

Semester: IV List of Open Elective – II

Sr. No.	List of Open Electives
1.	OE-02A Entrepreneurship and Innovation
2.	OE-02B Environmental Sustainability
3.	OE-02C Renewable Energy
4.	OE-02 D Measurement, Instrumentation and Sensors
5.	OE-02E Operation Research
6..	OE-02F Computational Mathematics
7.	OE-02G Professional Business Communication
8.	OE-02H Electric Traction and Rolling Stock

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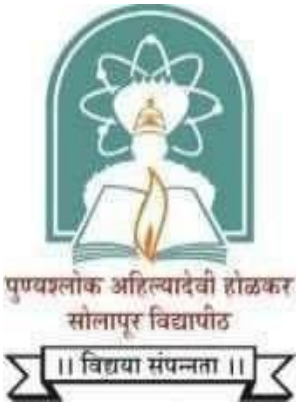


NAAC Accredited-2022

'B++'Grade(CGPA2.96)

Name of the Faculty: Science and Technology

NEP 2020

Syllabus: Mechanical and Rail Engineering

Name of the Course: S. Y. B. Tech.

Semester-III

(Syllabus to be implemented w.e.f. A.Y. 2026-27)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical & Rail Engineering)

Semester-III

MERLPCC- 01: Thermodynamics

***Teaching Scheme**

Lectures: 02 Hours/week, 02 Credits

Practical: 02 Hours/week, 01Credit

***Examination Scheme**

ESE:70Marks

ISE: 30Marks

ICA: 25Marks

Course Introduction: Applied Thermodynamics is one of the core courses in the Mechanical Engineering curriculum and one of the traditional courses, dating back from the last many centuries. In Applied Thermodynamics the significance moves from studying general concepts with illustrative examples to develop methods and performing analyses of real-life problems. The objective of this subject is to apply knowledge of basic thermodynamic concepts to understand and evaluate the working of various thermodynamic cycles and devices used in thermal power plants and reciprocating air compressors.

Course Objectives:

During this course, student is expected to:

1. Learn about of laws of thermodynamics and apply them to thermodynamic systems.
2. Study steam properties and calculate the performance of steam boilers
3. Learn about vapour power cycles and their analysis
4. Study steam nozzles and evaluate the performance of steam turbines
5. Study steam condensers
6. Study reciprocating air compressors and calculate their performance

Course Outcomes:

At the end of this course, student will be able to:

1. Apply mathematics and laws of thermodynamics to solve engineering problems.
2. Evaluate steam properties and analyze the performance of steam generators using the steam table.
3. Apply knowledge of basic thermodynamic concepts for the analysis of vapour power Cycles.
4. Describe the thermodynamics of steam nozzles and analysis of steam turbine.
5. Explain steam condensers for various applications.
6. Calculate various performance parameters of reciprocating air compressors & Determine lubricant properties.

Section I

Unit-1: Basic Laws of Thermodynamics **No. of lectures-06**

Review of basic concepts of thermodynamics, Zeroth and First law of Thermodynamics, heat and work transfer. Applications of thermodynamic principles in railway locomotives, coach air-conditioning systems, and railway energy management.

Second Law of Thermodynamics: Limitations of the first law of thermodynamics, heat engine, refrigerator and heat pump, Kelvin-Plank and Clausius statements and their equivalence. Reversibility and Irreversibility, Clausius Inequality (**Numerical Treatment**) Introduction to Energy, Entropy, entropy change for: i) Phase change of pure substance ii) Change of state of an ideal gas iii) adiabatic mixing. (**Theoretical Treatment**)

Unit-2: Steam Generators **No. of lectures-06**

Formation of steam, Properties of Steam, Steam tables, Temperature-entropy, Temperature-enthalpy diagrams and Mollier diagram, Classification of Boilers, Evaporative capacity, equivalent evaporation, factor of evaporation, Boiler efficiency **(Numerical treatment**), Heat losses in boiler plant & heat balance sheet, Introduction to waste recovery, Introduction to steam locomotive boilers, their construction, operation, and performance characteristics **(Theoretical Treatment)**

Unit-3: Vapour Power Cycles **No. of lectures-03**

Classification of thermodynamic cycles, vapour power cycles, Carnot vapour power cycle, simple Rankine cycle, actual Rankine cycle, Performance Parameters, Effect of Operating conditions on Rankine cycle efficiency **(Numerical Treatment)**

Section II

Unit-4: Steam Nozzles and Turbines **No. of lectures-06**

Types of Nozzles, flow of steam through nozzles **(Theoretical Treatment)**

Steam Turbines: -Advantages and classification of steam turbines, simple impulse turbine, compounding of steam turbines, Parson's reaction turbine, Velocity diagrams, work done and Efficiencies **(Numerical Treatment)**

Unit-5: Steam Condensers **No. of lectures-03**

Elements of steam condensing plants, advantages of using condensers, types of condensers, vacuum efficiency, Condenser efficiency **(Theoretical Treatment)**

Unit-6: Reciprocating Air Compressors and Railway Pneumatic Systems **No. of lectures-06**

Classification of compressors, constructional detail of single & multistage compressors, computation of work (polytropic, isentropic and isothermal compression), the effect of clearance, Efficiencies of compressors, FAD, (**Numerical Treatment)**

Air brake systems in trains, Pneumatic door operation, Pantograph control systems, Compressed air applications in locomotives and coaches, **Lubrication**-Properties of Lubricants (**Theoretical Treatment)**

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc. Any six of the following:

1. Study of Boilers
2. Study of Boilers Mountings and Accessories.
3. Study/trial on a steam calorimeter
4. Two problems using Steam table for finding steam properties.
5. Study/trial on reciprocating air compressor
6. Study of different types of condensers
7. To determine the Flash and Fire point of lubricating oil
8. Trial on Redwood viscometer
9. Study/trial on Bomb Calorimeter.
10. Industrial visit to any process/power industry

Text Books:

1. A Course in Thermal Engineering-S. Domukundwar, Kothandraman, DhanpatRai & Co. Delhi.
2. Thermal Engineering -R. K. Rajput – Laxmi Publication – New Delhi (Sixth Edition)
3. Basic & Applied Thermodynamics- P.K. Nag TataMcGraw Hill Publication

Reference Books

1. Thermodynamics by C.P. Arora TMH New Delhi 1998 edition.
2. Thermodynamics & Heat Engine – Vol. 1 &2 – R. Yadav Central Book Depot.
3. Thermodynamics- Cengel Boles, Tata McGraw Hill New Delhi.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical & Rail Engineering)

Semester-III

MERLPCC-02: Elements of Railway Engineering Systems

***Teaching Scheme**
Lectures: 02 Hours/week, 02 Credits
Practical: 02 Hours/week, 01Credit

***Examination Scheme**
ESE:70Marks
ISE: 30Marks
OE: 25Marks

Course Introduction: Introduction to Railway Engineering Systems provides an overview of the major components of railway infrastructure**,** including railway tracks, stations, yards, signaling systems, rolling stock, and railway operations. Students will learn how different elements of a railway system work together to ensure safe, reliable, and efficient train movement.

Course Objectives:
During this course, students are expected to:

1. Understand basic concepts and the importance of railway transportation systems**.**
2. Learn about the components of the railway track (permanent way), such as rails, sleepers, ballast, and formation.
3. Develop understanding of track geometry**,** including gauges, gradients, curves, and super elevation.
4. Explain the design and function of points and crossings used in railway track layouts.
5. Understand the working and classification of railway stations and yards**.**
6. Understand the basic principles of railway signaling, safety systems, and modern railway technologies**.**

Course Outcomes:
At the end of this course, students will be able to:

1. Understand the basic concepts, history, and development of railway transportation systems.
2. Identify and explain the components of railway track (permanent way), such as rails, sleepers, ballast, and formation.
3. Understand the principles of track geometry, including gauges, gradients, curves, and super elevation.
4. Explain the working and importance of points, crossings, and railway track layouts used for train movement.
5. Describe the functions and classification of railway stations and yards in railway operations.
6. Understand railway signaling, safety systems, and modern railway technologies used for efficient train control.

Section I

Unit-1: Introduction to Railway Engineering **No. of lectures-5**

History and development of railways, Importance of railway transportation, Classification of railways, Components of railway engineering system, Organization of railways, Railway electrification basics, Advantages and limitations of railway transport, Modern trends in railway engineering.

Unit-2: Railway Track and Track Components **No. of lectures-5**

Permanent way and its functions, Components of railway track: Rails, Sleepers, Ballast, Subgrade / formation, Types of rails and rail joints, Types of sleepers (wooden, steel, concrete).

Unit-3: Track Geometry **No. of lectures-5**

Introduction to track geometry, Railway gauges and types of gauges, Gradients in railways, Curves in railway track, Super elevation (cant), Widening of gauge on curves, Measurement and maintenance of track geometry, Effects of improper track geometry on safety and comfort.

Section II

Unit-4: Points and Crossings **No. of lectures-5**

Need and purpose of points and crossings, Types of points and crossings, Components of turnout, Layout of railway junctions, geometry and design of turnouts, Crossing number, lead, and radius, Standard dimensions and specifications, Operation and maintenance of points and crossings, Safety measures and defect detection.

Unit-5: Railway Stations and Yards **No. of lectures-5**

Introduction to railway stations and yards, Functions of railway stations, Classification of railway stations, Types of railway yards: Passenger yard, goods yard, Marshalling yard, Locomotive yard, Safety measures in station and yard operations, Modern developments in station and yard planning.

Unit-6: Railway Signaling and Safety, Modern Railway Systems **No. of lectures-5**

Objectives of railway signaling, Types of signals, Interlocking systems, Block system, Safety measures in railway operation, Railway electrification, High-speed rail systems, Metro rail systems, Modern signaling and control systems.

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc.

1. Study of Railway Track Components
2. Study of Types of Rails and Rail Sections
3. Study of Different Types of Sleepers
4. Study of Railway Gauges
5. Study of Points and Crossings
6. Study of Railway Signals
7. Study of Railway Stations and Yard Layouts
8. Study of Modern Railway Systems
9. Study of Railway Level Crossing
10. Visit to Railway Station / Railway Track (Field Visit)

Text Books:

1. "A Textbook of Railway Engineering" by S.P. Arora & S.C. Saxena
2. "Railway Engineering" by Satish Chandra & M.M. Agarwal
3. "Railway Engineering" by S.C. Rangwala
4. "Railway Engineering" by B. L. Gupta & Amit Gupta
5. "Railway Engineering: Design, Construction and Operation" by Nathan Bush

Reference Books

1. "Railway Engineering and Systems" **by** Marshall Roy
2. "Fundamentals of Railway Design" by Marco Guerrieri
3. "Railway Transportation Systems: Design, Construction and Operation" by Christos N. Pyrgidis
4. "Railway Engineering Technology: Developments and Innovations" edited by V. M. Ravindra Kumar, K. P. Vineesh & Sunil Kumar Sharma

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical and Rail Engineering)

Semester-III

MERLPCC-03: Strength of Materials

***Teaching Scheme**

Lectures: 03 Hours/week, 03 Credits

Tutorial: 01 Hours/week, 01Credit

***Examination Scheme**

ESE:70Marks

ISE: 30Marks

ICA: 25Marks

Course Introduction:

Strength of materials introduces the four concept-force, stress, strain and deformation of deformable bodies. As the engineering design of different components, structures etc. used in practice are carried using different kinds of materials, it is essential to understand the basic behavior of such materials. The present course is to make students acquainted with force and displacement relation of structural elements subjected to uniaxial stress, bending, twisting and impact is studied. This course emphasizes the fundamentals of material strength necessary while designing and analysis of mechanical components This course improves problem solving skill of the students. In particular, course require prerequisite knowledge of engineering mechanics and basics calculus.

Course Objectives:

During this course, student is expected to:

1. To study different types of stresses, strains and deformation induced in mechanical components due to external load.
2. To study distribution of different stresses in mechanical elements such as beams and shafts etc.
3. To study effect of component dimensions and shape stress and deformation

Course Outcomes:

At the end of this course, student will be able to:

1. Demonstrate fundamental knowledge of different types stress and loading condition.
2. Compute the stresses in basic mechanical components under axial, torsional and flexural loading.
3. Draw and interpret SFD and BMD for different types of loads and support conditions.
4. Develop shear force and bending moment diagrams to analyze bending and shear stress offered by beam.
5. Determine slope and deflection of beam under concentrated and uniformly distributed load.
6. Compute the principal stress and position planes in a member subjected to different types of stress system

Section I

Unit-1: Simple stress and strains **No. of lectures-06**

Concept and types of stresses and strains, Poisson's ratio, stresses and deformation in homogeneous and compound bars under axial loads, stress-Strain diagrams, Hooke's law, elastic constants and their relationships, temperature stress & strain in simple bars under axial loading, Application of stress-strain principles in railway rails, couplers and wagon frames

Unit-2: **No. of lectures-08**

a) Torsion of Circular Shafts: Theory of torsion and assumptions, torsion of solid and hollow circular shafts, derivation of torsion equation, determination of torsional shear stress and angular twist for solid and hollow shafts used in power transmission applications.

b) Strain Energy and Impact Load: Concept of strain energy, proof resilience and modulus of resilience, determination of strain energy in tension and compression for axially loaded members due to gradual, sudden and impact loads.

Unit-3: Shear force and bending moment **No. of lectures-06**

Concept and definitions of shear force and bending moment in determinate beams, SF and BM diagrams for cantilever, simply supported beams with or without overhang, calculations of maximum shear force and bending moment and point of contra flexure under i) concentrated load ii) Uniformly distributed load iii) Combination of concentrated and uniformly distributed load iv) uniformly varying load iv) Couple. Relation between the rate of loading, shear force and the bending moment.

Section II

Unit-4: Bending and shear stresses in beams **No. of lectures-08**

Concept of theory of pure bending of beams, assumptions and sign conventions, bending stresses in beams with derivation and application to commonly used beam cross sections as circular rectangular, I-sections and T-sections. Concept of shear stresses and shear stress distribution in beam, determination of shear stresses for rectangular, I and T sections of beams.

Unit-5: Slope and Deflection of Beams **No. of lectures-06**

Concept and definitions of slope and deflection, relationship between bending moment, slope and deflection by moment area method, determination of slope and deflections of i) cantilever beam ii) simply supported beam under concentrated and uniformly distributed load.

Unit-6: Principal stresses and strains **No. of lectures-06**

Concept of normal and shear stresses on oblique planes, principal stresses and strains and principal planes, two-dimensional stress system, determination of principal stresses and maximum shear stresses using analytical and Mohr's circle method (2-D cases only).

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc. any six.

1. Assignment on simple stresses and strains.
2. Assignment on torsion of circular shafts.
3. Assignment on strain energy and impact loads.
4. Assignment on shear force and bending moment diagrams.
5. Assignment on bending stresses in beams.
6. Assignment on shear stresses in beams.
7. Assignment on slope and deflection of beams.
8. Stress analysis of wheel axle using strain gauges
9. Study of stress-strain characteristics of rail steel.

Text Books:

1. Rajput R. K., Strength of materials, S. Chand & Co. Ltd., New Delhi.
2. Bansal R.K., Strength of materials, Laxmi publications (P) Ltd., New Delhi.
3. Subramanyam, Strength of Materials, Oxford University Press, Edition 200
4. Rajput R. K., Strength of materials, S. Chand & Co. Ltd., New Delhi.

Reference Books

1. Timoshenko & Young, Elements of Strength of Materials, CSB Publishers
2. Ramamrutham S. Strength of Materials DhanpatRaiand Co.(p) Pvt. Ltd. Delhi
3. S. S. Rattan Mechanics of Materials, TMH Pvt. Ltd
4. Basu A. R., Strength of materials, Dhanpat Rai & Co. (P) Ltd., Delhi.
5. Beer and Johnson, Strength of materials, Mc-Graw Hill International student series.
6. Khurmi R. S. & Gupta J. K., Strength of materials, S. Chand & Co. Ltd., New Delhi
7. Basavarajaiah and Mahadevappa, Strength of Materials, Khanna Publishers, New Delhi.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical and Rail Engineering) Semester-III

MERLFP-01: Mini-Project on Workshop Practice

***Teaching Scheme**
Practical :04Hours/week, 02Credit

***Examination Scheme**
ICA: 50 Marks
OE: 25Marks

Course Introduction: The mini project is designed to help students develop practical ability and knowledge about practical tools/techniques in order to solve real life problems related to the industry, academic institutions and society. This course will also develop investigative, research and report writing skills and will provide an opportunity to investigate in considerable depth. Mini Project provides the opportunity for students to demonstrate the application of their research skills, and to apply their knowledge to complex computing problems. A mini project is an assignment that strengthens the understanding of fundamental knowledge through effective application of theoretical concepts.

Course Objectives:

The course aims to:

1) Details about mechanical workshop tools and equipment's
2) Clarify safety awareness in work shop
3) Operating principle of various machines
4) Construct engineering drawing
5) Prepare process sheet
6) Estimation of time and cost of manufacturing

Course Outcomes:

At the end of this course, student will be able to:

1) Demonstrate practical knowledge
2) Develop manufacturing skills
3) Enhance drawing understanding skills
4) Cost and time estimation
5) Enhance skills of PPC
6) Do material requirement and planning

Mini project based on:

1) Design and development of jig and fixtures
2) Design and development of press tool/Draw tool
3) Miniature of wind turbine
4) Automatic conveyor belt
5) Pneumatic arm manipulator
6) Hydraulic lift system
7) Solar water heater
8) Miniature of EV
9) Automatic plant watering
10) Design and development of any power pack unit

Internal Continuous Assessment (ICA)-

Guidelines for Mini-Project content & Mark Distribution

1. A group of maximum 04 students be formed for Mini-Project work.

2. Work diary and reporting to guide as per prescribed contact hours.

3. The contents of work diary shall reflect the efforts taken by project group for

   i. Searching suitable mini-project work

   ii. Brief report preferably on journals/ research or conference papers/ books or literature surveyed to select and bring out the mini-project area.

   iii. Brief report of feasibility studies carried to implement the conclusion.

   iv. Rough Sketches/ Design Calculations, etc.

4. The mini-project may be based on above mentioned topics.

5. It will be preferable if student will work on the area of mini project in line with their proposed final year project.

6. The group has to give a power point presentation in front of the faculty members / panel of department at the end of semester along with the spiral bound report (Limited to 25 Pages).

A. Multidisciplinary Minor in "Material Science and Energy Engineering"

Semester	Course Code	Course Title
III	MERLMDM-01A	Fundamentals of Material Science in Mechanical and Rail Systems

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical and Rail Engineering) Semester-III

Multidisciplinary Minor in "Material Science and Energy Engineering"

MERLMDM-01A: Fundamentals of Material Science in Mechanical and Rail Systems

(Multidisciplinary Minor-I)

***Teaching Scheme**
Lectures: 02 Hours/week, 02 Credits
Practical: 02 Hours/week, 01Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:

This course introduces the fundamental principles of Materials Science and Engineering with special emphasis on materials used in Mechanical and Railway Engineering applications. The course discusses the basic structure of solids, classification of materials based on the structure and the correlation between the structure and properties. The evolution of properties based on the structure and its alteration is also dealt with. The course provides a broad and general knowledge of various types of materials like Ferrous materials, Non-ferrous materials, Polymers, Ceramics, Composite materials, Nano-materials, Electronic materials, Magnetic materials, Nuclear material, etc. which are widely used in development of new technologies along with properties and applications of these materials in various sectors like Railway, Aerospace, Automobile, Healthcare, Electronics, Energy storage devices, etc. The course aims to give an understanding of how different materials are and what these differences mean for their properties and applications.

Course Objectives:

During this course, student is expected:

1. To know the different types of engineering materials with their structure.
2. To understand concept of Ferrous alloys with their composition, types, properties and applications.
3. To understand different types of Non-ferrous alloys with their composition, types, and properties used in railway and other applications.
4. To know the Polymer materials with their properties, classification and applications.
5. To understand the different types of Ceramic Materials with their properties and applications.
6. To know the different types new materials with their applications in various sectors.

Course Outcomes:

At the end of this course, students will be able to:

1. Describe and distinguish between different engineering materials based on their structure.
2. Select suitable Ferrous material for various Engineering applications.
3. Select suitable Non-ferrous material for railway and other applications.
4. Classify and select different types of Polymer materials for various Engineering applications.
5. Explain the classification, properties and applications of ceramic materials.
6. Describe the advantages and limitations of New materials over conventional materials

Section I

Unit-1: Basics of Materials Science and Railway Applications No. of lectures- 05

Introduction to engineering materials and classification, Structure - description of unit cell and space lattices, Coordination number, APF for cubic and hexagonal close packed structures, Miller indices, Gibbs phase rule, Cooling curves, Phase diagram, Isomorphous system, Lever rule, Material selection for rails, wheels, axles, bogies, etc.

Unit-2: Study of Ferrous materials and its alloys No. of lectures- 05

Classification of Metallic materials, Fe-Fe3C equilibrium diagram, Critical temperature lines with significance, Eutectic, Eutectoid and Peritectic transformations, Plain carbon steels: classification, composition, applications & properties, Effect of alloying elements on steels, Alloys steels: Silicon steels, Spring steels, Invar Steels, HSLA Steels uses in rails.

Unit-3: Study of Non-ferrous materials and its alloys No. of lectures- 05

Non-ferrous alloys: Copper alloys: brasses, bronzes. Cu-Zn Equilibrium diagram, Aluminum alloys: Al-Si alloy, Al-Cu alloy. Steps in precipitation hardening (Steps only), Study of White metal alloys or Babbitts. Introduction to Ni alloys, Fusible alloys.

Section II

Unit-4: Polymers No. of lectures- 05

Introduction of polymers with classification: Thermoplastic polymer & Thermosetting polymer, Polymerization mechanisms with types: Addition polymerization and Condensation polymerization, Degree of polymerization (D.P.) with numerical on molecular weight and DP calculations, Crystallization of polymers, Deformation of polymers, Vulcanization of rubber.

Unit-5: Ceramics No. of lectures- 05

Introduction to ceramic materials; Classification of ceramics, Crystal structure and bonding of common advanced ceramic materials; Mechanical behavior of ceramics, Glass and glass ceramics, Preparation and characterization of ceramics powders; Characterization of ceramic materials; Applications of ceramics in advanced technologies

Unit-6: New Materials in Railways and Other Applications No. of lectures- 05

Composite materials: Classification and Applications, Nanomaterials: Classification and Applications, Magnetic materials, electronic materials, nuclear materials, FRP coach panels, carbon-fiber components, high-speed rail structures, energy storage devices and magnetic levitation systems

Internal Continuous Assessment (ICA):

List of Experiments/Assignments/Case Studies, etc (Any six).

Minimum 6 Experiments/assignments from the following areas are required to be completed.

1. Study of Metallurgical Microscope
2. Study of Specimen Preparation for Microstructure Observations.
3. Study of microstructures of different Plain Carbon Steels.
4. Study of microstructures of Brasses and Bronzes.
5. Assignment on material selection for railway wheels, axles, rails, and bogies.
6. Study of various Polymer materials with their properties, classification, Polymerization types and applications of polymers.
7. Study of Ceramic materials, New materials with their classification, types, properties and applications.
8. Industrial visit report on material testing or railway workshop practices.

Text Books:

1. Material Science and Metallurgy – Dr. Kodgire (Everest, Pune).
2. Introduction to Engg. Materials – B. K. Agarwal (TMH).
3. Rajendra Kumar Goyal," Nanomaterials and nanocomposites: Synthesis, Properties, Characterization Techniques and Applications" CRC Press, 2017, ISBN: 978-14987616662017.
4. William F. Smith, Javed Hashemi, Ravi Prakash, " Foundation of Materials Science and Engineering", TATA Mc Graw-Hill International Edition,4th Edition, 2008.

Reference Books:

1. Introduction to Physical metallurgy – S.H. Avner, TMH.
2. W.D. Callister, D.G. Rethwisch, Materials science and Engineering: An Introduction, 8th ed., Wiley, 2010.
3. Electronic Materials Handbook, ASM International, Materials Park, 1989.
4. Buschow K.H.J.," Handbook of Magnetic Materials", Amsterdam: Elsevier, Volume 15, First Edition December 2003.

B. Multidisciplinary Minor in "Industrial and Project Management"

Semester	Course Code	Course Title
III	MERLMDM-01B	Industrial and Railway Management

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.TECH. (Mechanical and Rail Engineering) Semester-III
Multidisciplinary Minor in "Industrial and Project Management"
MERLMDM-01B: Industrial and Railway Management
(Multidisciplinary Minor-I)

Teaching Scheme
Lectures:02 Hours/week, 02 Credits
Practical:02Hours/week, 01Credit

Examination Scheme
ESE:70Marks
ISE: 30Marks
ICA:25Marks

Course Introduction:

Industrial and Railway Management involves the study of management principles, organizational structures, production systems, quality practices, and human resource management applicable to manufacturing industries and railway organizations. The knowledge of Industrial management comprises of those fields of business administration that are necessary for the success of companies within manufacturing sector and the encompassing services (primarily operations management, marketing and financial management). The course also covers material, quality, and human resource management used in modern industrial and railway organizations.

Course Prerequisite:

1. Knowledge of various manufacturing process.
2. Knowledge of industrial working environment through industrial training and Industrial visits.

Course Objectives:

During this course, student is expected:

1. To give the students an overview of the general functions of Management applicable to industrial & railway organizations.
2. To understand planning, organizing, leadership, and communication in industrial environments.
3. To make students aware about different motivational techniques and leadership styles
4. To introduce various statistical process controls to students
5. To familiarize students with project management concepts related to railway infrastructure and rolling stock projects.

Course Outcomes:

At the end of this course, student will be able to:

1. Explain the fundamentals of industrial and railway management.
2. Apply management functions in manufacturing and railway organizations.
3. Demonstrate various leadership and communication types.
4. Apply various material management technique for real life problems.
5. Explain human resource development practices and project management concepts in industries.

Section I

Unit-1: Introduction to Industrial and Railway Management No. of lectures- 05

Nature, purpose & scope of Management, System's approach to Management, Functions of Managers, Social responsibility & Ethics in Managing, Introduction to management structure in railway organizations (in railway workshops, depots and production units)

Unit-2: Planning and Organizing No. of lectures- 06

Planning: Meaning, Types of plans, steps in planning, planning process, decision making. Organizing: Nature & purpose of organizing, Organization structure, Departmentation in railway and other industries

Unit-3: Leading and Communication No. of lectures- 04

Factors in managing, Motivation, 'Carrot & Stick' theory, Maslow's theory of Hierarchy of needs, leadership styles, communication: process. Types- oral, written & nonverbal.

Section II

Unit-4: Material and Quality Management No. of lectures- 07

Material requirements planning (MRP), Inventory management, Procurement and stores management, Production systems: Job, Batch, and Mass Production, Productivity and productivity improvement techniques, Production Planning and Control (PPC), Routing, Scheduling, Loading, and Dispatching, Definition of Quality, Elements of quality, quality specifications. Factors affecting quality of design & quality of conformance, quality control, quality costs

Unit-5: Railway Project Management No. of lectures- 03

Concept of project management, Project life cycle, Planning and scheduling of railway projects, Resource allocation, Risk and safety management in railway projects

Unit-6: Human Resource Development No. of lectures- 05

Definition, Performance appraisal, Training & development. Strategic importance HRM; objectives of HRM; challenges to HR professionals; role, Responsibilities and competencies of HR professionals; HR department operations; Human Resource Planning - objectives and process.

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc. (Any six)

Minimum 6 Experiments/assignments from the following areas are required to be completed.

1. Study of organizational structure of Indian Railways or Metro Rail systems.
2. Case study on management practices in manufacturing industry.
3. Assignment on planning and scheduling of rolling stock maintenance.
4. Study of inventory management in industries.
5. Case study on quality assurance practices in industries.
6. Assignment on human resource development in industries.
7. Study of project management in railway infrastructure projects.
8. Analysis of productivity improvement techniques in any one industry.

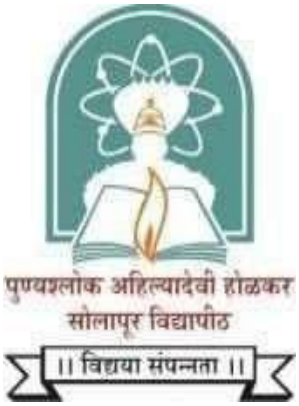
Text Books:

1. Essentials of Management – Koontz WeihrichBy TMH
2. Principles of Management & Administration – D. Chandra Bose. PHI
3. Statistical Quality Control – M. Mahajan By Dhanpat Rai & Co.
4. Total Quality Management – Besterfield& Others PHI

Reference Books

1. Principles of Management – Tripathy, Reddy by TMH
2. Management- James A.F. Stoner, R. Edward Freeman, Dainel R. Gilbert, JR. Peason Education Inc. and Dorling Kindersley Publishing Inc. ISBN 978-81317-0704-3
3. Railway Management and Engineering – V.A. Profillidis.
4. Railway Operation and Control – Joern Pachl.
5. Railway Workshop and Maintenance Manuals.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur



NAAC Accredited-2022

'B++'Grade(CGPA2.96)

Name of the Faculty: Science and Technology

NEP 2020

Syllabus: Mechanical and Rail Engineering

Name of the Course: S. Y. B. Tech.

Semester-IV

(Syllabus to be implemented w.e.f. A.Y. 2026-27)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.TECH. (Mechanical and Rail Engineering)
Semester-IV
MERLPCC-04: Theory of Machines

***Teaching Scheme**
Lectures: 02 Hours/week, 02 Credits
Practical: 02 Hours/week, 01 Credit

***Examination Scheme**
ESE:70Marks
ISE: 30Marks
OE: 25Marks

Course Introduction:
Theory of Machines is a fundamental subject in mechanical engineering that deals with mechanisms and machines used for transmitting motion and power. It introduces basic concepts such as kinematic links, kinematic pairs, kinematic chains, degrees of freedom, and types of constrained motion. Important laws like Kutzbach's law, Grubler's criterion, and Grashof's law are used for mechanism analysis. The subject also explains the analysis of velocity and acceleration in mechanisms using graphical methods. It includes the study of cams, gears, and gear trains used in mechanical systems. Additionally, it covers governors for engine speed regulation and balancing of rotating and reciprocating masses to reduce vibration and ensure smooth machine operation.

Course Objectives:

During this course, student is expected to:

1. Study Fundamentals of Kinematics of Machines.
2. Apply Graphical methods to determine motion parameter of mechanism
3. Follow procedure to generate cam profile for different motions of follower
4. Study basics of toothed gearing and procedure for gear train analysis
5. Understand relations for governor characteristics
6. Study need and method for balancing of rotary masses and reciprocating masses

Course Outcomes:

At the end of this course, student will be able to:

1. Select Mechanism for different applications
2. Perform velocity and acceleration analysis of mechanisms
3. Develop cam profile for given set of motion inputs.
4. Select gears and design gear trains for given application
5. Explain types of governors and their characteristics
6. Do balancing of rotary and reciprocating masses

Section I

Unit-1: Simple Mechanisms **No. of lectures-05**

Kinematic links, Kinematic pairs, Classification of pairs, Kinematic chain, Degrees of freedom, Types of constrained motion, Kutzbach's and Grubler's criteria for plane mechanisms, Structure, Mechanism, Machine, Grashoff's law for four bar mechanism, Inversion, Inversions of four bar chain, single slider crank chain and double slider crank chain, Railway pantograph linkage mechanisms

Unit-2: Velocity and Acceleration in Mechanisms **No. of lectures-05**

Velocity and acceleration analysis of mechanisms using following graphical methods: Instantaneous Centre Method (for velocity only), Relative velocity and relative acceleration method (for velocity and acceleration), Klein's construction (for velocity and acceleration)

Unit-3: Cams **No. of lectures-05**

Applications of cams in industrial automation, Types of cams and followers, cam nomenclature, displacement, velocity and acceleration diagrams, motions of the follower (Uniform velocity, Simple harmonic motion, Uniform acceleration & uniform retardation, Cycloidal motion), Construction of cam profile for radial cams with different types of followers (reciprocating followers), Construction of cam profile for oscillating roller follower.

Section II

Unit-4: Gear & Gear trains **No. of lectures-05**

Gear: - Geometry of motion, Gear geometry, Types of gear profile- involute & cycloidal, Theory of Spur gears, Interference in gears with involute tooth profile and methods for its prevention, Contact ratio, Path of contact (No numerical treatment for gears) Gear Trains: - Types of Gear trains (Simple, Compound, Epicyclic, Reverted), Tabular method for finding the speeds of elements in simple and compound epicyclic gear trains, Gear drives in EMU and Metro coaches

Unit-5: Governor **No. of lectures-04**

Need of governors, Types of governors (Watt, Porter & Hartnell governors), Derivations related to speed of spindle in Porter governor and Stiffness of Spring in Hartnell governor, Sensitivity, Stability, Isochronism and Hunting of governor, Governor effort, Power and Controlling force diagram of governors.

Unit-6: Balancing and Dynamics of Railway Vehicles **No. of lectures-06**

Need for balancing of rotating masses, Graphical method for balancing of rotating masses (masses rotating in same plane and different planes), Balancing of reciprocating masses, railway wheel balancing, traction motor rotor balancing, dynamic behavior of wheelsets, Introduction to railway vibrations, ride comfort and stability concepts

List of Experiments/Assignments/Case Studies, etc.

Internal Continuous Assessment (ICA):

All the sheets (*) are compulsory and any four from remaining.

1. Demonstration of various mechanisms.
2. Sheet based on Instantaneous Centre Method & Relative Velocity-Acceleration Method*
3. Sheet based on Klein's Construction*
4. Sheet based on generating cam profile for different followers and follower motions*
5. Assignment-based solving gear train problems.
6. Study of governor characteristics.
7. Dynamic balancing of railway wheelsets (case study).
8. Sheet based on graphical method for balancing of rotary masses*
9. Determination of gyroscopic effect of a rotating disc.
10. Study of Free and forced vibration apparatus.

Text Books:

1. Ballaney P. L., Theory of Machines, Khanna Publications, New Delhi

2. Khurmi R. S. & Gupta J. K., Theory of Machines, S. Chand publications, New Delhi.

3. Bansal R. K., Theory of Machines, Laxmi publications, New Delhi.

4. V.P. Singh, Theory of Machines, Dhanpat Rai & Sons Co. Pvt. Ltd., Delhi.

Reference Books

1. Rattan S. S., Theory of Machines, Tata McGraw Hill publication, New Delhi.

2. Shigley J., Theory of Machines & Mechanisms, McGraw Hill International Students' Edition.

3. Thomas Bevan, Theory of Machines, CBS publication, New Delhi

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.TECH. (Mechanical and Rail Engineering)
Semester-IV
MERLPCC-05: Rolling Stocks & Operations

***Teaching Scheme**
Lectures: 02 Hours/week, 02 Credits
Practical: 02 Hours/week, 01Credit

***Examination Scheme**
ESE:70Marks
ISE: 30Marks
ICA: 25Marks

Course Introduction:
This course introduces students to the organization, standards and operational systems used in Indian Railways. The course covers railway rolling stocks such as locomotives, coaches and wagons, railway track components, rail–wheel interaction, braking and traction systems and recent advancements in railway transportation technology.

Course Objectives:
During this course, student is expected to:

1. To introduce students to the organization structure of Indian Railways.
2. To understand railway standards, codes and classifications.
3. To study construction and working of railway rolling stocks.
4. To understand railway track components and mechanisms.
5. To study braking, traction and suspension systems used in trains.
6. To understand modern developments in Indian Railways.

Course Outcomes:
At the end of this course, student will be able to:

1. Explain the organization structure of Indian Railways.
2. Identify railway standards, codes and classifications.
3. Describe locomotives, coaches, wagons and bogies.
4. Analyze railway track components and rail–wheel interaction.
5. Explain braking, traction and suspension systems.
6. Discuss advancements in modern railway transportation

Section I

Unit-1: Introduction to Rolling Stock & Wheel-Rail Interface No. of lectures- 05

Introduction to Rolling Stock: Classification of rolling stock (locomotives, coaches, wagons, high-speed trains) Wheel-Rail Geometry: Wheel profile (conicity), rail profile, and track gauge Contact Mechanics: Mechanics of wheel-rail contact, Hertzian contact theory, and creep/slip phenomena Forces & Resistance: Train resistance forces (aerodynamic, rolling, gradient, and curve resistance). Forces acting on the track Derailment Mechanics: Mechanisms of derailment, Nadal's formula, and safety criteria against derailment.

Unit-2: Suspension, Bogie Design & Train Dynamics No. of lectures-05

Bogie Systems: Functions and types of bogies (two-axle, three-axle, articulated). Structural components of a bogie frame, Suspension Systems: Primary and secondary suspension. Coil springs, leaf springs, rubber springs, and air suspension systems. Dampers and anti-roll bars. Train Dynamics: Ride index and passenger comfort criteria, Vibration and Stability: Hunting oscillation, critical speed of rolling stock, and methods to mitigate instability.

Unit-3: Traction, Propulsion & Braking Systems No. of lectures-05

Traction Systems: Diesel-electric, AC/DC electric traction, and battery/hydrogen fuel cell propulsion trends. Traction-adsorption characteristics, Traction Motors: Characteristics of DC series motors and 3-phase induction motors for rail application, Braking System Fundamentals: Requirements of railway braking, Braking Mechanisms: Pneumatic (air) brakes, vacuum brakes, and electro pneumatic (EP) brakes. Direct and automatic air brake systems.

Section II

Unit-4: Coaches, Wagons and Bogies No. of lectures-05

Railway Coaches and Wagons: Types of coaches such as IRS, ICF and LHB. Types of wagons including open wagon, covered wagon, tank wagon, flat wagon and hopper wagon. Components and assembly of coaches and wagons. Bogie maintenance and types of bogies such as CASNUB, ICF and FIAT.

Unit-5: Railway Track Systems and Mechanisms No. of lectures-05

Railway Track Systems: Rails and sleepers, rail joints, fish plates, spikes, fang bolts and hook bolts. Functions and requirements of sleepers. Rail-wheel geometry, adhesion and friction, points and crossings, turnout design and layout.

Unit-6: Braking Systems and Advancements in Railways No. of lectures-05

Railway Systems and Advancements: Braking systems including friction and regenerative braking, HVAC systems in trains, traction systems with AC drives, suspension systems and coupling systems such as screw coupler, CBC and Janney coupler. Modern railway systems including metro, monorail, bullet train, maglev and recent advancements in Indian Railways.

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc.

1. Assignment on railway organization structure
2. Assignment on railway standards and codes
3. Assignment on locomotives and rolling stock
4. Case study on coaches, wagons and bogies
5. Demonstration of rail wheel interaction
6. Mini project on railway engineering application

Text Books:

1. Principles of Railway Engineering – S.C. Rangawala, Charotar Publication
2. A Text Book of Railway Engineering – Dhanpat Rai & Sons

Reference Books

1. Railway Transportation Systems – Christos N. Pyrgidis
2. Railway Engineering – M.M. Agrawal
3. Railway Track Engineering – J.S. Mundrey
4. A Text Book of Railway Engineering – S.C. Saxena and S.P. Arora

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical and Rail Engineering)

Semester-IV

MERLPCC-06: Fluid Mechanics and Hydraulic Machines

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical: 02 Hours/week, 01 Credits

***Examination Scheme**
ESE:70Marks
ISE: 30Marks
ICA: 25Marks

Course Introduction:

Fluid Mechanics and Hydraulic Machines is the core subject in Mechanical Engineering. Conversion of fluid energy into mechanical energy and vice versa, is the scope for Fluid Mechanics and Hydraulic Machines. As far as applications are concerned, areas like industrial hydraulics & pneumatics, tribology, process equipment design, piping engineering; irrigation engineering requires knowledge of fluid mechanics. The contents of fluid mechanics & fluid machine subject, encourages students to become involved in learning principles of fluid flow systems.

Course Objectives:

During this course, students are expected to:

1. Various properties of fluids & related principles
2. Understand fundamentals of Fluid Statics, Kinematics & Dynamics
3. Evaluate Energy Losses in Pipes
4. Apply dimensional analysis and Buckingham's II theorem to understand the dimensions of fluid properties, and use these principles to analyze forces on immersed bodies
5. Examine Water Turbines
6. Understand Centrifugal Pumps

Course Outcomes:

At the end of this course, student will be able to:

1. Explain and apply principles of fluid statics to analyze the equilibrium and stability of submerged and floating bodies.
2. Apply mathematical models to describe fluid motion, enabling the analysis of streamlines, potential flow, and velocity components.
3. Illustrate major and minor energy losses in pipe systems using empirical equation
4. Apply dimensional analysis to predict forces on immersed bodies, deriving dimensionless parameters for a comprehensive understanding of fluid properties.
5. Analyze impulse and reaction water turbines.
6. Calculate various parameters of centrifugal Pumps.

Section I

Unit-1: Fluid Statics **No. of lectures- 05**

Introduction to subject, Fluid mechanics, Fluid Properties, Center of pressure, Total pressure on immersed surfaces – horizontal, Center of pressure, Total pressure on immersed surfaces –vertical & inclined, The principle of buoyancy, Archimedes' principle, Conditions of equilibrium for submerged & floating bodies, Discussions on stability, Meta-center & metacentric height.
(No numerical treatment to Metacentric height)

Unit-2: Fluid Kinematics and Dynamics **No. of lectures- 08**

Fluid kinematics: Types of flow with examples, Streamlines, path lines & streak lines, velocity components, Local & convective acceleration, velocity potential function, equi-potential lines, Laplace equation governing potential flow, Stream function, continuity equation in Cartesian co-ordinates Fluid dynamics: Introduction, Euler's equation along a stream line, Bernoulli's equation, Bernoulli's Theorem, Applications of Bernoulli's Theorem: Venturi meter, Applications of Bernoulli's Theorem: Orifice meter & Pitot tube

Unit-3: Flow Through Pipes **No. of lectures- 07**

Introduction, Major & minor Energy losses, Darcy-Weisbach equation, Loss of head in pipe connections & fittings (Numerical treatment on only major Losses), Equivalent pipe, Hydraulic Gradient Line (HGL) & Total Energy Line (TEL), Siphon (No numerical treatment to HGL, TEL & Siphon), Concept of flow through pipes in series & parallel (Numerical treatment), Efficiency of power transmission, maximum transmission of fluid power through a given pipe (No numerical treatment on HGL, TEL& Power Transmission through Pipe)

Section II

Unit-4: Dimensional Analysis and Forces on Immersed Bodies **No. of lectures- 04**

Introduction, Dimensions of Commonly Encountered Fluid Properties, Dimensional Analysis, Buckingham's Π theorem, similitude, modeling, Drag & Lift on immersed bodies, Drag & Lift forces on stationary body.

Unit-5: Water Turbines **No. of lectures- 08**

Introduction, Euler's equation for rotodynamic machines, Classification of water turbines, Pelton wheel, Work done and efficiencies of Pelton wheel, Working proportions of Pelton wheel, Design of Pelton Turbine runner, Governing of Pelton turbine, Introduction, Construction and Working of Francis turbine, Work done and efficiencies of Francis turbine, Construction and Working of Kaplan turbine, Work done and efficiencies of Kaplan turbine, Working Proportions of Francis & Kaplan turbine, Draft tube (Theoretical treatment only for draft tube), Types and function, Governing of reaction turbines

Unit-6: Centrifugal Pumps **No. of lectures- 08**

Introduction, working principle, construction, types, various Heads of Centrifugal pump, Multistage pumps, Velocity triangles, Minimum starting speed, Maximum Suction Height, Net Positive Suction Head, Methods of priming, Calculations of efficiencies, Discharge, blade angles, Heads, Power required, Impeller dimensions, specific speed of pumps, Performance characteristics of pumps

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc.

Assignments (Compulsory)

1. Numerical & theoretical assignments on basics of fluid mechanics (Properties of fluids & related laws)
2. Numerical & theoretical assignments on study of manometer

List of Experiments (Any Seven out of following)

1 Determination of meta centric height for a ship
2 Verification of Bernoulli's theorem.
3 Calibration of Venturi meter/ Orifice meter.
4 Determination of hydraulic coefficients of an orifice.
5 Determination of Coefficient of friction for Parallel Pipes/Series Pipes (any one)
6 Study & Demonstration of Pelton wheel Turbine.
7 Study & Demonstration of Francis/ Kaplan turbine.
8 Study & Demonstration of centrifugal pump.

Text Books:

1. **T1:** Dr. P.N. Modi and Dr. S.M. Seth - Hydraulics and Fluid Mechanics including Hydraulic Machines, Standard Book House.
2. **T2:** Dr. R.K. Bansal - Fluid Mechanics and Hydraulic Machines - , Laxmi Publication Pvt. Ltd., New Delhi.
3. **T3:** Streeter, Wylie, Bedford - Fluid Mechanics, McGraw Hill Publication.

Reference Books

1. White - Fluid Mechanics, McGraw Hill Publication
2. Irving Shames - Mechanics of Fluid, McGraw Hill Publication.
3. Murlidhar - Advanced Fluid Engineering, Narosa Publication.
4. S. K. Som, G. Biswas- Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill publications

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical and Rail Engineering) Semester-IV

MERLVSC- 01: Advanced Lab on CAD

***Teaching Scheme**
Lectures: 01 Hours/week, 01 Credits
Practical: 02 Hours/week, 01Credit

***Examination Scheme**
ICA: 25Marks
POE: 25Marks

Course Introduction:

Computer Aided Design (CAD) & Computer Aided Manufacturing (CAM) has become a vital tool in modern day manufacturing industry. Basically, it deals with using computer systems (or workstations) for creating component models, analyzing component as per working conditions, optimizing the component designs and for generating programs which Are input to CNC Machines that carry out the machining of the machine components. Individual parts manufactured, are further assembled to form a machine. A very basic step in the process is to model the machine component accurately in the CAD/CAM software Packages available. This course introduces the preliminary commands, procedures, programming used in such software's. Use of software's in the engineering design & manufacturing increases the productivity of the designer, improves the quality of design, improves communications through documentation, and creates a database for Manufacturing. The course helps in skill development as per the need of the modern day Industry & thus, enhances the employability.

Course Objectives:

During this course, student is expected:

1. To develop the ability of using a software for drafting purpose
2. To provide introduction of different drafting and modeling techniques
3. To develop a pre-requisite for higher courses like CAD/CAM & FEM

Course Outcomes:

At the end of this course, student will be able to:

1. Classify the drafting & modeling techniques.
2. Use software package for different drafting & modeling requirements of industry.
3. Perform preliminary steps required while working on high-end CAD/CAM software's.
4. Develop logical programs required for parametric modeling.

Section I

Unit-1: Basics of Computer Aided Drafting **No. of lectures-04**

Introduction to Computer Aided Drafting – Introduction, Significance, Packages, Applications, User interface of the drafting package, status bar, different toolbars, viewing options, zoom, pan, layers & properties, etc, Draw commands (2D): line, polyline, circle, arc, ellipse, polygon, hatch, region, etc, Edit & Modify commands (2D): erase, scale, rotate, copy, move, trim, fillet, chamfer, extend, mirror, etc, Text commands, dimensioning: dimension style, Dimensioning common features.

Unit-2: Computer Aided Drafting (2D) **No. of lectures-03**

Drafting 2D machine components, Isometric Drawing: Snap Settings, Isoplane, Isocircle, Isometric drawings of machine components, Plotting options available in the drafting package

Section II

Unit-3: Details and assembly drawing (2D) **No. of lectures-03**

To prepare detailed part drawings of an assembly, To prepare assembly drawing from the prepared part drawings, Plotting of Part & assembly drawings including fits & tolerances **Content Delivering Methods**: Demonstration on suitable software package.

Unit-4: Computer aided drafting (3D) **No. of lectures-04**

Introduction to modeling: Wireframe, Solid, Surface Modeling, Three-dimensional drawing: UCS & three dimensional co-ordinates, Viewing in three dimensions, Solid modeling commands: primitive solids, extrude, revolve, sweep, loft, press pull, etc, Solid editing commands: 3D-rotate, 3D-Move. 3D-Scale, Boolean operations, Slice, Sections, etc

Internal Continuous Assessment (ICA):

List of Experiments/Assignments/Case Studies, etc.

Any Six out of Following

1. Introduction to Computer aided drafting
2. Computer aided drafting (2D) of simple components and print out
3. Computer aided drafting (2D) of isometric drawing and print out
4. Computer aided drafting (2D) of Simple Machine Components and print out.
5. Computer aided drafting (2D) of Simple Assembly Drawing and print out
6. Computer aided drafting (3D) of simple components and print out
7. Computer aided drafting (3D) of Machine components and print out
8. Computer aided drafting (3D) Assembly of Machine components and print out

Text Books:

1. Ajeet Singh, “Working with AutoCAD 2000”, Tata McGraw Hill..
2. George Omura, “ABC of Autolisp ” BPB Publications, New Del. P.S. Gill, Machine Drawing.,S.K. Kataria and Sons , Delhi.
3. N. D. Bhatt,. Machine Drawing. Charotor Publication House, Bombay.
4. N. Sidheshwsr .P. Kannaiah& V.V.S. Sastry. Machine Drawing, Tata McGraw Hill, NewDelhi.
5. K. L. Narayana, P. Kanniah, & K.V. Reddy, “Machine Drawing”.SciTech Publications (IndiaPvt. Ltd.) Chennai.

Reference Books

1. IS: SP46- Engineering drawing practice for schools and colleges, B.I.S. Publications.
2. IS: 696- Code of practice for general engineering drawings B.I.S. Publications.
3. IS: 2709-Guide for selection of fits, B.I.S. Publications.
4. IS: 919- Recommendation for limits and fits for Engineering, B.I.S. Publications.
5. IS: 8000- Part I, II. III. TV, geometrical tolerancing of technical drawings, B.I.S. Publications.

A. Multidisciplinary Minor in "Material Science and Energy Engineering"

Semester	Course Code	Course Title
IV	MERLMDM-02A	Advanced Materials for Mechanical and Railway Technology Development

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical and Rail Engineering) Semester-IV

A. Multidisciplinary Minor in "Material Science and Energy Engineering"

MERLMDM- 02A: Advanced Materials for Mechanical and Railway Technology Development

(Multidisciplinary Minor-II)

***Teaching Scheme**

Lectures: 02 Hours/week, 02 Credits
Practical : 02 Hours/week, 01Credit

***Examination Scheme**

ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:

The course provides a broad and general knowledge of various types of materials like Composite materials, Nano-materials, Electronic materials, Magnetic materials, Nuclear material, etc. which are widely used in development of new technologies along with properties of these materials, manufacturing methods, testing methods and applications of these materials in various sectors like Railway, Aerospace, Automobile, Healthcare, Electronics, Energy storage devices, etc. The course aims to give an understanding of how different materials are and what these differences mean for their properties and application.

Course Objectives:

During this course, student is expected:

1. To understand advanced materials used in railway and mechanical engineering systems.
2. To introduce the students to the world of nanoscience and provide knowledge of various synthesized/developed and natural nanomaterials and their possibilities.
3. To equip the students with the knowledge of available methods to synthesize nanostructures and materials and make them aware, the huge potential of nanomaterials/structures in engineering/technologies.
4. To know the different types of Electronic materials with their properties and applications.
5. To know the different types of Magnetic materials with their properties and applications.
6. To know the different types of Nuclear materials with their properties and applications.

Course Outcomes:

At the end of this course, student will be able to:

1. Select suitable composite materials for railway and mechanical engineering applications.
2. Describe the effect of particles or grains size on mechanical, thermal, optical and electrical properties of nanomaterials and synthesis the nanomaterials by top-down and bottom-up approaches.
3. Explain the theoretical concepts of about the applications of nanomaterials in structural, electronics, optical, magnetic, and bio-medical fields, nanocomposites etc.
4. Identify and explain the basic principles of various electronic materials.
5. Identify and explain the basic principles of various Magnetic materials.
6. Explain the basic principles of various Nuclear materials in sustainable transportation systems

Section I

Unit-1: Composite Materials for Mechanical and Railway Applications No. of lectures- 06

Concept and classification of composite materials, Polymer matrix composites (PMC), Carbon carbon composites, Reinforcements and matrices, Fiber selection and mechanical properties, Manufacturing processes, Testing of Composites: Mechanical testing of composites, Tensile testing, Compressive testing, Applications of Composites- Railway seating systems, High speed train body shells

Unit-2: Introduction to Nanomaterials and Nanotechnology No. of lectures- 05

Length scales, surface area/volume ratio of micron to nanoscale materials, Importance of Nanoscale and Technology, Top down and bottom-up approaches, Classification of nanomaterials, effect of particle size on thermal properties, electrical properties, phase transformation, mechanical properties, magnetic properties, optical properties, wear resistance and chemical sensitivity. Examples of inspiration from the Nature and ancient history. Top-down approaches-lithography, mechanical alloying, severe plastic deformation, Bottom-up approaches-physical vapour deposition, chemical vapour deposition, molecular beam epitaxy, colloidal or wet chemical route, green chemistry route, sol-gel method, atomic layer deposition, combustion method.

Unit-3: Applications of Nanomaterials in Transportation Systems: No. of lectures- 04

Applications of nanomaterials: nanofluids, hydrogen storage, solar energy, antibacterial coating, self-cleaning coating, nanotextiles, biomedical field, water treatment, automotive sector, catalysts, nanopore filters, nano diamond, hydrogen powered trains, energy efficient cooling systems, solar powered railway stations

Section II

Unit-4: Electronic Materials No. of lectures- 06

Electrical and Thermal Conduction in Solid metal and conduction by electrons, Resistivity and its Temperature dependence, Thermal Conductivity, Thermal Resistance Temperature coefficient of Resistivity, Impurity Effect, Resistivity Mixture Rule, Skin Effect. Electrical Conductivity of Non - Metals: Ionic Crystals and Glasses, Semiconductors, Solar Radiation Fundamentals.

Semiconductors, Extrinsic, Intrinsic, Recombination and Generation in Semiconductors, Semiconductor Devices, Compound Semiconductor, Metal Semiconductor contacts, Microelectronic Devices Such as LED, CMOS, MOSFETS, BPT etc, Manufacturing Methods and Applications, Si wafer Manufacturing, Solar Cell Device and Quantum Efficiency Calculations.

Unit-5: Magnetic Materials for Railway propulsion and Control System No. of lectures- 05

Magnetic Properties and quantities, Classification of Magnetic Materials, Ferromagnetism Origin, Exchange Interaction, Saturation Magnetization, Curie Temperature, Ferromagnetic Domains, Magnetostriction, Demagnetization, Magnetic Alloys: Soft and Hard Magnetic materials, Ferrites, Magnetic Recording Materials, Magnetoelectric materials, magnetic sensors and maglev train technology, speed monitoring systems

Unit-6: Nuclear Materials No. of lectures- 04

Materials Specifications for fuel, cladding, moderator, coolant, shield, pressure vessel; Materials selection influenced by the need for a low capture cross-section for neutrons. Nuclear metallurgy; Structures and properties of materials with special relevance for nuclear power generation: uranium and other actinides, beryllium, zirconium, graphite. Recycle and waste management and disposal. environmental impact; safety.

Internal Continuous Assessment (ICA):

List of Experiments/Assignments/Case Studies, etc. (Any six)

1. Assignment on types of Composite material and its applications.
2. Assignment on Manufacturing processes and testing methods used for Composite materials.
3. Assignment on types of Nanomaterials with their properties and applications.
4. Assignment on Topdown and bottom-up approaches used in Nanotechnology.
5. Assignment on sustainable energy materials for railway electrification.
6. Assignment on Electronic devices Such as LED, CMOS, MOSFETS, BPT etc.
7. Case study on Maglev and high-speed rail technologies.
8. Assignment on Introduction to Nuclear materials with its applications.

Text Books:

1. Jones R. M., “Mechanics of Composite Materials”, Hemisphere Publishing Corporation, New York.
2. Rajendra Kumar Goyal," Nanomaterials and nanocomposites: Synthesis, Properties, Characterization Techniques and Applications" CRC Press, 2017, ISBN: 978-14987616662017.
3. William F. Smith , JavedHashemi, Ravi Prakash, " Foundation of Materials Science and Engineering", TATA Mc Graw-Hill International Edition,4th Edition, 2008.
4. S. O. Kasap," Principles of Electronic Materials and Devices", Tata Mc Graw-Hill Publication, 2nd Edition, 2002.
5. C.K.Gupta," Materials in Nuclear Energy Applications", CRC Press, 1st Edition 1989

Reference Books:

1. Chawla, Krishan K (2012), Composite Materials, Science and Engineering, ISBN: 978-0-387- 74365, Springer.
2. Dieter Vollath, "Nanomaterials: An introduction to synthesis, properties and applications", 2nd Edition, Aug 2013, Wiley-CVH (ISBN: 978-3-527-33379-0)
3. Electronic Materials Handbook, ASM International, Materials Park, 1989.
4. Buschow K.H.J.," Handbook of Magnetic Materials", Amsterdam: Elsevier, Volume15, First Edition December 2003.

B. Multidisciplinary Minor in "Industrial and Project Management"

Semester	Course Code	Course Title
IV	MERLMDM-02B	Production Systems and Railway Operations

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical and Rail Engineering) Semester-IV

C. Multidisciplinary Minor in "Industrial and Project Management"

MERLMDM 02B: Production Systems and Railway Operations

(Multidisciplinary Minor-II)

*Teaching Scheme	*Examination Scheme
Lectures:02Hours/week, 02Credits	**ESE:70Marks**
Practical :02 Hours/week, 01Credit	**ISE:30Marks**
	ICA:25Marks

Course Introduction:

Strategic growth & competiveness of organizations are depending upon the effective utilization of the critical production resources of the organization. Production/operations function is concerned with design & control systems responsible for the productive use of raw materials, human resources, equipment and facilities in the development of a product or services. The syllabus is divided into two sections; each section contains three chapters. Section I focuses on the introduction to Production and Operations Management, the forecasting and its significance and capacity planning. Inventory Management, Plant maintenance, Value Engineering and the Advanced Manufacturing concepts are included in Section-II.

Course Objectives:

During this course, student is expected to:

1. Develop knowledge about the principles of production and operations management.
2. Solve organizational problems related to production as well as operations management.
3. Empower students to handle case studies related to industrial and railway problems.

Course Outcomes:

At the end of this course, student will be able to:

1. Explain the scope and need of production and operation management
2. Evaluate the future demands using different forecasting methods and apply the concept of capacity planning and aggregate planning to various types of manufacturing systems
3. Explain the importance and functions of production planning and control
4. Apply the inventory control models in production processes
5. Apply the concept of plant maintenance.
6. Explain various advanced techniques such as Lean manufacturing, value engineering, six sigmas, Kanban, Supply chain management.

Section- I

Unit-1: Introduction to Production and Operations Management **No. of lectures-04**

Introduction to POM- Definitions, objectives, Scope and History of Production Management, Manufacturing system and its types, Operation managements in Coach factories, locomotive production units, and maintenance organizations.

Unit-2: Forecasting and Capacity Planning **No. of lectures-07**

Forecasting- Need, types of Forecasting, Statistical method, Moving average method, exponential smoothing method, Least square method, Regression and Correlation method (Numerical Treatment), Passenger and freight demand forecasting.

Capacity Planning- Concept, measurement and measures of capacity, factor affecting, capacity planning procedure, Aggregate planning, Investment decision and replacement analysis (Numerical Treatment), Workshop capacity planning (bogie overhaul, wheelset machining, coach maintenance).

Unit-3: Production Planning and Control **No. of lectures-04**

Objectives, Functions, Co-ordination of PPC with other Department, Routing Scheduling, Loading and Sequencing, Line balancing, Production Control – Dispatching, Function and documents, Follow up, Evolution

Section II

Unit-4: Inventory Management for Railway Spares and Materials **No. of lectures- 05**

Inventory concepts, costs, EOQ, EBQ, ABC analysis, MRP, fixed-period and fixed-quantity systems (Numerical Treatment), Rails, sleepers, fasteners, brake blocks, bearings, traction motor spares, signaling spares, lubricants, and depot consumables, ABC classification for critical railway components.

Unit-5: Plant Maintenance **No. of lectures-04**

Definition, Need, Importance, Functions, scope and organization of maintenance department Types of maintenance- preventive, break down, Identification of break down using fishbone diagram, and TPM, Reliability and life testing

Unit-6: Value Engineering and Value Analysis and Advanced manufacturing System **No. of lectures-06**

Value Engineering and Value Analysis -Definition, objectives and use of value analysis,
reason of unnecessary cost, value analysis procedure. Advanced manufacturing System - Lean Manufacturing Basics, Just- in Time (JIT), Kanban System, KAIZAN, Zero defect, six sigmas, Supply chain Management.

Internal Continuous Assessment (ICA):

List of Experiments/Assignments/Case Studies, etc.

(1 mandatory and any 5 out of remaining 7)

1. A micro project on categorization of industries based on production type and production system
   (Categorize any (minimum) six industries by type of production and production system and justify the categorization. This micro project is based on the Industry, products of the industry and further their categorization)
2. Numerical treatment on different forecasting techniques by using Microsoft Excel spreadsheet
3. Numerical treatment on capacity planning by using Microsoft Excel spreadsheet
4. Numerical treatment on inventory management
5. A Case study on plant maintenance or TPM preferably from the research paper from reputed peer reviewed journal
6. A Case study on value analysis
7. A Case study on Six Sigma
8. A Case study/online course (minimum 2 hrs.) on Supply chain Management

Text Books:

1. Industrial engineering and Production management by Martand Telsang. (S. Chand)
2. Elements of Production Planning and Control by Samuel. (Universal Pub.)
3. Modern Production/Operation Management by Buffa Sarin. (Wiley)
4. Industrial Engineering and Management by O. P. Khanna

Reference Books

1. Production and Operation Management by M. E. ThukaramRao. (New Age International Pub)
2. Sunil Chopra and Peter Meindl "Supply Chain Management – Strategy, Planning, and Operation", 6th Edition, Peason Education Asia, 2016.

A. Honors in Robotics Engineering

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
III	MerlHon - 01A	Industrial Robotics	3	-	2	4	70	30	25	-	125
IV	MerlHon - 02A	Machine Vision	3	-	2	4	70	30	25	-	125
		Total	6	-	4	**8**	**140**	**120**	**50**	-	**250**

Honors Course will be for the students of same Program

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Honors) (Mechanical and Rail Engineering) Semester-III

A. Honors in Robotics Engineering

MerlHon-01A: Industrial Robotics

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical: 02Hours/week, 01Credit

***Examination Scheme**
ESE:70Marks
ISE: 30Marks
ICA:25Marks

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Course Introduction:

This course is designed to give the student an in depth understanding of manipulative robotics and its uses. It covers the topics such as automation types, introduction to industrial robotics, Anatomy of an industrial robot, robot history, configurations, sensors and actuators, end effectors and AGVs Kinematics of multi-degree-of-freedom systems, Jacobean matrices, kinematics, and dynamics. Robot trajectories. Design of installations, The Work cell —concepts and design, etc. This course requires the students to take part in site visits and case study presentations. Students are also required to complete a simulation and image processing in any suitable Simulation Software.

Course Objectives:

During this course, the student is expected to:

1. Understand the basic construction of an industrial robot.
2. Acquaint with existing market distribution and future trends.
3. Understand the technology behind a modern robot such as sensors, actuators, grippers, controllers, machine vision etc.
4. Understand and bridge the gap (regarding industrial robots) between textbooks to industry.

Course Outcomes:

At the end of this course, student will be able to:

1. Explain types of robots including Cobots.
2. Solve simple kinematics and dynamics problems on robot motion.
3. Select appropriate robot specifications for industrial applications.
4. Use any robot simulation software to simulate a robot and its Work cell.
5. Explain sensors and actuators used in robot
6. Solve simple kinematics and dynamics problems on robot motion.

Section I

Unit-1: Introduction, types of Robots **No. of lectures - 8**

History and fundamentals of Industrial Robots, Definition as per ISO & IFR, Technology Evolution, components of industrial robots, configuration, typical specifications, current market scenario, "Collaborative Robots", Service Robots. AGVs, classification, navigation techniques, applications. Mobile robots: Classification, wheeled and tracked robots, autonomous navigation and control methods and applications, Humanoid robots, Bio-mimetic.

Unit-2: Sensors and Actuators **No. of lectures - 8**

Sensors: Sensor classification, joint angle sensors, rotary encoders, proximity sensors & switches, range sensors, GPS, INU, Actuators: Compare Hydraulic, Pneumatic and Electric drives, Review of DC motors and stepper motors, AC motors, speed control of AC motors, VFD drives, and drive selection criteria.

Unit-3: Grippers and End Effectors **No. of lectures - 4**

End Effectors: End effectors & grippers, classification, applications, design, and selection criteria.

Section II

Unit-4: Kinematics & Dynamics **No. of lectures - 8**

Forward kinematics: Coordinate frames, transformations, arm equations, forward kinematics of 2 DOF and 3 DOF planar manipulator.

Inverse Kinematics: Tool Configuration, inverse kinematics of 2 DOF and 3 DOF planar manipulator. Dynamics: Velocity Jacobian, singularities, induced torque and forces, Lagrange's Equation, Dynamic models of two-axis planar robots.

(Derivations and Numerical Exercises on simple 2DOFmanipulators only.)

Unit-5: Control and Path Planning **No. of lectures - 6**

Control architecture of robots, Overview of advanced control techniques such as force control, PID control adaptive control, PWM control. Trajectory planning, joint space schemes, Cartesian space schemes, issues in trajectory planning.

Unit-6: Applications of Industrial Robots **No. of lectures - 6**

General considerations for selecting robots (including layout and work cell) for material handling and machine tending, spot welding, continuous welding, sealant application, spray painting, assembly, inspection, electronics assembly.

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc. (Any Six)

1. Survey assignment on robot's industry and manufacturers and applications
2. Assignment on robot sensors and actuators.
3. Assignment on EOAT.
4. Assignment on forward and inverse kinematics on software supported by hand calculations
5. Assignment on DH notations using software supported by hand calculations.
6. Assignment on manipulator dynamics using software supported by hand calculations
7. Assignment on robot control using software.
8. One software based assignment on path planning and programming techniques.
9. One assignment on various applications in industry.
10. One assignment which involves building a work cell and offline programming using software.

Text Books:

1. S.K Saha, Introduction to Robotics, McGraw-Hill
2. Mikell Groover et.al, Industrial Robotics, McGraw Hill.
3. James, Keramas, Robot Technology Fundamentals, Delmar Cengage Learning.
4. Gunter Ulrich, Automated Guided Vehicle Systems, Springer.

Reference Books

1. Asitava Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford Press
2. Siegwart et.al, Autonomous Mobile Robots, Prentice Hall India.
3. Shimon Nof, Handbook of Industrial Robotics, Wiley.
4. Schilling, Fundamentals of Robotics, Prentice Hall India.
5. International Federation of Robotics - https://www/ifr.org

Note: *Students are expected to go through websites of top industrial robot manufacturers. In addition to the IFR website for up to date and real world information including statistical data. Content in textbooks is too generic and may not be up to date.*

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Honors) (Mechanical and Rail Engineering) Semester-IV

A. Honors in Robotics Engineering

MerlHon-02A: Machine Vision

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical: 02Hours/week, 01Credit

***Examination Scheme**
ESE:70Marks
ISE: 30Marks
ICA:25Marks

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Course Introduction:

This course is designed to give the student an in depth understanding of Machine Vision using in suitable software package. This course requires the students to take part in site visits and case study presentations. This course covers the fundamentals of Machine Vision such as segmentation, template matching, edge detection, camera calibration, shape analysis, object identification, Cameras (CCD, CMOS, Area Scan, and Line Scan), camera specification and selection, Image Processing using suitable software package, etc.

Course Objectives:

During this course, student is expected to:

1. Understand components of a machine vision system and its working.
2. Acquaint with existing market distribution and future trends
3. Understand the fundamentals of image processing and analysis
4. Understand fundamentals of Cameras (CCD, CMOS, Area Scan, and Line Scan)
5. Understand the scope and applications of modern machine vision systems.
6. Understand the technology behind a modern robot machine vision

Course Outcomes:

At the end of this course, student will be able to:

1. Use the Image Processing toolbox available in suitable software package.
2. Use Image Analysis toolbox in in suitable software package.
3. Use Computer Vision toolbox in in suitable software package.
4. Explain components of machine vision and image processing fundamentals.
5. Explain construction and applications of different types of robots.
6. Define segmentation and explain concept such as template matching, edge detection, shapeanalysis etc.

Section I

Unit 1 – Introduction to Machine Vision **No. of lectures - 06**

Machine Vision definition, Machine vision system components, block diagram of machine vision system, lighting techniques, front light source and back light source, application of machine vision system, Analog to digital converter (A/D Converter), image storage frame grabber

Unit 2 – Image processing fundamentals **No. of lectures -08**

Image processing fundamentals: Image representation, Image processing and analysis, image data reduction, Segmentation, Thresholding, region growing, Edge detection, corner point detection, shape analysis

Unit 3- Image Analysis **No. of lectures - 06**

Object identification, template matching, object recognition, lead through programming method, textual robot programming method

Section II

Unit 4 – Cameras **No. of lectures - 06**

Cameras: image devices Charge couple device (CCD), Complementary metal oxide semiconductor (CMOS), Area Scan, Line Scan, camera specification and Camera selection, camera calibration. difference between CCD and CMOS, Needof CCD and CMOS cameras

Unit 5 – Machine vision system **No. of lectures - 08**

Sensing and digitizing function in machine Vision, Feature extraction- basic features and measures for 2D object, numerical on finding area, minimum aspect ratio, diameter, centroid, thinness measures of image, training the vision system.

Unit 6 – Application of Machine vision system **No. of lectures - 06**

Robotic applications i.e. inspection, identification, visual surveying and navigation, Agricultural applications of Machine vision system, application of machine vision for control of AGVs

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc. (any six)

1. Survey assignment on robots, AGVs, control by using machine vision.
2. Theory assignment on Machine vision system.
3. One assignment on Image Processing using suitable software package.
4. One assignment on Image Analysis using suitable software package.
5. Survey assignment on robots industry and manufacturers and applications.
6. One assignment on CCD & CMOS Cameras
7. One assignment on Segmentation
8. One assignment on Problem Solving
9. One theory assignment on Illumination techniques.
10. One assignment on shape analysis.

Text Books:

1. S.K Saha, Introduction to Robotics, McGraw-Hill.
2. Mikell Groover et.al, Industrial Robotics, McGraw Hill.
3. Stuart Russel & Peter Norvig, Artificial Intelligence a Modern Approach.
4. E. Rich and K. Knight, "Artificial intelligence", TMH.
5. N.J. Nilsson, "Principles of AI", Narosa Publ. House, 2000.

Reference Books

1. Asitava Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford Press.
2. Siegwart et.al, Autonomous Mobile Robots, Prentice Hall India.
3. Robin R Murphy, Introduction to AI Robotics, PHI Publication, 2000.
4. Bishop et.al, Handbook of Mechatronics, CRC Press.
5. Schilling, Fundamentals of Robotics, Prentice Hall India.
6. Robert Babuška, Fuzzy Modeling for Control, Springer.
7. Dan Patterson, Introduction to Artificial Intelligence and Expert Systems, Prentice-Hall.
8. International Federation of Robotics - https://www/ifr.org

B. Honors in Electric Vehicle Engineering

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
III	MerlHon - 01B	Introduction to Automobile Engineering	3	-	2	4	70	30	25	-	125
IV	MerlHo n - 02B	Introduction to Electric and Hybrid Vehicles	3	-	2	4	70	30	25	-	125
		Total	6		4	**8**	**140**	60	50		250

Honors Course will be for the students of same Program

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Honors) (Mechanical and Rail Engineering) Semester-III

B. Honors in Electric Vehicle Engineering

MerlHon-01B: Introduction to Automobile Engineering

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical: 02Hours/week, 01Credit

***Examination Scheme**
ESE:70Marks
ISE: 30Marks
ICA:25Marks

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Course Introduction:

The objective of this course is to provide a fundamental understanding of the various systems of a typical automobile. The systems that are covered are IC engines, their types, components and applications, the clutch and gearbox, calculation of gear ratios, driveline and differential, steering system, types of steering, brakes, ABS, suspension, wheels and tyres and electronics and electrical systems.

Course Objectives:

During this course, the student is expected to:

1. Understand different automobile layouts
2. Understand automobile ICE and their applications
3. Understand the construction and working of different automobile subsystems.
4. Understand how the automobile is serviced and maintained.
5. Understand how an automobile is built.
6. Understand components of electricals & electronics.

Course Outcomes:

At the end of this course, student will be able to:

1. Identify automobile body types accurately
2. Explain construction and working of different automobile subsystems
3. Calculate gear ratios, steering angle, steering forces, brake forces etc. using standard formulae.
4. Locate and identify automobile subsystems and components on an actual vehicle.
5. Explain different electrical and electronics systems in an automobile and their functions.
6. Explain automotive electricals & electronics components.

Section I

Unit -1: Automobile body type and powertrain **No. of lectures - 8**

Automobile layout, automobile body styles, chassis construction, Automotive powertrain, Classification of Internal Combustion Engines, Engine Components, Operation of Four Stroke Engines, Two-Stroke Engines, Engine Cycles, Engine Performance, Supercharging, engine subsystems and engine selection. EVs, HEVs

Unit -2: Automotive Clutch, Transmission, Powertrain Analysis **No. of lectures - 6**

Automobile Clutch, Types, basic calculations, automobile transmissions and its types, power train calculation and analysis, transmission matching.

Unit - 3: Brake System **No. of lectures - 6**

Fundamentals of Braking, braking requirements, drum brakes, disc brakes, hydraulic brakes, air brakes, brake selection for 2W, 3W, 4W and commercial vehicles, ABS.

Section II

Unit - 4: Steering System **No. of lectures - 6**

Automotive Steering, components of the steering system, type of steering (R&P, recirculating ball, etc), Ackerman steering, simple calculations for steering ratio and steering angle, power assisted steering.

Unit - 5: Wheels, Tyres and Suspension System **No. of lectures - 8**

Wheel alignment, wheel types, tyres and its tyres, radial tyres, types of suspension for front and rear, requirements of suspension system, independent and dependant suspension, shock
absorbers and suspension analysis.

Unit - 6: Automotive Electricals and Electronics **No. of lectures - 6**

Automotive sensors and actuators, microcontrollers in automobiles, electric and electronic components in an automobile, automobile battery and its types, starter, spark plugs etc.

Internal Continuous Assessment (ICA):

List of Experiments/Assignments/Case Studies, etc.

1. Survey assignment on 2W, 3W, 4W and CVs.
2. Study of ICEs for 2W, 3W, 4W and CVs
3. Braking calculations and brake selection 2W, 3W, 4W and CVs
4. Study of Clutch and transmission systems for 2W, 4W, CVs
5. Study of steering for 2W, 4W, CVs
6. Study of Suspension System for 2W, 4W, CVs
7. Study of wheels and tyres for 2W, 4W, CVs
8. Study of automotive electrical and electronics.
9. Field visit to a service station.
10. Field visit to an automobile manufacturing plant.

Text Books:

1. D. Crolla, "Automotive Engineering: Powertrain, Chassis System and Vehicle Body", Elsevier
2. R. Stone and J. K. Ball, "Automotive Engineering Fundamentals", SAE International, 2004
3. T. K. Garrett, K. Newton, and W. Steeds, The Motor Vehicle, 13th Edition, SAE International, 2001
4. Julian Happian-Smith, "An Introduction to Modern Vehicle Design", BH
5. William B. Ribbens, "Understanding Automotive Electronics", Newnes

Reference Books

1. D. Crolla, D. E. Foster, T. Kobayashi and N. Vaughan (Editors-in-Chief), "Encyclopedia of Automotive Engineering, Parts 1-6", Wiley, 2015
2. D. B. Astow, G. Howard and J. P. Whitehead, Car Suspension and Handling, 4th Edition, SAE International, 2004.
3. R. Limpert, Brake Design and Safety, SAE International, 1992.
4. Bosch, Automotive Handbook, 2004
5. The Automotive Chassis, SAE

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Honors) (Mechanical and Rail Engineering) Semester-IV

B. Honors in Electric Vehicle Engineering

MerlHon-02B: Introduction to Electric and Hybrid Vehicles

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical: 02Hours/week, 01Credit

***Examination Scheme**
ESE:70Marks
ISE: 30Marks
ICA:25Marks

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Course Introduction:

The objective of this course is to provide a fundamental understanding of the various systems of typical electric and hybrid electric vehicles. The covered systems are battery electric vehicles their types, components and applications, hybrid electric vehicles (HEVS), types of HEVs, batteries for EVs and HEVs, charging techniques and connectors, and the future of EVs and HEVs.

Course Objectives:

The Course aims to:

1. Understand the construction and working of EVs
2. Understand the construction and working of HEVs
3. Understand the types of electric motors and drives for EVs
4. Understand the types of control methods for electric motors

Course Outcomes:

At the end of this course, the student will be able to:

1. Define all nomenclature associated with EVs and HEVs.
2. Explain construction and working of EVs and HEVs.
3. Perform basic calculations about EV performance.
4. Explain the construction, operation and selection of motors for different EV and HEVapplications.
5. Explain different types of EV drive cycles.
6. Explain different types of EV motor Controller

Section I

Unit-1: EV history and fundamentals **No. of lectures - 8**

History of the electric vehicle, Electric vehicle components, Vehicle mass and performance, electric motor and engine ratings, fuel economy, Electric vehicle market. Electric Vehicles, Overview of Electric Vehicles in India, Gravitational Energy Density, Volumetric Energy Density, Energy Efficiency, Capital Cost of EV Battery, Operational Cost of EV Battery, Battery cost reduction strategy, Swapped battery, Vehicle Weight, Range Anxiety, Fast charge, Slow charge, Range-Extender batteries.

Unit-2: EVs **No. of lectures - 6**

Electric vehicle configurations, electric motor characteristics, tractive effort and transmission requirements, tractive effort in normal driving, energy consumption and vehicle performance.

Unit-3: HEVs **No. of lectures - 6**

Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains, Plug-In Hybrid Electric Vehicle, Powertrain Component Sizing, Mass Analysis and Packaging.

Section II

Unit-4: Electric Motors for EVs **No. of lectures - 6**

Basic construction working and control principles of DC motors, BLDC motors, AC induction and synchronous motors, SRM motors.

Unit-5: Motor Controllers **No. of lectures - 6**

Choppers, Inverters, VFDs, torque control of DC motors, speed control of DC motors, torque and speed control of AC motors.

Unit-6: Drive Cycle **No. of lectures - 8**

Drive cycle, Energy Efficiency, Speed, Acceleration, Idling, Deceleration, Standard Drive Cycle, India Drive Cycle, Regeneration Efficiency, Modified Indian Drive Cycle, Electric Compact Sedan, Compact Sedan Energy Efficiency, Low-End Electric Trucks, Delivery Truck Specifications, Truck MIDC, Traction Energy for Drive Cycle, Summary of the impact of various parameters.

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc. (Any six)

1. History and development of EVs and HEVs
2. EV types and components
3. HEV types and components
4. Basic performance calculations for EVs
5. DC motors for EVs.
6. AC motors for EVs.
7. DC motor modelling and control.
8. AC motor modelling and control.
9. Motor controllers and power electronics.
10. Drive Cycles

Text Books:

1. Iqbal Husain, *Electric and Hybrid Vehicles Design Fundamentals*, Taylor and Francis,2021
2. Ehsani, et al, *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles*, CRC press
3. R.Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", Prentice-Hallof India, Pvt. Ltd., New Delhi, 2003.

Reference Books:

1. Austin Hughes, "Electric Motors and Drives – Fundamentals, Types and Applications", Elsevier – a division of Reed Elsevier India Private Limited, New Delhi, 2006.
2. Vedam Subramanyam, "Electric Drives – Concepts and Applications", Tata McGraw Hill,2000.