Kavayitri Bahinabai Chaudhari
NORTH MAHARASHTRA UNIVERSITY,
JALGAON (M.S.)

Second Year Bachelor of Engineering
in
Mechanical

(As per NEP 2020 Guidelines)

Faculty of Science and Technology

कवयित्री बहिणाबाई चौधरी उत्तर महाराष्ट्र विद्यापीठ
अंतरी पेटवू ज्ञानज्योत
1990
'A' Grade
NAAC Re-Accredited
(4th Cycle)

SYLLABUS STRUCTURE
For Affiliated Colleges
Semester –III & IV
W.E.F. 2025 – 26

Syllabus Structure for Second Year Engineering (Semester – III, Level – 5.0) (Mechanical) (w.e.f. 2025 – 26)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ME-301	Engineering Mechanics	PCC	3			3	40	60			100	3
ME-302	Engineering Mechanics Lab	PCC			2	2			25	25 (OR)	50	1
ME-303	Applied Thermodynamics	PCC	3			3	40	60			100	3
ME-304	Applied Thermodynamics Lab	PCC			2	2			25	25 (PR)	50	1
ME-305	Machine Drawing and Computer Graphics lab.	PCC	1		2	3			25	25 (PR)	50	2
ME-306	Ergonomics and Human-Centered Design	MD M	2			2	40	60	25		125	2
OE-307	Open Elective – I	OE	3			3	40	60			100	3
ME-308	Industrial Economics	HSSM	2			2						2
ME-309	Universal Human Values	HSSM	1		2	3			25		25	2
ME-310	Community Engagement Project / Field Project	ELC			4	4			50		50	2
			15		**12**	**27**	**160**	**240**	**175**	**75**	**650**	**21**

ISE: Internal Sessional Examination ESE: End Semester Examination ICA: Internal Continuous Assessment

CA: College Assessment UA: University Assessment

Syllabus Structure for Second Year Engineering (Semester – IV, Level – 5.0) (Mechanical) (w.e.f. 2025 – 26)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ME-401	Manufacturing Processes	PCC	3			3	40	60			100	3
ME-402	Manufacturing Processes Lab	PCC			2	2			25	25 (OR)	50	1
ME-403	Fluid Mechanics & Hydraulic Machines	PCC	3			3	40	60			100	3
ME-404	Fluid Mechanics & Hydraulic Machines Lab	PCC			2	2			25	25 (PR)	50	1
ME-405	Metrology and Quality Control Lab	PCC	1		2	3			25	25 (PR)	50	2
ME-406	Biology for Engineers	MD M	2			2	40	60	25		125	2
OE-407	Open Elective – II	OE	3			3	40	60			100	3
ME-408	Advance Welding Processes	VSEC			2	2			25		25	1
ME-409	Ability Enhancement Course	AEC			2	2			25		25	1
ME-410	Operation Research	HSSM	2			2						2
ME-411	Environmental Sciences	HSSM	2			2		25			25	2
			16		**10**	**26**	**160**	**265**	**150**	**75**	**650**	**21**

ISE: Internal Sessional Examination ESE: End Semester Examination ICA: Internal Continuous Assessment

CA: College Assessment UA: University Assessment

EXIT COURSE FOR U. G. DIPLOMA in Mechanical (DURATION 8 WEEKS)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ME-412	Internship / Apprenticeship	OJT							125			4
ME-413	Mini Project	Project							25			4
									150			8

Kavayitri Bahinabai Chaudhari

NORTH MAHARASHTRA

UNIVERSITY, JALGAON (M.S.)

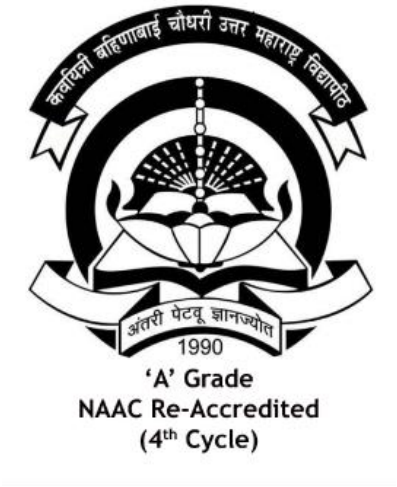
Second Year Bachelor of Engineering

in

Mechanical

(As per NEP 2020 Guidelines)

Faculty of Science and Technology



COURSE OUTLINE

For Affiliated Colleges

Semester – III

W.E.F. 2025 – 26

ENGINEERING MECHANICS (PCC)				
COURSE OUTLINE				
Course Title:	**ENGINEERING MECHANICS**	**Short Title: EM**	**Course Code:**	**ME-301**

Course description:

Engineering Mechanics is an introductory course that discusses the force, motion, and equilibrium concepts in mechanical systems. It addresses force analysis, centroid, moment of inertia, kinematics, kinetics, and friction. Problem-solving skills with analytical and graphical approaches are focused on. Students learn structural stability, machine components, and dynamic systems through practical applications.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite course(s):

Mathematics course with vector calculus

Course objectives:

The objective of this course is to:

1. Free body diagrams and solution to problems using graphical methods and law of triangle of forces.
2. Force and friction, direction and its application.
3. Centre of gravity, area moment of inertia and mass moment of inertia.
4. Motion in straight line and in curvilinear paths, its velocity and acceleration computation and methods of representing plane motion.
5. Rigid body motion kinematics and kinetics.

Course outcomes:

After successful completion of this course the student will be able to:

1. Understand and analyse the forces acting on bodies under static conditions in co-planar and non-coplanar force systems under equilibrium.
2. Evaluate the centroid and centre of gravity of given figures and analyse forces in statically determinate structures.
3. Calculate and compute the area moment of inertia and mass moment of inertia for regular laminae and objects.
4. Evaluate and apply principles of kinematics and kinetics to real-world problems using D'Alembert's principle and the work-energy principle for rigid body motion.
5. Analyze and interpret the effects of friction on bodies and machines under equilibrium conditions, incorporating the concept of the instantaneous centre of rotation.

COURSE CONTENT

ENGINEERING MECHANICS		**Semester:**	**III**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE) UA:**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE) CA:	**40 marks**

Unit–I : Introduction to Engg. Mechanics	**No. of Lectures: 09 Hours**	**Marks: 12**

Systems of Forces , Coplanar Concurrent Forces , Resultant, Free Body Diagrams, Lami's Theorem, Moment of Force and its Application – Couples. Equilibrium of Coplanar Systems, and non -Coplanar force System & Analysis of simple beams , Equations of Equilibrium for

Spatial System of forces.

Unit–II : Centroid, Centre of Gravity and Analysis of Determinant Structures	**No. of Lectures: 09 Hours**	**Marks: 12**

A) Centroids of simple figures (from basic principles) – Centroids of Composite sections and wires, Centre of Gravity and its implications.
B) Analysis of Determinant Structures – Analysis of simple truss, Method of Sections; Method of Joints; Zero force members.

Unit–III (Moment of Inertia and Mass Moment of Inertia	**No. of Lectures: 09 Hours**	**Marks: 12**

Definition, Moment of inertia of plane sect ions from first principles, Theorems of moment of inertia, Moments of Inertia of Standard Figures and Composite Figures. Mass Moment of Inertia of Circular Plate, Cylinder, Cone, Sphere.

Unit–IV: Kinematics & Kinetics of Rigid Bodies	**No. of Lectures: 09 Hours**	**Marks: 12**

A) Basic terms, general principles in dynamics; Types of mot ion, Velocity and Acceleration – Rectilinear motion – Motion with uniform and variable acceleration.
B) D'Alembert's Principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion.

Unit–V: Friction and ICR	**No. of Lectures: 09 Hours**	**Marks: 12**

A) Introduction, limiting friction and impending motion, coulomb's laws of dry friction, coefficient of friction, cone of friction, Static and Dynamic Friction, ladder friction, wedge friction, Motion of body friction and simple machines (Screw Jacks).
B) Instantaneous centre of rotation in plane motion and simple problems.

Text Books:

1. S. S. Bhavikatti (2009), Engineering Mechanics, New Age International Publishers.

Reference Books:

2. F P Beer and E R Johnson, "Mechanics for Engineers – Statics", McGraw-Hill Publication. Tayal A.K., Engineering Mechanics, Umesh Publications.
3. S P Timoshenko and D H Young, "Engineering Mechanics", McGraw- Hill Publications.
4. R C Hibbeler, "Engineering Mechanics statics and dynamics", Pearson Education.
5. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall.
6. Shanes and Rao (2006), Engineering Mechanics, Pearson Education.
7. Bansal R.K. (2010), A Text Book of Engineering Mechanics, Laxmi Publications.
8. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.
9. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications.

NPTEL Links:

1. Prof. K Ramesh, Engineering Mechanics, IIT Madras, https://archive.nptel.ac.in/courses/112/106/112106286/
2. Prof. Mahesh V Panchgune,IIT Madras, https://archive.nptel.ac.in/courses/112/106/112106180/

ENGINEERING MECHANICS LAB (PCC)					
LAB COURSE OUTLINE					
ENGINEERING MECHANICS LAB		**Semester:**	**III**	**Course Code:**	**ME-302**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**			**25 marks**
Semester Credits:	**1**	**End semester exam (ESE) (UA):**			**25 marks**
End Semester Exam (ESE) Pattern:		**Oral (OR)**			

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Study of vectors.
a. To calculate resultant of coplanar and non-coplanar (space) forces.
b. To calculate unknown force (reaction)
2. Verification of law of polygon of forces.
a. To verify law of polygon of forces.
b. To calculate analytically and experimentally resultant of concurrent force system.
c. To compare analytical values with measured ones.
3. Verification of Lami's theorem.
a. To Verify Lami's theorem.
b. To observe the ratios of P/sin α, Q/sin β, R/sin γ and compare the same.
4. Reactions of beam.
a. To verify conditions of equilibrium of a system of coplanar parallel forces using reaction of beam apparatus.
b. To understand active and reactive forces.
5. Simple friction on horizontal and inclined planes.
a. To describe frictional force, limiting friction, coefficient of friction, angle of repose.
b. To know the concept that the Force ∝ Reaction.
c. To find coefficient of friction for bodies in equilibrium on inclined planes.
6. Study of simple machines and verification of law of machines
a. To describe efficiency, load, effort, velocity ratio, frictional effort and verify law of machines.
b. To establish the law of machine from graph.
7. Centroid of simple and Composite section
a. To find centroid of Triangular Section
b. To find centroid of Semicircle
c. To find centroid of composite sections with and without holes.
8. Analysis of Truss (Method of Joints & Sections)
a. To analyze forces in truss members using graphical and analytical methods (One Problem on Each Method).
9. Moment of Inertia
a. To determine the moment of inertia of different any two sections experimentally.
10. Mass Moment of Inertia
a. To determine the mass moment of inertia of a rotating system (Eg. fly wheel)

Text Books:

1. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.

Reference Books:

1. F P Beer and E R Johnson, "Mechanics for Engineers – Statics", McGraw-Hill Publication. Tayal A.K., Engineering Mechanics, Umesh Publications.

2. S P Timoshenko and D H Young, “Engineering Mechanics”, McGraw- Hill Publications.
3. R C Hibbeler, “Engineering Mechanics statics and dynamics”, Pearson Education.
4. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall.
5. Shanes and Rao (2006), Engineering Mechanics, Pearson Education.
6. Bansal R.K. (2010), A Text Book of Engineering Mechanics, Laxmi Publications.
7. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.
8. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications.

NPTEL Links:

1. https://archive.nptel.ac.in/courses/115/104/115104094/ - IIT Kanpur

Guide lines for ICA:

Students must submit ICA in the form of journal. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. Evaluation will be based on oral and performance in the ESE.

APPLIED THERMODYNAMICS (PCC)				
COURSE OUT LINE				
Course Title:	**APPLIED THERMODYNAMICS**	**Short Title: AT**	**Course Code:**	**ME-303**

Course description:

This course provides an advanced understanding of thermodynamic principles applied to real-world engineering systems, including IC engines, gas and steam power cycles, refrigeration, and air-conditioning systems. Students will learn to analyze energy conversion, efficiency, and performance of thermal systems, applying concepts like entropy, exergy, and psychrometry. The course integrates computational tools and experimental techniques to enhance problem-solving skills and industry relevance.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite course(s):

Engineering Thermodynamics, Engineering Mathematics, Basic Physics

Course objectives:

The objective of this course is:

1. To extend fundamental thermodynamics principles to practical applications in power cycles and heat engines.
2. To analyze and evaluate the performance of internal combustion (IC) engines, compressors, turbines, and boilers.
3. To understand refrigeration and air-conditioning systems and their applications.
4. To introduce exergy analysis and combustion thermodynamics for performance enhancement.
5. To provide hands-on experience through experiments and computational simulations.

Course outcomes:

After successful completion of this course the student will be able to:

1. Study and evaluate the, exhaust gas analysis and thermodynamics laws.
2. Study, evaluate and design vapour power cycle, steam turbines and study of principles of boilers and its applications.
3. Analyze thermodynamic cycles (Otto, Diesel, Rankine, Brayton) and assess their efficiency.
4. Explain the working of reciprocating compressors and analyze its design
5. Apply and analyze the basic principles refrigeration & psychrometry to real-world thermal system.

COURSE CONTENT

APPLIED THERMODYNAMICS		**Semester:**	**III**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE):	**40 marks**

Unit–I: Fundamentals of Thermodynamics	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to solid, liquid and gaseous fuels–Stoichiometry, exhaust gas analysis, First law analysis of combustion reactions. Introduction to Steady flow energy equation, Second Law of Thermodynamics and its application to Heat Engine, Refrigerator &Heat Pump. Introduction to Entropy ,		
Unit–II: Vapor and Gas Power Cycles:	**No. of Lectures: 09 Hours**	**Marks: 12**
Properties of steam, Vapor power cycles Rankine cycle with superheat, reheat and regeneration. Introduction to Supercritical and ultra-super-critical, Introduction of steam turbine, Analysis of steam turbines single stage, velocity triangle (analytical/graphical) velocity and pressure compounding of steam turbines.		
Unit–III: Air Standard Cycles and Gas Turbines	**No. of Lectures: 09 Hours**	**Marks: 12**
Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle, effect of reheat, regeneration and intercooling.		
Unit–IV: Reciprocating Compressors and Multistage Compression:	**No. of Lectures: 09 Hours**	**Marks: 12**
Reciprocating compressors, staging of reciprocating compressors, work done, efficiency, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors.		
Unit–V: Refrigeration and Psychrometry:	**No. of Lectures: 09 Hours**	**Marks: 12**
Vapor compression refrigeration cycles, refrigerants and their properties. Properties of dry and wet air, use of psychometric chart, processes involving limited to heating/cooling and Humidification / dehumidification, dew point.		

Text Books:

1. Thermal Engineering – R.K. Rajput, Covers applied thermodynamics for mechanical and energy engineers.

Reference Books:

1. "Engineering Thermodynamics" – P.K. Nag, Covers thermodynamic cycles, energy systems, and problem-solving approaches.
2. "Applied Thermodynamics" – R.K. Rajput, Detailed coverage of thermal machines, engines, and refrigeration cycles.
3. "Thermodynamics: An Engineering Approach" – Yunus A. Çengel, Michael A. Boles, Practical applications with modern examples and real-world energy systems.
4. "Fundamentals of Engineering Thermodynamics" – Moran & Shapiro, Conceptual and mathematical understanding of applied thermodynamics.
5. "Thermal Engineering" – Ballaney P.L. , Focuses on power plant engineering, IC engines, and refrigeration systems.
6. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of
7. Thermodynamics, John Wiley and Sons.

NPTEL Links:

1. Applied Thermodynamics for Engineers – Prof. Ravi Kumar (IIT Roorkee) https://nptel.ac.in/courses/112107209
2. Laws of Thermodynamics – Prof. S.K. Som (IIT Kharagpur) https://nptel.ac.in/courses/112105123
3. Steam and Gas Power Systems – Prof. S. K. Som (IIT Kharagpur) https://nptel.ac.in/courses/112105221

4. Internal Combustion Engines – Prof. B. P. Pundir (IIT Roorkee)
   https://nptel.ac.in/courses/112103262
5. Refrigeration and Air Conditioning – Prof. Ravi Kumar (IIT Roorkee)
   https://nptel.ac.in/courses/112105128

APPLIED THERMODYNAMICS LAB (PCC)					
LAB COURSE CONTENT					
APPLIED THERMODYNAMICS LAB		**Semester:**	**III**	**Course Code:**	**ME-304**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**			**25 marks**
Semester Credits:	**1**	**End semester exam (ESE) (UA):**			**25 marks**
End Semester Exam (ESE) Pattern:		**Practical (PR)**			

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. **Analysis of Exhaust Gas Composition in a Diesel Engine Using an Exhaust Gas Analyzer** – To measure and analyze CO, CO_2, O_2, and NOx emissions from a diesel engine under different load conditions.
2. **Performance Evaluation of a Diesel Engine by Measuring Brake Power, Indicated Power, and Thermal Efficiency** – To determine the brake power (BP), indicated power (IP), brake thermal efficiency (BTE), and specific fuel consumption (SFC) of a diesel engine at varying loads.
3. **Preparation of a Heat Balance Sheet for a Petrol Engine to Analyze Energy Distribution** – To perform an energy balance analysis by measuring input fuel energy and its distribution as useful work, exhaust losses, and cooling losses.
4. **Determination of Volumetric Efficiency, Air-Fuel Ratio, and Brake-Specific Fuel Consumption in a Petrol Engine** – To study the effect of air-fuel ratio on engine performance parameters and calculate volumetric efficiency.
5. **Study of Air Standard Otto Cycles with Efficiency** – To analyze the thermodynamic processes of Otto cycles, calculate their efficiencies, with real engine performance.
6. **Study of Air Standard Diesel cycle with Efficiency** – To analyze the thermodynamic processes of Diesel cycles, calculate their efficiencies, with real engine performance.
7. **Performance Testing of a Single-Stage Reciprocating Compressor to Determine Volumetric and Isothermal Efficiency** – To evaluate the efficiency, power consumption, and pressure ratio of a single-stage reciprocating compressor.
8. **Performance Analysis of a Vapor Absorption Refrigeration System by Measuring COP and Cooling Effect** – To study the working principle of a vapor absorption refrigeration system and determine its coefficient of performance (COP).
9. **Analysis of Psychrometric Processes in an Air Conditioning Test Rig Using a Psychrometric Chart** – To Determine air conditioning processes such as cooling, heating, humidification, and dehumidification by plotting data on a psychrometric chart.

Text Books:

1. Internal Combustion Engines – V. Ganesan, Focus on IC engine performance, fuel properties, and emissions.
2. Thermal Engineering – R.K. Rajput, Covers applied thermodynamics for mechanical and energy engineers

NPTEL Links: 1. Dr. Niranjan Sahu, IIT Guwahati , https://archive.nptel.ac.in/courses/112/103/112103307/- 2. Dr. V. Raghwan, IIT Madras , https://onlinecourses.nptel.ac.in/noc25_me06/preview 3. Dr.Niranjan Sahu, IIT Guwahati , https://onlinecourses.nptel.ac.in/noc24_me103/preview 4. Dr. Babu Vishwanathan, IIT Madras , https://nptel.ac.in/courses/112106314
Guide lines for ICA:
Students must submit ICA in the form of journal. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.
Guide lines for ESE:
ESE will be based on practical assignment submitted by the student in the form of journal. Evaluation will be based on oral, paper work and performance in the ESE.

MACHINE DRAWING AND COMPUTER GRAPHICS LAB. (PCC)					
LAB COURSE OUTLINE					
Course Title:	**MACHINE DRAWING AND COMPUTER GRAPHICS LAB.**	**Short Title:**	**MDCG**	**Course Code:**	**ME - 305**

Course description:

The Machine Drawing and Computer Graphics Lab is designed to develop students' ability to interpret, create, and analyze engineering drawings using both manual drafting techniques and computer-aided design (CAD) software. The course integrates mechanical component visualization, machine part modeling, and engineering graphics principles, ensuring students gain practical exposure to industry-relevant design tools.

Students will learn orthographic projections, isometric views, assembly and part drawings, and 3D modeling techniques using CAD software like AutoCAD, SolidWorks, CATIA, or Fusion 360. Additionally, they will explore computer graphics fundamentals, including transformations, curves, and solid modeling. This hands-on lab bridges the gap between theoretical learning and real-world engineering applications.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	01	15	15	02
Practical	02	15	30	

Prerequisite course(s):

Basics of Engineering Graphics, Fundamentals of Mechanical Design, Knowledge of Coordinate Geometry & Projection Techniques, Basic computer literacy and familiarity with CAD software.

Course objectives:

The objective of this course is to:

1. Developing the ability to understand and interpret mechanical drawings using standard conventions.
2. Providing hands-on experience in CAD software for designing machine components.
3. Familiarizing students with 3D modeling, orthographic projections, and assembly drawings.
4. Enhancing problem-solving skills through computer-aided drafting techniques.
5. Bridging the gap between theoretical concepts and practical applications in engineering design.

Course outcomes:

After successful completion of this course the student will be able to:

1. Interpret engineering drawings using BIS standards and drawing conventions.
2. Create machine component drawings using both manual and CAD tools.
3. Develop orthographic, isometric, sectional, and assembly drawings.
4. Implement computer graphics concepts in engineering applications.
5. Use CAD software for 3D modeling and rendering of machine parts.

COURSE CONTENT

MACHINE DRAWING AND COMPUTER GRAPHICS LAB.		**Semester:**	**III**
Teaching Scheme:		**Examination scheme:**	
Lectures:	**1 hours/week**	**Internal Continuous Assessment (ICA) CA:**	**25 marks**
Practical:	**2 hours/week**	**End semester exam (ESE) (UA):**	**25 marks**
End Semester Exam (ESE) Pattern:		**Practical (PR)**	

Introduction and Application of machine drawing and computer graphics

a) Engineering drawing standards (BIS, ISO, ASME), Types of lines, dimensions, symbols, and tolerances, Limits, fits, and tolerances (Shaft and Hole Basis System), Surface roughness and machining symbols, Freehand sketching of machine components.
b) Orthographic Projections: First-angle and third-angle projections, Isometric views and projections, Sectional views and conventions (full, half, offset, and revolved sections), Intersection of solids and development of surfaces.
c) Introduction to machine components: Bolts, Nuts, Screws, Keys, Rivets, Joints, Assembly and disassembly drawings (Bearing, Couplings, Engine parts, Joints), Exploded views and BOM (Bill of Materials).
d) Introduction to AutoCAD, 2D drafting: Lines, circles, layers, dimensions, text annotations, 3D modeling: Extrusion, Revolve, Loft, sweep operations, generating orthographic, sectional, and isometric views from 3D models.
e) Basics of transformation techniques (Translation, Scaling, Rotation), Wireframe, surface, and solid modeling techniques.

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Sketching of machine components with freehand / CAD tools.
2. Development of isometric drawings in CAD.
3. Creation of sectional views of mechanical components.
4. 3D modeling of machine components using CAD software.
5. Assembly modeling and rendering of mechanical parts.
6. Wire frame modeling of machine component.
7. Application of limits, fits, and tolerances in machine components.
8. Auto lips programming for rectangle and circle.

Text Books:

1. Machine Drawing – N.D. Bhatt, A foundational book covering mechanical drawing techniques and conventions.

Reference Books:

1. Machine Drawing – K. L. Narayana, P. Kannaiah, K. Venkata Reddy, Covers engineering drawing standards, machine part detailing, and assembly drawing techniques.
2. Engineering Drawing – N.D. Bhatt & V.M. Panchal, Comprehensive reference for BIS standards, projection methods, and technical illustrations.
3. Engineering Drawing and Graphics Using AutoCAD – T. Jeyapoovan, Focuses on CAD applications in engineering drawing with practical examples.
4. Computer Graphics: Principles and Practice – James D. Foley, Andries van Dam, Explores the mathematical and programming aspects of computer graphics.
5. AutoCAD 2023 for Engineers – Shawna Lockhart, A step-by-step guide to mastering AutoCAD for engineering applications.
6. SolidWorks 2023 Bible – Matt Lombard, covers 3D modeling, rendering, and design automation using SolidWorks.
7. Engineering Drawing – P.S. Gill, Covers technical drawing with emphasis on machine elements and drafting practices.
8. Computer Graphics with OpenGL – Donald Hearn & M. Pauline Baker, Provides fundamental concepts of computer graphics and OpenGL programming.

9. Machine Drawing with AutoCAD – Ajeet Singh, Integrates machine drawing fundamentals with CAD-based drafting techniques.
10. Introduction to Computer Graphics – Foley, Van Dam, A detailed exploration of computational techniques used in modern graphics.

NPTEL Links:

1. **Engineering Drawing and Computer Graphics** – Prof. Pradeep Yammiyavar (IIT Guwahati)
   https://nptel.ac.in/courses/112104033
2. **Computer Graphics** – Prof. Prem Kalra (IIT Delhi)
   https://nptel.ac.in/courses/106102065
3. **Engineering Drawing and Design** – Prof. Rajaram Lakkaraju (IIT Kharagpur)
   https://nptel.ac.in/courses/112105218
4. **Machine Drawing** – Prof. Surya Prakash (IIT Roorkee)
   https://nptel.ac.in/courses/112107298
5. **Computer-Aided Design (CAD)** – Prof. S. Shankar (IIT Bombay)
   https://nptel.ac.in/courses/112101003

Guide lines for ICA:

Students must submit ICA in the form of journal. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. Evaluation will be based on oral, paper work and performance in the ESE.

ERGONOMICS AND HUMAN CENTERED DESIGN (MDM)				
COURSE OUT LINE				
Course Title:	**ERGONOMICS AND HUMAN CENTERED DESIGN**	**Short Title: EHCD**	**Course Code:**	**ME-306**

Course description:

This course explores the principles of ergonomics and human factors engineering, emphasizing the design of user-friendly systems. Topics include anthropometry, biomechanics, displays and controls, environmental conditions, and risk assessment methods for occupational tasks. Students will learn to apply ergonomic principles to optimize safety, efficiency, and comfort in workplace and product design. Emerging trends like AI, VR, and wearable technology in ergonomics are also discussed.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	02	15	30	02

Prerequisite course(s):

Human Anatomy and Physiology, Engineering Mechanics, Basic Psychology, Fundamentals of design thinking, usability.

Course objectives:

The objective of this course is to:

1. Introducing the fundamental principles of ergonomics and human factors in design.
2. Developing an understanding of human capabilities and limitations in the design of systems, products, and workplaces.
3. Enhancing the ability to create user-centered designs that improve efficiency, safety, and usability.
4. Applying ergonomic principles to the design of work environments and consumer products.
5. Familiarizing students with modern tools and methods used in ergonomic assessment and human-centered design.

Course outcomes:

After successful completion of this course the student will be able to:

1. Explain the fundamental principles of ergonomics and human-centered design.
2. Analyze human capabilities and limitations in product and workplace design.
3. Apply ergonomic principles to improve usability, safety, and efficiency in design.
4. Assess ergonomic risks in work environments and propose solutions.
5. Integrate advanced technologies and emerging trends in ergonomic design.

COURSE CONTENT

Ergonomics and Human Centered Design		**Semester:**	**III**
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE):	**40 marks**
		Internal Continuous Assessment (ICA) CA:	**25 marks**

Unit–I: Introduction	**No. of Lectures: 06 Hours**	**Marks: 12**

Introduction to Human factors Engineering/Ergonomics: Scope and objectives, Definition & historical evolution, Basic principles, System approach to ergonomics, Significance of ergonomics, Components of man-machine systems.		
Unit–II: Displays and controls and Environmental conditions Illumination	**No. of Lectures: 06 Hours**	**Marks: 12**
Displays and controls: Classification of displays, quantitative and qualitative displays, alphanumeric displays, multiple displays, colour, resolution, auditory displays, display layouts, Controls: types, design criteria of controls, Relationship between displays and controls. **Environmental conditions Illumination**: nature of light, visibility, effects of lighting on performance, measurement of light. Noise: noise and effects of noise on performance, noise exposure limits, measuring noise levels, control of noise Hot and cold environments: occupational heat stress exposure, assessment at workplace, permissible limits.		
Unit–III: Anthropometry Static and dynamic anthropometry	**No. of Lectures: 06 Hours**	**Marks: 12**
Ergonomics and design, user-centred approach, statistical description of human variability, Anthropometric data: measurements, percentiles, use of anthropometric data in design, adjust-ability requirements, visibility and normal line of sight.		
Unit–IV: Biomechanics of work	**No. of Lectures: 06 Hours**	**Marks: 12**
Musculoskeletal system & work-related musculoskeletal disorders: causes and prevention, Lower back pain, awkward postures, and risk associated with it. RULA/REBA/Strain index/OWAS methods for risk assessment in occupational tasks. Manual material Handling: NIOSH lifting equation.		
Unit–V: Advanced Topics and Emerging Trends	**No. of Lectures: 06 Hours**	**Marks: 12**
Virtual reality (VR) and augmented reality (AR) in ergonomics, Artificial intelligence (AI) and human-centered design, Wearable technology and its ergonomic impact.		
Text Books:		
1. Suresh Dalela- Work Study and Ergonomics by std. publishers distributers.		
Reference Books:		
1. GavrielSalvendy-Editor, Handbook of Human Factors and Ergonomics, Wiley 2. Stephen Pheasant – Body Space -Anthropometry, Ergonomics and the Design of Work, Third Edition 3rd Edition, CRC Press 3. Stephen J. Guastello- Human Factors Engineering and Ergonomics: A Systems Approach, Second Edition 2nd Edition ,Online link: https://nptel.ac.in/courses/107103004/31 4. Kroemer, K. H. E., Kroemer, H. B., & Kroemer-Elbert, K. E. – Ergonomics: How to Design for Ease and Efficiency (Prentice Hall) 5. Sanders, M. S., & McCormick, E. J. – Human Factors in Engineering and Design (McGraw-Hill). 6. M.I. Khan- Industrial Ergonomics- PHI 7. Bridger, R. S. – Introduction to Human Factors and Ergonomics (CRC Press)		
NPTEL Links: 1. Ergonomics for beginners: Industrial design perspective by Prof. Debkumar Chakrabarti Department of Engineering Design IIT Guwaha https://archive.nptel.ac.in/courses/107/103/107103004/		

2. Human Factors Engineering By Prof. Pradip Kumar Ray, Prof. V. K. Tewari | IIT Kharagpur, IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc22_mg108/preview
3. Applied Ergonomics By Prof. Shantanu Bhattacharya, Prof. Ankur Gupta | IIT Kanpur
   https://onlinecourses.nptel.ac.in/noc20_me11/preview
4. Introduction to Human Factors and Ergonomics By Vivek Kant, Ph.D. | IIT Bombay
   https://onlinecourses.swayam2.ac.in/aic20_ed03/preview

Guidelines for ICA:

Students must submit ICA in the form of journal. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

INDUSTRIAL ECONOMICS (HSSM)				
COURSE OUT LINE				
Course Title:	**Industrial Economics**	**Short Title: IE**	**Course Code:**	**ME-308**

Course description:

This course covers the basics of microeconomics, focusing on how households, businesses, and markets work together to set prices for goods and services based on demand and supply. It also introduces key macroeconomic topics like national income, economic growth, inflation, international trade, and government policies that affect the economy. Lastly, the course looks at how businesses use demand forecasting and price-setting techniques to make informed decisions in a changing market.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	02	15	30	02

Prerequisite course(s):

Principles of Managements

Course objectives:

The student will understand :

1. The concept of economy & economic laws
2. The objectives & concepts of micro economics & macroeconomics.
3. The basic and concept of demand, supply & price, their inter-relation & their elasticity.
4. The concept of demand forecasting, national income, economic growth & inflation
5. The concept of international trade policy, rate of exchange, trade, deficit, monetary & fiscal policy.

Course outcomes:

After successful completion of this course the student will be able to:

1. Learn to recognize and compare different types of markets (like perfect competition, monopoly, and oligopoly) and understand how they affect prices, production, and efficiency.
2. Analyze how companies decide on pricing, production, and entering markets, while considering costs, competition, and market power.
3. Understand how the government regulates industries, looking at the effects of laws, taxes, and subsidies on market competition and outcomes.
4. Learn to apply economic models to real-world problems like setting prices, forecasting demand, and analyzing how markets perform.
5. Understand how global trade, exchange rates, and international competition impact industries and influence decisions in local markets.

COURSE CONTENT

Industrial Economics		**Semester:**	**III**
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**		
Unit–I: Introduction to economics	**No. of Lectures: 06 Hours**		

Definition, importance, issues, Concept & objective of micro & macroeconomics, Two & four sector model , capitalist, socialist & mixed economy. Economic laws – their nature, limitation, importance & application.
Law of diminishing return / marginal utility, circular flow of economy.

Unit–II: Demand	**No. of Lectures: 06 Hours**

Concept, individual & market demand, factors effecting demand, Law of demand,

demand curve, demand forecasting. Supply – Concept, individual & market supply, factors effecting supply, law of supply.		
Unit–III: Production	**No. of Lectures: 06 Hours**	
Concept of production, Short run, long run, very long run; issues, short run production curve, marginal &average production, Laws of production; cost concepts, concept of market, Price determination in different types of market.		
Unit–IV: Macro-economic	**No. of Lectures: 06 Hours**	
Concept, definition, importance & scope, National Income –Concept, definition & methods of measurement, Economic Growth – definition, factors affecting growth Inflation – Concept, definition, Consumer Price Index (CPI), GDP deflator, demand.		
Unit–V: International Trade	**No. of Lectures: 06 Hours**	
Law of Reciprocal demand, basic principles of free trade, trade protection policy, Concepts of rate of foreign exchange, Balance of Payment, Monetary & Fiscal Policy – Concept, objectives, instruments & limitations.		
Text Books:		
1. Principles of Economics by D.N. Dwivedi – Vikas Publishing House		
Reference Books:		
1. Business Economics by Gillespe – Oxford University Press 2. Microeconomics by D.N. Dwivedi - Pearson 3. Principles of Economics by Frank and Bernanke – Tata McGraw hill publication.		
NPTEL Links: 1. Introduction to Microeconomics - https://archive.nptel.ac.in/courses/109/104/109104125/ 2. Principles Of Economics- https://onlinecourses.nptel.ac.in/noc23_ec06/preview		
Guidelines for ICA:		
Concern faculty should frame the five assignments based on each unit. The Students must submit assignment in the form of journal. Each assignment should be well documented.		

UNIVERSAL HUMAN VALUES (HSSM)				
COURSE OUTLINE				
Course Title:	**UNIVERSAL HUMAN VALUES**	**Short Title: UHV**	**Course Code:**	**ME - 309**

Course description:

Today, education has become more and more skill biased, and hence, the basic aspiration of a human being, that is to live with happiness and prosperity, gets defeated, in spite of abundant technological progress. This course is aimed at giving inputs that will help to ensure the right understanding and right feelings in the students in their life and profession, enabling them to lead an ethical life. In this course, the students learn the process of self-exploration, the difference between the Self and the Body, the naturally acceptable feelings in relationships in a family, workplace and society, the comprehensive human goal in the society, the mutual fulfilment in the nature and the co-existence in existence. As a natural outcome of such inputs, they are able to evaluate an ethical life and profession ahead.

Thus, this course is intended to provide a much-needed orientation input in value education to the young enquiring minds.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	01	15	15	02
Practical	02	15	30	

Prerequisite course(s):

Course objectives:

The objective of this course is to:

1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

Course outcomes:

After successful completion of this course the student will be able to:

1. Become more aware of themselves, and their surroundings (family, society, nature);
2. Become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. Have better critical ability.
4. Become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
5. Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning will be made in this direction.

COURSE CONTENT

UNIVERSAL HUMAN VALUES		**Semester:**	**III**
Teaching Scheme:		**Examination scheme:**	
Lectures:	**1 hours/week**	**Internal Continuous Assessment (ICA) CA:**	**25 marks**

Practical:	**2 hours/week**		
Unit–I:	**No. of Lectures: 03 Hours**		
Introduction to Value Education			
Understanding Value Education Self-exploration as the Process for Value Education Basic Human Aspirations and their Fulfilment Right Understanding, Relationship and Physical Facility Happiness and Prosperity – Current Scenario Method to Fulfil the Basic Human Aspirations			
Unit–II:	**No. of Lectures: 03 Hours**		
Harmony in the Human Being			
Understanding the Human Being as Co-existence of the Self and the Body Distinguishing between the Needs of the Self and the Body The Body as an Instrument of the Self Understanding Harmony in the Self Harmony of the Self with the Body Programme to Ensure Self-regulation and Health			
Unit–III:	**No. of Lectures: 03 Hours**		
Harmony in the Family and Society			
Understanding Harmony in the Family – The Basic Unit of Human Interaction 'Trust' – The Foundational Value in Relationship Respect – As the Right Evaluation Other Values in Human-to-Human Relationship Understanding Harmony in the Society Vision for the Universal Human Order			
Unit–IV:	**No. of Lectures: 03 Hours**		
Harmony in the Nature (Existence)			
Understanding Harmony in Nature Interconnectedness, Self-regulation and Mutual Fulfilment among the Four Orders of Nature Realizing Existence as Co-existence at All Levels The Holistic Perception of Harmony in Existence			
Unit–V:	**No. of Lectures: 03 Hours**		
Implications of the Holistic Understanding – A Look at Professional Ethics			
Basis for Universal Human Values Definitiveness of (Ethical) Human Conduct Professional Ethics in the Light of Right Understanding A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order Holistic Technologies, Production Systems and Management Models-Typical Case Studies Strategies for Transition towards Value-based Life and Profession			
Text Books:			
1. R R Gaur, R Asthana, G P Bagaria, A Foundation Course in Human Values and Professional Ethics, 3rd Revised Edition, UHV Publications, 2023. 2. R R Gaur, R Asthana, G P Bagaria, A Foundation Course in Human Values and Professional Ethics – Teachers Manual, 3rd Revised Edition, UHV Publications, 2023 3. Premvir Kapoor, Professional Ethics and Human Values, Khanna Book Publishing, New Delhi, 2022. 4. UHV-II: Universal Human Values: Understanding Harmony and Ethical Human Conduct https://fdp-si.aicte-india.org/UHVII.php			

https://uhv.org.in/uhve

Reference Books:

1. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)
14. Reports, Papers and Impact Studies on UHV Implementation,
    a. https://drive.google.com/drive/folders/1N_1Z1tIm8-iDfy9nQRcHbs_Bjtrk_d24
    b. https://fdp-si.aicte-india.org/Activity_and_Impact.php

Video Links:

1. About UHV Refresher for UHV-II – English, https://www.youtube.com/watch?v=NhFBzn5qKIM&list=PLWDeKF97v9SO8vvjC1KyqteziTbTjN1So
2. https://www.youtube.com/playlist?list=PLWDeKF97v9SP_Kt6jqzA3pZ3yA7g_OAQz

Guidelines for ICA:

Students must submit ICA in the form of journal with **FIVE** assignments / activities based on the practice sessions outlined in the Teacher's Manual (Text Book No. 2, https://uhv.org.in/frontend/download/Teachers%20Manual%20Foundation%20Course%20in%20Human%20Values%20and%20Professional%20Ethics%20(eBook).pdf), encompassing a process of self-investigation and self-exploration, suitably framed by concerned teacher / faculty mentor.

The assessment, in this course, is to provide a fair state of development of the student, so participation in classroom discussions, self-assessment, peer assessment etc. shall be used in evaluation. The evaluation criteria for assessment are as follows.

Assessment by Teacher / faculty mentor: 05 marks
Self-assessment: 05 marks
Assessment by peers: 05 marks
Socially relevant project/Group Activities/Assignments: 10 marks

Faculty in charge will assess the assignments continuously and grade or mark each assignment / activity on completion date declared for each assignment / activity.

COMMUNITY ENGAGEMENT PROJECT / FIELD PROJECT				
COURSE OUTLINE				
Course Title:	**COMMUNITY ENGAGEMENT PROJECT / FIELD PROJECT**	**Short Title: CEP**	**Course Code:**	**ME - 310**

Course description:
The subject Community Engagement Project / Field Project involves activities that will expose students to the socio-economic issues in society so that the theoretical learnings can be supplemented by actual life experiences to generate solutions to real-life problems.

	Hours/week	No. of weeks	Total hours	Semester credits
Practical	04	15	60	02

Prerequisite course(s):

Course objectives:

The objective of this course is to:
1. To develop an appreciation of rural culture, life-style and wisdom amongst students
2. To learn about the status of various agricultural and development programmes
3. To understand causes for distress and poverty faced by vulnerable households and explore solutions for the same
4. To apply classroom knowledge of courses to field realities and thereby improve quality of learning

Course outcomes:

After successful completion of this course the student will be able to:
1. Gain an understanding of rural life, Indian culture & ethos and social realities
2. Develop a sense of empathy and bonds of mutuality with local community
3. Appreciate significant contributions of local communities to Indian society and economy
4. Learn to value the local knowledge and wisdom of the community
5. Identify opportunities for contributing to community's socio-economic improvements

COURSE CONTENT

COMMUNITY ENGAGEMENT PROJECT / FIELD PROJECT		**Semester:**	**III**
Teaching Scheme:		**Examination scheme**	
Practical:	**4 hours/week**	**Internal Continuous Assessment (ICA) CA:**	**50 marks**

The course requires students to participate in any **TWO** field-based learning/projects as listed below under the supervision of faculty. This will help educate local communities about new technological innovations as well as aware students about ways to harness local technology and knowledge. In this approach, students apply their knowledge and skills in a chosen community to improve the lives of people in that community. The activities may also be conducted other than working hours.

Recommended field-based activities (Tentative):

1. Interaction with Self Help Groups (SHGs) women members, and study of their functions and challenges; planning for their skill building and livelihood activities
2. Visit Mahatma Gandhi National Rural Employment Guarantee Act 2005 (MGNREGS) project sites, interact with beneficiaries and interview functionaries at the work site
3. Field visit to Swachh Bharat project sites, conduct analysis and initiate problem solving measures

4. Conduct Mission Antyodaya surveys to support under Gram Panchayat Development Plan (GPDP)
5. Interactive community exercise with local leaders, panchayat functionaries, grass-root officials and local institutions regarding village development plan preparation and resource mobilization
6. Visit Rural Schools / mid-day meal centres, study academic and infrastructural resources and gaps
7. Participate in Gram Sabha meetings, and study community participation
8. Associate with Social audit exercises at the Gram Panchayat level, and interact with programme beneficiaries
9. Visit to local Nagarpalika office and review schemes for urban informal workers and migrants
10. Attend Parent Teacher Association meetings, and interview school drop outs
11. Visit local Anganwadi Centre and observe the services being provided
12. Visit local NGOs, civil society organisations and interact with their staff and beneficiaries,
13. Organize awareness programmes, health camps, Disability camps and cleanliness camps
14. Aware / conduct soil health test, drinking water analysis, energy use and fuel efficiency surveys and guiding solar powered village
15. Raise understanding of people's impacts of climate change, building up community's disaster preparedness
16. Organise orientation programmes for farmers regarding organic cultivation, rational use of irrigation and fertilizers and promotion of traditional species of crops and plants
17. Formation of committees for common property resource management, village pond maintenance and fishing
18. Identifying the small business ideas for rural areas to make the people self-reliant.
19. Undertaking research projects in partnership with local community through community-based research methods
20. Social innovation projects with a social impact
21. Financial Literacy Awareness Programme
22. Digital Literacy Awareness Programme
23. Education Loan Awareness Programme
24. Entrepreneurship Awareness Programme
25. Awareness Programmes on Government Schemes
26. Products Market Awareness
27. Services Market Awareness
28. Consumer Awareness Programme
29. Accounting Awareness Programme for Farmers
30. Accounting Awareness Programme for Street Vendors etc.
31. Nutrition survey for mothers and children, and educate them about hygiene and nutrition.
32. Study / Survey / Field based Project on contributions / implications / influence / impact of Indian Knowledge System on Indian Society / Community / life / values / practices / principles / technology / development etc.

Students must conduct comprehensive studies on various challenges that they face in their chosen field. Every work relevant to the subject matter should be compiled and documented.

Students should keep separate fieldwork diary or maintain journal in order to record their fieldwork experiences i.e. reading, e- contents, tasks, planning and work hours have to be recorded in the diary. Detailed work records report on students' fieldwork experiences and activities to be submitted and should be presented.

Every student shall submit a report in the form of journal that may include, but not limited to, the following.

1. A map (physical, visual or digital) of the village you visited and write an essay about inter-family relations in that village / community.
2. Videos and/or Geo-tagged photographs of events / activities conducted
3. Describe your analysis of rural household economy, its challenges and possible pathways to address them
4. How effectively are institutions functioning? What would you suggest to improve their effectiveness? Present a case study (written or audio-visual).
5. Describe the benefits received and challenges faced in the delivery of one of these programmes in the local community; give suggestions about improving implementation of the programme for the community.

Guide lines for ICA:

Students must submit ICA in the form of journal. Faculty in charge will monitor and assess continuously with grade or mark each project on completion date declared for each of them.
Assessments of students shall include review of their involvement and contributions to community engagement. It shall also include presentation of project findings as documented in the journal.

Kavayitri Bahinabai Chaudhari

NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Second Year Bachelor of Engineering

in

(Common for all)

(As per NEP 2020 Guidelines)

Faculty of Science and Technology



COURSE OUTLINE FOR OPEN ELECTIVE - I

For Affiliated Colleges

Semester – III

W.E.F. 2025 – 26

Open Elective – I

A Student can opt for any one subject out of available institute wide subjects defined in the following list as Open Elective provided, he/she has not taken that particular subject in his/her Programme core, Programme elective, Multidisciplinary Minor, other Open elective and Vocational and Skill Enhancement courses etc. throughout his / her four years of UG Engineering Programme. The student must opt a subject that is compulsorily from faculty other than that of the Major discipline.

Course Code	Name of the Subject / Course	Faculty Offered by	Department Offered by
Open Elective - I (w.e.f. 2025 - 26 at Semester - III, Second Year Engineering)			
OE – 307 A	Quantitative Reasoning and Problem Solving	Sci. & Tech.	Mathematics
OE – 307 B	Management Science	Comm. & Mgmt.	Management
OE – 307 C	Business Ethics & Professional Values	Comm. & Mgmt.	Management
OE – 307 D	Plant Nursery and Management	Sci. & Tech.	Botany
OE – 307 E	General Clinical Pathology	Sci. & Tech.	Biochemistry
OE – 307 F	Herbal Home Remedies	Sci. & Tech.	Botany
OE – 307 G	Psychology of Well-being	Humanities	Psychology
OE – 307 H	Fundamentals of Banking	Humanities	Economics

QUANTITATIVE REASONING AND PROBLEM SOLVING (Open Elective – I)					
COURSE OUTLINE					
Course Title:	**QUANTITATIVE REASONING & PROBLEM SOLVING**	**Short Title:**	**QRPS**	**Course Code:**	**OE - 307 A**
Course description:					
The Quantitative Reasoning course is designed to develop a student's ability to understand, analyze, and apply mathematical concepts and reasoning techniques to solve real-world problems. The course emphasizes critical thinking and logical analysis, focusing on the interpretation and manipulation of quantitative data.					

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	03	15	45	03

Prerequisite course(s):

Course objectives:

1. Use appropriate mathematical and statistical language in oral, written, and graphical forms.
2. Think critically about mathematical models for relationships between different quantities and use those models effectively and accurately to solve problems and reach sound conclusions about them.
3. Interpret and analyze various representations of data.

Course outcomes:

After successful completion of this course the student will be able to:

1. Perform arithmetic calculations on number system, HCF and LCM and age
2. Solve application problems involving Time, Distance, Speed.
3. Calculate the time required to do the work and fill the cistern.
4. Calculate problems based on percentage, average and simple interest.
5. Analyze and interpret data using statistical techniques

COURSE CONTENT

QUANTITATIVE REASONING AND PROBLEM SOLVING		Semester:	III
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE) UA:**	**60 marks**
		Duration of EE:	**03 hours**
		Internal Sessional Exam (ISE) CA:	**40 marks**

Unit–I:	No. of Lectures: 09 Hours	Marks: 12

Number System: Fundamental Concepts, Tests of Divisibility, Factorial of number, Modulus of a number, Greatest integral Value, Multiplication by Short cut method, Division algorithm.
Highest Common Factor and Least Common Factor: Factors and Multiples, Factorization method, Division Method, HCF and LCM of fractions, HCF and LCM of decimal Fractions. **Problems on Ages** : Ratio Based Age Problems, Equation Solving Type Age Problems, Finding Ratio Between Ages.

Unit–II:	No. of Lectures: 09 Hours	Marks: 12

Time and Distance: Unit Conversion Time and Distance Problems, Average Speed When Travelling

To A Place And Returning, Problems Based On Changing Time And Changing Speed.

Problem on Trains: Important facts and Formulae, Time taken by train to pass pole/standing man / Signal post, relative Speed of trains/ bodies moving in same direction, cross time of trains/bodies moving in opposite direction, Cross time trains/ bodies moving in same direction with different speed, reaching time of two trains/ bodies start at the same time from point A and B towards each other destination.

Problem on Boat: Speed of downstream, Speed of upstream, Speed in still water, Rate of stream, Speed of the man in still water.

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Time and Work: Calculate Time to Complete Work by 2 or More People, Equations Based Time and Work Problems, Efficiency Based Time and Work Problems, Calculate Time When Efficiency is Given in Percentage, Calculate Time When Workers Leave in Between, Share of Salary Based on Work**.**

Pipes and Cisterns: Important Facts and Formulae, Calculate Time Taken to Fill a Tank By 2 or More Pipes, Calculate Time Taken to Fill a Tank with Leakage, Equations Based Pipes and Cistern Problems, Calculate Time Taken When Pipes Are Opened for Different Periods, Calculate Number of Pipes.

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Percentage: Concepts of percentage, Results on population, Result on depreciation, Salary Comparison percentage problems, Appreciation and depreciation based Percentage problems, Price and consumption based percentage problems

Average: Number Series Summation based Averages, Consecutive Even/Odd Type Problems, Distance and Speed based Averages.

Simple Interest: Important Fact and Formulae, Simple Interest Formula based Direct Problems, **Compound Interest** Formula based Direct Problems

Ratio and Proportion : Combined Ratio Based on Individual Ratios, Distributing any Quantity Based on Ratios, Coins Based Ratio Problems, Mixtures & Replacement Based Ratio Problems

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**

Clocks: Finding angle between Minute and Hour Hands, Finding Time if angle is given, Correct Time on incorrect (Fast or Slow) Clocks.

Calendar: Odd day, Leap year, Ordinary Year, Counting of Odd days, Day of the week related to odd days.

Data Interpretation: Tabulation, Bar Graph, Pie Chart, Line graph, Problem on data Interpretation: Sum and Difference based, Average based questions, percentage-based questions.

Text Books:

1. Dr. R.S. Aggarwal “Quantitative Aptitude” S. Chand Publication, Revised Edition 2017

MANAGEMENT SCIENCE (Open Elective – I)					
COURSE OUTLINE					
Course Title:	**MANAGEMENT SCIENCE**	**Short Title:**	MS	**Course Code:**	**OE – 307 B**

Course description:

This course provides students with a fundamental understanding of Management Science, covering key concepts such as decision-making, organizational structure, operations and process management, project management, and modern management practices. The course focuses on essential management functions, managerial skills, quality control techniques, inventory management, and project planning tools like PERT and CPM. It aims to develop students' analytical and problem-solving skills, preparing them for effective decision-making and managerial roles in various industries.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	03	15	45	03

Prerequisite course(s):

Principles of Management, Quantitative Techniques for Management, Operations Management, Project Planning and Control and Business Analytics

Course objectives:

The objective of this course is to impart knowledge so that the student will:

1. To understand the fundamental principles and functions of management and their historical evolution.
2. To analyse organizational structures and evaluate their impact on business efficiency.
3. To apply quality management techniques and inventory control methods for process optimization.
4. To utilize network analysis techniques like PERT and CPM for project planning and management.
5. To implement modern management practices such as ERP, JIT, TQM, and Six Sigma for continuous improvement.

Course outcomes:

After successful completion of this course the student will be able to:

1. Explain core management concepts and their relevance in organizational success.
2. Evaluate and implement appropriate organizational structures based on business needs.
3. Apply inventory and quality management techniques to optimize business processes.
4. Demonstrate the use of project management tools for effective planning and execution.
5. Implement modern management methodologies such as Kaizen, Kanban, and Lean Manufacturing to improve organizational performance.

COURSE CONTENT

MANAGEMENT SCIENCE		Semester:	III
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE) UA:**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE) CA:	**40 marks**

Unit–I:	No. of Lectures: 09 Hours	Marks: 12

Fundamentals of Management

Definitions, Nature, Importance, and Functions of Management
Historical Perspectives: Evolution of Management Thought
Levels of Management and their Functions
Decision-Making Types & Process
Managerial Skills and Roles (Mintzberg's)

Unit–II:	No. of Lectures: 09 Hours	Marks: 12

Organization and Structure		
Concepts and Principles of Organization Formal and Informal Organization, Authority, Responsibility, Delegation Types of Organizational Structures: Line, Line and Staff, Matrix, and Team Structures Departmentation: Need, Importance, and Bases of Departmentation		
Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**
Operations and Process Management		
Fundamentals of Work Study: Time and Motion Study Techniques Quality Management: Tools and Techniques (P-Chart, R-Chart, C-Chart) Inventory and Material Management: Importance of Inventory Control Economic Order Quantity (EOQ) Calculation ABC Analysis and its Variants (HML, SDE, VED, FSN)		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Project Management		
Introduction to Project Management: Objectives and Importance Network Analysis: Concepts and Applications PERT (Program Evaluation and Review Technique) and CPM (Critical Path Method): Comparison and Implementation Project Optimization: Cost-Time Trade-Off and Crashing Techniques		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Modern Management Practices		
Materials Requirement Planning (MRP) and Enterprise Resource Planning (ERP) Just-In-Time (JIT) and Lean Manufacturing Total Quality Management (TQM): Principles and Implementation Six Sigma: Concepts and DMAIC Process Japanese Management Practices: Kaizen, Kanban, and 5S		
Text Books:		
1. Essentials of Management by Harold Koontz & Heinz Weihrich, 6th Edition, Tata McGraw-Hill (2005)		
Reference Books:		
1. Koontz & Weihrich: Essentials of Management, 6/e, TMII, 2005 2. Kanishka Bedi: Production and Operations Management, Oxford University Press, 2004 3. Samuel C. Certo: Modern Management, Pearson Education, 2005 4. Mahajan, M. (2015). Industrial engineering and production management. Dhanpat Rai & Co. (P) Limited.		
NPTEL Links: 1. Principles of Management by Prof. Usha Linka https://archive.nptel.ac.in/courses/110/107/110107150/ 2. Production and Operation Management by Prof. Rajat Agrawal https://archive.nptel.ac.in/courses/110/107/110107141/ 3. Economic Order Quantity by Prof. Puran Singh https://www.youtube.com/watch?v=_h4i9C47rT8 4. Total Quality Management by Prof. Raghunandan Sengupta https://archive.nptel.ac.in/courses/110/104/110104080/		

BUSINESS ETHICS & PROFESSIONAL VALUES (Open Elective – I)

COURSE OUTLINE

Course Title:	**BUSINESS ETHICS & PROFESSIONAL VALUES**	**Short Title:**	BE&PV	**Course Code:**	**OE – 307 C**

Course description:

This course provides students with a fundamental understanding of business ethics and professional values, focusing on ethical decision-making, corporate governance, workplace ethics, and corporate social responsibility (CSR). It explores ethical leadership, environmental sustainability, and the ethical challenges posed by emerging technologies.

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	03	**15**	**45**	**03**

Prerequisite course(s):

Course objectives:

The objective of this course is to impart knowledge so that the student will:

1. Understand the principles and significance of business ethics in organizational success.
2. Analyse ethical theories and decision-making models in corporate environments.
3. Evaluate corporate governance, ethical leadership, and workplace ethics.
4. Explore ethical challenges in technology, globalization, and sustainability.
5. Develop a strong foundation in professional values and responsible business conduct.

Course outcomes:

After successful completion of this course the student will be able to:

1. Apply ethical principles and decision-making frameworks in business scenarios.
2. Assess the role of corporate governance and ethical leadership in business success.
3. Analyse workplace ethics and strategies for ethical corporate culture.
4. Evaluate ethical considerations in technology, cyber security, and sustainability.
5. Demonstrate professional values such as integrity, accountability, and transparency in decision-making.

COURSE CONTENT

BUSINESS ETHICS & PROFESSIONAL VALUES		**Semester:**	**III**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE) UA:**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE) CA:	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Fundamentals of Business Ethics

Definition, significance, and principles of business ethics
Ethical theories: Utilitarianism, Deontology, Virtue Ethics
Ethical decision-making models: Consequentialist, Non-consequentialist and Hybrid Approaches
Role and importance of ethics in achieving organizational goals
Corporate Governance and Ethical Business Practices
Ethical dimensions of corporate social responsibility (CSR)

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Ethical Leadership and Workplace Practices

Key aspects: Workplace ethics, confidentiality, and transparency
Ethical leadership: Traits, decision-making, and influence on organizational culture

Technology ethics: Privacy, cybersecurity, and AI-related challenges
Addressing dilemmas: Whistleblowing, conflicts of interest, and ethical challenges
Diversity, equity, and inclusion (DEI) in ethical decision-making
Corporate fraud and unethical business practices: Causes, consequences and Preventive measures

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Emerging Ethical Challenges and Trends

Ethical considerations in disruptive technologies: AI, blockchain, IoT, and robotics
Intellectual property rights (IPR): Significance and ethical dimensions of innovation
Ethical challenges in globalization: Cultural relativism and navigating cross-border practices
Future trends: Sustainable leadership, stakeholder capitalism, and Industry 4.0
Environmental ethics in business: Carbon footprint reduction, sustainable resource management and corporate environmental responsibility
Cyber security and ethical hacking: Digital ethics, protection against cybercrimes, ethical dilemmas in surveillance, and hacking ethics

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Environmental and Sustainability Ethics

Organizational responsibilities for health, safety, and the environment
Green engineering: Sustainable designs and renewable technologies
Case studies: Lessons from environmental disasters (e.g., Bhopal Gas Tragedy, Exxon Valdez oil spill)
Regulatory frameworks: Environmental laws, compliance, and ethical practices
Climate change and corporate responsibility: Strategies for sustainable business operations
Role of businesses in achieving Sustainable Development Goals (SDGs)

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**

Professional Values

Definition and relevance of professional values
Core values: Honesty, integrity, accountability, transparency, and respect
Workplace ethics: Building an ethical culture and promoting positive work environments
Professional codes of conduct: ASME, ASCE, IEEE, IETE
Business etiquette and ethical decision-making in professional interactions
Role of mentorship and leadership in cultivating professional values

Text Books:

1. "Business ethics: Concepts and cases (9th ed.)" by Velasquez, M. G. (2020) Pearson.

Reference Books:

1. Crane, A., Matten, D., Glozer, S., & Spence, L. J. (2019). Business ethics: Managing corporate citizenship and sustainability in the age of globalization (5th ed.). Oxford University Press.
2. Fernando, A. C. (2019). Business ethics: An Indian perspective (4th ed.). Pearson Education India.
3. Saha, B. (2010). Environmental ethics: A practical approach. Aadi Publications.
4. Johnson, D. G., & Wetmore, J. M. (2008). Technology and society: Building our sociotechnical future. MIT Press.

NPTEL Links:

1. Business Ethics by Prof Susmita Mukhopadhyay
   https://archive.nptel.ac.in/courses/110/105/110105079/
2. Intellectual property rights By Dr. K. D. Raju
   https://archive.nptel.ac.in/courses/110/105/110105139/
3. Ethics in Engineering Practice by Prof Susmita Mukhopadhyay
   https://archive.nptel.ac.in/courses/110/105/110105097/
4. Introduction to Industry 4 0 and Industrial Internet of Things by a Prof. Sudip Misra

https://archive.nptel.ac.in/courses/106/105/106105195/

PLANT NURSERY AND MANAGEMENT (Open Elective – I)					
COURSE OUTLINE					
Course Title:	**PLANT NURSERY AND MANAGEMENT**	**Short Title:**	**PNM**	**Course Code:**	**OE – 307 D**

Course description:

This course is designed to provide students with an in-depth understanding of the processes, practices, and techniques involved in the establishment and management of plant nurseries. It covers various aspects of plant production, from seedling propagation to the management of nursery operations. Students will gain practical knowledge in selecting plant species, propagating plants, maintaining nursery health, and understanding the financial and operational considerations in managing a nursery.

	Hours/week	No. of weeks	Total hours	Semester credits
Lecture	**03**	**15**	**45**	**03**

Prerequisite course(s):

Course objectives:

1. To provide knowledge about basic concepts and principles of nursery techniques.
2. To impart basic and technical knowledge on nursery management for strengthening of horticulture sector.
3. To study the disease and pest controlling nursery with practical experience.
4. To help students to study marketing and management relating to nursery.
5. To help students to manage nurseries and propagate healthy plants on a commercial scale.

Course outcomes:

After successful completion of this course the student will be able to:

1. Understand the importance of a plant nursery and basic infrastructure to establish it.
2. Explain the basic material, tools and techniques required for nursery.
3. Demonstrate expertise related to various practices in a nursery.
4. Comprehensive knowledge and skills to get an employment or to become an entrepreneur in plant nursery sector.
5. To know green house and playhouse technology.

COURSE CONTENT

PLANT NURSERY AND MANAGEMENT		**Semester:**	**III**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE) UA:**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE) CA:	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Plant nursery:

Introduction, definition and importance. Types of nurseries, Temporary (Features, Advantages and disadvantages).Permanent (Features, Advantages and disadvantages.) Ornamental, Vegetable, Fruit plant, Forest plant, Open field and High-tech nurseries. Selection of place, lay out and components of a good nursery. Important role of nursery in horticulture development.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Nursery Basic requirement and setup:

Nursery beds–types and precautions to be taken during preparation. Growing media, nursery tools and implements, and containers in brief. Soil and seed treatments sowing of seeds and planting material used for nursery.

Unit–III:	No. of Lectures: 09 Hours	Marks: 12

Plant Propagation Technique:

Introduction, Sexual propagation (Advantages and dis-advantages) Cutting (Root, Stem and leaf cutting) Layering (Simple and Air layering) (Gootee) Budding (T and Patch budding) Grafting (Whip and tongue grafting). Green house and Polyhouse Types and importance.

Unit-IV:	No. of Lectures: 09 Hours	Marks: 12

Nursery Management practices:

Potting and repotting, application of manures and fertilizers. Plant bio-regulators and growth retardants, Water quality and management. Common diseases, pests, care and management of nursery plants. Seasonal activities and routine operations in a nursery. Common possible errors in nursery activity. Bureau of Indian Standards (BIS-2008) related to nursery. Economics of nursery development, pricing and record maintenance. Packing, transport, Branding and marketing of nursery plants. Entrepreneurship development through nursery.

Unit-V:	No. of Lectures: 09 Hours	Marks: 12

Vertical farming and Hydroponics:

Vertical Farming: Introduction, scope and importance. Plants suitable for vertical farming. Advantages of vertical farming. Hydroponics: Introduction, scope and importance. Basic concepts and designs, Importance of light, temperature and humidity. Nutrient film technique (NFT) Advantages and Plants suitable for hydroponics.

Text Books:

1. "Plant Nursery Management: Principles and Practices, Central Arid Zone Research Institute" by Ratha Krishnan, P. Kalia Rajwant K.Tewari, J.C., Roy M.M., (2014).

Reference Books:

1. Bose, T.K. Sanyal, Dand Sandhu, M.L. (1998) Propagation of Horticultural crops. Naya Prakash Publishers, Kolkatta.
2. K.K. Nanda and V.K. Kochhar (1985). Vegetative propagation of plants. Kalyani Publisher-NewDelhi-Ludhiana.
3. Kunte, Y.N.,Kawthalkar, M.P.andYawalkar,K.S.(2005).Principles of Horticulture and Fruit Growing. Agri-Horticultural Publishing House, Nagpur.
4. Rahudkar W.B., Bhujbal B.G.,Madhuri Sonawane, Hemraj Rajput ,(2010), CMOU, Text book Publication No. AGR 227Horticulture Nursery Management.
5. Randhawa G.S., A. Mukhopadhyay (2001). Floriculture in India. Book published by Allied Publishers Limited, New Delhi

NPTEL Links:

1. Basics of Crop Breeding and Plant Biotechnology (https://onlinecourses.nptel.ac.in/noc25_ag01/preview)
2. Plant Developmental Biology By Prof. Shri Ram Yadav | IIT Roorkee (Plant Developmental Biology - Course (nptel.ac.in))

GENERAL CLINICAL PATHOLOGY (Open Elective – I)					
COURSE OUTLINE					
Course Title:	**GENERAL CLINICAL PATHOLOGY**	**Short Title:**	GCP	**Course Code:**	**OE - 307 E**
Clinical pathology is the second major subdivision of the discipline of pathology after anatomic pathology. It is concerned with laboratory investigations for screening, diagnosis, and overall management of diseases by analysis of blood, urine, body fluids, and other specimens. The specialties included under the discipline of clinical pathology are clinical chemistry, hematology, blood banking, medical microbiology, cytogenetics and molecular genetics.					

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	**03**	**15**	**45**	**03**

Prerequisite course(s):

Course objectives:

The objective of this course is to:

1. To study the basic principles of laboratory medicine.
2. Laboratory examination of various body fluids for screening and diagnosis of diseases.
3. To study the tests required for assessing various organ functions.
4. Laboratory examination of formed elements of blood and to study different tests involved in the diagnosis of disorders of blood.
5. To study blood group systems, blood transfusion, screening tests for infections transmissible by transfusion and its adverse effects.

Course outcomes:

After successful completion of this course the student will be able to:

1. Explain the significance of clinical pathology in screening and diagnosis of diseases.
2. Describe the role of laboratory in examination of various body fluids, metabolic disorders, gastric anatomy, pregnancy and reproductive system disorders.
3. Explain the structure and function of different organs present in clinical pathology setting and enlist the classification of tests required for evaluating those respective organ functions.
4. Enlist the components of blood and describe the role of several formed elements of blood in clinical pathology.
5. Describe the blood group systems, types of blood donors, screening and identification of antibody.

COURSE CONTENT

GENRAL CLINICAL PATHOLOGY		**Semester:**	**III**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE) UA:**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE) CA:	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Laboratory tests for organ function and examination of body fluids:

Basic principles of laboratory medicine, Examination of Urine, Kidney Function Tests, Laboratory test in Diabetes Mellitus, Liver Function test, Laboratory test in disorders of lipids, Biochemical Cardiac Markers, Examination of Cerebrospinal fluid, Examination of Synovial Fluid, Examination of Sputum.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Gastric system and reproductive system analysis:

Examination of Feces, Gastric Analysis, est for Malabsorption and Pancreatic function test, Thyroid

function test, Laboratory tests in pregnancy, Infertility, Semen Analysis, Pyrexia of unknown origin.		
Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**
Methods for estimation of Blood cell count:		
Haematopoiesis, Collection of blood, Automated complete blood cell count, Estimation of Haemoglobin, Packed cell volume, Total leucocyte count, Reticulocyte count, Platelet count, Blood smear, Red cell indices, Erythrocyte sedimentation rate, Examination of bone marrow.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Laboratory test for disorders of Blood:		
Malignancy, Laboratory test in bleeding disorders, Laboratory test in Thrombophilia, Laboratory Hematology of infectious disease, Laboratory tests in anaemia, Laboratory test in Hematological test in porphyrias.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Blood group systems and Transfusion of blood:		
Blood Group systems, Blood grouping, Collection of donor blood, processing and storage, Screening tests for infections transmissible by transfusion, Antibody Screening and Identification, Compatibility Test, Whole blood, blood components and blood derivatives, Adverse effects of Transfusion.		
Text Books:		
1. "Essentials of Clinical Pathology" by Shirish M. Kawthalkar, JP Medical Ltd, 2018.		
Reference Books: 1. Clinical Pathology, Hematology & Blood banking, 3rd Edition, Nanda Maheshwari. 2. Clinical Pathology Interpretations, A.H.Nagi, Fourth Edition. 3. Essential textbook of Clinical Pathology with Practicals, Tapeshwar yadav & Asheshwar Yadav. 4. Consise text in Clinical pathology, Hematology & Blood banking, Surabhi Bansal, AITBS Publisher. 5. Laboratory Manual of clinical pathology and hematology, Santosh Kumar Mondal. 6. A consise textbook of Clinical Pathology, Hematology & Blood banking, Rakesh Joshi.		

HERBAL HOME REMEDIES (Open Elective – I)					
COURSE OUTLINE					
Course Title:	**HERBAL HOME REMEDIES**	**Short Title:**	HHR	**Course Code:**	**OE – 307 F**

The herbal home remedies course is designed to introduce individuals to the power of natural, plant-based remedies that can be used for common ailments and overall health maintenance. Participants will learn the principles of herbal medicine, understand the therapeutic properties of different herbs, and explore how to incorporate them into daily life through simple, safe, and effective home remedies. The course will cover a wide range of herbs and their uses in treating various conditions, including digestive issues, skin problems, stress, sleep disturbances, and immune system support. By the end of the course, students will have the knowledge to prepare herbal teas, tinctures, salves, and other remedies.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s):

Course objectives:

The objective of this course is to:

1. Understand the basics of herbal medicine and its history in various cultures.
2. Familiarize yourself with common medicinal herbs and their healing properties.
3. Gain hands-on experience in making teas, tinctures, syrups, salves, and poultices.
4. Discover herbal solutions for everyday health concerns like colds, headaches, digestive problems, and skin issues.
5. Learn how to incorporate herbs into your diet, beauty routines, and wellness practices.

Course outcomes:

After successful completion of this course the student will be able to:

1. Identify and classify common herbs and their medicinal uses.
2. Create their own herbal remedies such as teas, tinctures, and oils tailored to specific health needs.
3. Apply natural remedies to improve personal health and wellness in a safe and sustainable way.
4. Understand how to work with herbs to support emotional and physical balance in the body.
5. Integrate herbs into daily routines to enhance lifestyle, nutrition, and overall well-being.

COURSE CONTENT

HERBAL HOME REMEDIES		**Semester:**	**III**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE) UA:**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE) CA:	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to Herbal Medicine:

Definition of herb, herbal medicine, Source of Herbs, Basic introduction of Ayurveda, Siddha, Unani and Homeopathy, Introduction of in cultivation of medicinal plants, Leaf, bark, root, seed, flowers, fruits & gums.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Herbal Identification and Properties:

Basic home remedies for general problem: Cold and Cough, Fever, Acidity, Itching, Constipation, Headache, Toothache, Vomiting.

Unit–III:	No. of Lectures: 09 Hours	Marks: 12
Preparing Herbal Remedies:		
Source of minerals, vitamins, protein, Source of home spices & plant: honey, ashwagandha tulsi, shilagit, bhel, adulsa, pipal, black pepper , caraway seeds , cardamom seed powder , cayenne , celery seed , chives , chile peppers , Korintje cinnamon, Vietnamese cinnamon , cloves , cumin , dill seed , dill weed , garlic , gumbo filé , lemon , mace , marjoram , nutmeg , onion , oregano (Mediterranean).		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Herbal Remedies for Common Ailments:		
Herbal compound for oral care, skin care, sun care, hair care, decorative cosmetics, body care and perfumes.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Integrating Herbal Remedies into Daily Life:		
Preparation of Ayurvedic formulations viz powder, Ghutika, Churna and Bhasma.		
Text Books:		
1. "Textbook of Pharmacognosy" by Trease & Evans. 2. "Pharmacognosy" by Kokate, Purohit and Gokhale.		
Reference Books: 1. Pharmacognosy & Phytochemistry by V. D. Rangari. 2. Pharmacopoeal standards for Ayurvedic Formulation (Council of Research in Indian Medicine & Homeopathy).		

PSYCHOLOGY OF WELL-BEING (Open Elective – I)					
COURSE OUTLINE					
Course Title:	**PSYCHOLOGY OF WELL-BEING**	**Short Title:**	POWB	**Course Code:**	**OE – 307 G**

The Psychology of Well-Being course explores the psychological factors that contribute to human flourishing, happiness, and life satisfaction. This course delves into the scientific study of well-being, examining how positive emotions, healthy relationships, resilience, and personal growth influence mental and physical health. Students will explore theories and research from positive psychology, focusing on practical strategies to enhance personal well-being and cultivate a meaningful life. By understanding the psychological principles behind well-being, students will be better equipped to foster positive mental health both in themselves and in others.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s):

Course objectives:

The objective of this course is to:

1. The psychological and physiological benefits associated with experiencing positive emotions, such as improved resilience, mental health, and social connections.
2. The mindfulness and its components, including present-moment awareness, non- judgmental acceptance, and compassion.
3. The different strategies for developing and enhancing emotional intelligence skills, including mindfulness practices, self-reflection exercises, and social skill-building activities.
4. The important concepts of well-being like conflict resolution, reconciliation, and stress management
5. Include mindfulness practices, self-reflection exercises, and social skill-building activities.

Course outcomes:

After successful completion of this course the student will be able to:

1. Understand the positive emotion and well-being, including the ability to define and differentiate these concepts from other affective states and mental health constructs.
2. Demonstrate an understanding of mindfulness principles and techniques, including the ability to define mindfulness and its components such as present-moment awareness, non-judgmental acceptance, and compassion.
3. Develop strategies for enhancing emotional intelligence competencies, including mindfulness practices, self-reflection exercises, and social skill-building activities.
4. Collaborate with peers to explore the application of gratitude and forgiveness principles in real-world scenarios, such as conflict resolution, reconciliation, and stress management, demonstrating the ability to work effectively with others and apply learned concepts in practical settings.
5. Developing personal tools and strategies for enhancing individual well-being.

COURSE CONTENT

PSYCHOLOGY OF WELL-BEING		**Semester:**	**III**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE) UA:**	**60 marks**

		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE) CA:	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Positive emotion and well-being :

Positive Emotions: Meaning of Positive Emotions, Identifying Positive Emotions, Benefits of Positive Emotions Barbara Fredrickson's Broaden and Build Theory of Positive Emotions Positive Emotions and Health Resources: Physical, Psychological and Social Resources. Positive Emotions and Well-being: Happiness and Positive Behaviour, Positive Emotion and Success, Positive Emotion and Flourishing (PERMA Model) Cultivating Positive Emotions: Flow Experiences, savoring.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Mindfulness and well-being :

Mindfulness: Meaning, Mindfulness as an Antidote for Mindlessness, Mindfulness as Present-centered, Awareness and Attention Mindfulness Meditation ,Attributes of Mindful Awareness- Non-Judging, Patience, Beginner Mind, Trust, Non-Striving, Acceptance, Letting go. Benefits of Mindfulness, Mindfulness and Mental Health, Living with Mindfulness: Being Mindfulness of Emotion, Being Mindfulness of Eating, Being Mindfulness of Exercise, Mindfulness Breathing and sitting as a Meditation Mindfulness and Happiness.

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Emotional intelligence:

Emotional Intelligence, Meaning, Nature and Definition Theories of EI, Peter Salovey and John D Mayre, Danial Golman, Bar-On Emotional Intelligence and Happiness Ways That Emotionally Intelligent People Choose for Happiness Factors - Emotional Intelligence Be Increased, Manage another Person's Emotions.

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Gratitude and forgiveness:

Gratitude: Meaning and Concept, Characteristics of Gratitude People, Gratitude Physical and Mental Health, Gratitude and Happiness, Ways to Practice Gratitude Forgiveness Meaning, Definition, Importance and Types, Benefits of Forgiveness, Forgiveness is the key of Happiness.

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**

Happiness and the Facts of Life:

Happiness Across the Life-Span - Focus on Research: Happiness and Where we Live - Stability in Well-Being Despite Life Changes - Temperament and Subjective Well-Being - Frequency, Intensity and Balance of Positive and - Negative Emotions - Measurement and Definitional Issues -The Shifting Basis of Life Satisfaction - Gender and Happiness - Gender differences in Emotional Experience - Negative Emotions - Positive Moods and Behaviors - Explaining the Paradox of Gender Other Facts of Life - Physical and Mental Health ,Work and Unemployment , Intelligence and Education - Religion - Race, Ethnicity and Stigma.

Text Books:

1. "The Role of Positive Emotions in Positive Psychology: The Broadenand-Build Theory of Positive Emotions" by Fredrickson, B. L. (2001) American Psychologist, 56, 218-226.

Reference Books:

1. Steve B. & Marie, C. (2015). Positive Psychology. Pearson Education.
2. Snyder C.R., Lopez S.J., Pedrotti J.T. (2011) Positive Psychology. Sage Publication.

NPTEL Links:

1. Introduction to Psychology By Prof. Braj Bhushan, IIT Kanpur
   https://onlinecourses.nptel.ac.in/noc21_hs49/preview

FUNDAMENTALS OF BANKING (Open Elective – I)					
COURSE OUTLINE					
Course Title:	**FUNDAMENTALS OF BANKING**	**Short Title:**	**FOB**	**Course Code:**	**OE – 307 H**
This course provides a fundamental understanding of banking concepts, types of banks, negotiable instruments, banking operations, and remittance methods. It covers essential topics like account management, banking regulations, and digital banking services, equipping students with foundational knowledge for careers in banking and finance.					
	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**	
Theory	**03**	**15**	**45**	**03**	
Prerequisite course(s):					
Course objectives:					
The objective of this course is to: 1. Explain the basic concepts, evolution, and significance of banking. 2. Provide knowledge of different types of bank accounts and their operations. 3. Introduce negotiable instruments and their role in banking transactions. 4. Familiarize students with endorsements, remittances, and digital banking methods. 5. Develop an understanding of banking regulations, customer protection, and ethical banking practices.					
Course outcomes:					
After successful completion of this course the student will be able to: 1. Understand the fundamental concepts and functions of banking. 2. Identify different types of bank accounts, cooperative banking structures, and their significance. 3. Analyze the characteristics and legal aspects of negotiable instruments and endorsements. 4. Evaluate different means of remittances and their role in modern banking. 5. Apply knowledge of banking regulations, digital banking, and financial security measures.					
COURSE CONTENT					
FUNDAMENTALS OF BANKING		**Semester:**	**III**		
Teaching Scheme:		**Examination scheme**			
Lectures:	**3 hours/week**	**End Semester Exam (ESE) UA:**	**60 marks**		
		Duration of ESE:	**03 hours**		
		Internal Sessional Exam (ISE) CA:	**40 marks**		
Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**			
Fundamentals of Banking					
Meaning and definition of banking Evolution of banking in the world and in India Importance of banking in the Indian economy Types of banks – Commercial Banks, Cooperative Banks, Development Banks, and Central Bank					
Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**			
Banking Operations and Account Management					
Types of bank accounts – Savings, Current, Fixed Deposit, Recurring Deposit, Non-Resident Accounts Procedure for opening, operating, and closing accounts KYC norms and customer due diligence Role of banks in financial inclusion					
Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**			

Negotiable Instruments and Endorsements		
Meaning, characteristics, and types of negotiable instruments – Promissory Notes, Bills of Exchange, Cheques Types of cheques – Bearer, Order, Crossed (General & Special) Endorsements – Definition, characteristics, types (Blank, Special, Partial, Restrictive, Conditional, Facultative) Rights and liabilities of parties to negotiable instruments		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Remittance Services and Digital Banking		
Different means of remittances – Demand Drafts, Letters of Credit Credit Cards, Debit Cards, ATMs – Advantages and Disadvantages MICR cheques and their significance Introduction to digital banking – NEFT, RTGS, UPI, Mobile Banking		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Banking Regulations and Ethical Practices		
Role of regulatory authorities – RBI, SEBI, and their functions in banking Consumer protection in banking – Banking Ombudsman Scheme Common banking frauds and security measures Ethical banking practices and financial literacy		
Text Books:		
1. "Basics of Banking and Finance" by K.M. Bhattacharya & O.P. Agrawal, Himalaya Publishing House. 2. "Fundamentals of Banking Theory and Practice" by A.K. Basu.		
Reference Books: 1. Elements Banking and Insurance – B. S. Shah Publication, Ahmadabad 2. Elements of Banking and Insurance – New Popular Publication, Surat 3. Banking Theory and Practice, Prem Kumar Srivastava, Himalaya Publishing House.		
NPTEL Links: 1. Management of Commercial Banking by Prof. Jitendra Mahakud, IIT Kharagpur https://nptel.ac.in/courses/110105143		

Kavayitri Bahinabai Chaudhari
NORTH MAHARASHTRA
UNIVERSITY, JALGAON (M.S.)

Second Year Bachelor of Engineering
in
Mechanical

(As per NEP 2020 Guidelines)

Faculty of Science and Technology



COURSE OUTLINE
For Affiliated Colleges
Semester – IV
W.E.F. 2025 – 26

MANUFACTURING PROCESSES (PCC)

COURSE OUT LINE

Course Title:	**MANUFACTURING PROCESSES**	**Short Title: MP**	**Course Code:**	**ME-401**

Course description:

This course covers the main methods used to make products in modern industries. Students will learn about key manufacturing techniques like casting, machining, and welding, metal forming & powder metallurgy. The course focuses on understanding how each process works, where they are used, their benefits, and their limits. Students will be able to solve the problems related to manufacturing process like design of gating system and poring time in casting processes. They will be familiarized with different machining process and machine tools. By the end of the course, students will know how to choose the right manufacturing method for different product designs and industries.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite course(s):

Materials Science , Applied Physics & Engineering Mechanics

Course objectives:

The student will able to:

1. Learn the basic methods used to make products, like casting, machining, shaping, welding, metal forming and powder metallurgy.
2. Understand the benefits, limits, and uses of different manufacturing techniques.
3. Explore how manufacturing methods affect material properties, product quality, and costs.
4. Learn how to choose the right manufacturing method for different product designs and industries.
5. Gain practical experience in evaluating and applying manufacturing processes through hands-on projects and case studies.

Course Outcomes:

After successful completion of this course the student will be able to:

1. Describe and explain different manufacturing methods such as casting, machining, welding, and powder metallurgy.
2. Identify and understand the concepts of various manufacturing techniques briefly.
3. Understand the different welding processes impact on the properties, quality, and cost of materials and products.
4. Identify and select the suitable machining method for different products.
5. Understand the concepts of powder metallurgy method.

COURSE CONTENT

Manufacturing Processes		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE):	**40 marks**

Unit–I: Metal Casting Process	**No. of Lectures: 09 Hours**	**Marks: 12**

Casting and molding: Casting, Patterns; types, material and design including pattern allowances; Molding sands; composition, preparation, properties and testing; Core; Purpose, definition, materials, preparation and applications; Gating system; elements of

gating system, characteristics, Classification, Estimation of pouring time for top gate and bottom gate .Heat transfer and Solidification, Inspection of casting, Special casting processes, Defects in casting processes. Design of gating system; pouring basin, sprue, runner and risers; Advantages.

Unit–II: Metal Forming Processes	**No. of Lectures: 09 Hours**	**Marks: 12**

Theoretical basis for metal forming process, Advantages and disadvantages of metal forming, Classification of metal forming, Effect of variables on metal forming, forging; Classification, considerations for sound forging, forging defects, rolling; Hot and cold rolling, Mechanism of rolling, Analysis of rolling process, Types of rolling mill, rolling defects, Drawing; Wire, Rod and Tube. Extrusion; types of extrusion, Advantages and disadvantages.

Unit–III: Welding/ Joining Process	**No. of Lectures: 09 Hours**	**Marks: 12**

Welding; Definition, Advantages, Limitations, Applications, Classification of welding process, Gas welding processes, types of flame, welding techniques in gas welding, use of filler rod and fluxes. Arc welding operation, weld bead, Electrode, designation of electrode, Spatter arc blow, Introduction to TIG welding ,MIG welding processes, Soldering, Brazing and Thermit welding, Defects in welding.

Unit–IV: Machining	**No. of Lectures: 09 Hours**	**Marks: 12**

Lathe machine; Parts of lathe machines (Tail stock, Head stock, Carriage, Bed), Operations on lathe (Plain turning, Taper turning, Thread cutting, Chamfering, Knurling). Shapers and Planners; Introduction, Shaper machine, cutting tools used in shaping, Principle of working. Milling Process; Introduction, Basic Milling process, types of milling process; peripheral milling, Face milling, End Milling, Milling machines. Grinding; Introduction, Specification of grinding wheel.

Unit–V: Powder Metallurgy	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction, Advantages and limitations of P/M, Manufacturing of metal
powders, Mixing and blending, Compaction, Sintering, Secondary operations, Recent trends in powder metallurgy, properties of powder metallurgy parts, Comparison of P/M parts with other processes.

Text Books:

1. Hajara Chaudhari, Bose S.K Elements of Workshop Technology Volume I & II.

Reference Books:

1. R. K. Jain, Production Technology, Khanna Publishers.
2. P. N. Rao, Manufacturing technology, Vol-I & II McGraw Hill publications
3. Dr. P. C. Sharma, Production Engineering, S. Chand & Company Ltd.
4. H. N. Gupta, R. C. Gupta, Arun Mittal, Manufacturing Processes, , New Age International Publishers
5. Kalpakjian and Schmid, Manufacturing processes for engineering materials, (5th Edition) Pearson India, 2014.
6. Mikell P. Groover, Fundamentals of modern manufacturing, John Wiley and Sons, Inc.

NPTEL Links:

1. Prof DK Dwivedi, IIT Roorkee Fundamental of Manufacturing Processes, - https://archive.nptel.ac.in/courses/112/107/112107219/
2. Prof Indradeep Singh, IIT Roorkee Manufacturing Processes-I - https://archive.nptel.ac.in/courses/112/107/112107145/

MANUFACTURING PROCESSES LAB. (PCC)					
LAB COURSE OUTLINE					
MANUFACTURING PROCESSES LAB.		**Semester:**	**IV**	**Course Code:**	**ME-402**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**			**25 marks**
Semester Credits:	**1**	**End semester exam (ESE) (UA):**			**25 marks**
End Semester Exam (ESE) Pattern:		**Oral (OR)**			

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. To prepare a sheet metal product (Funnel)
2. To prepare a pattern for given object for sand casting.
3. To melt and pour Aluminum metal into the mold.
4. To prepare a job in a lathe machine with operations like facing, turning, step turning and chamfering.
5. To study and observe the Forging techniques through demonstration
6. Demonstration of CNC lathe and milling machine
7. To prepare a job like “S” shape by hand forging.
8. To prepare a “T” joint by arc welding.
9. To prepare a Butt Joint by gas welding

Text Books:

1. R. K. Jain, “Production Technology’, Khanna Publishers.
2. P. N. Rao, “Manufacturing technology, Vol-I & II”, McGraw Hill publications

NPTEL Links:

1. https://onlinecourses-archive.nptel.ac.in/noc17_me03/preview - Prof. Shantanu Bhattacharya, IIT Kanpur
2. https://archive.nptel.ac.in/courses/112/104/112104301/ - Coordinated by IIT Kanpur

Guide lines for ICA:

Students must submit ICA in the form of journal. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. Evaluation will be based on oral and performance in the ESE.

FLUID MECHANICS & HYDRAULIC MACHINES (PCC)				
COURSE OUT LINE				
Course Title:	**FLUID MECHANICS & HYDRAULIC MACHINES**	**Short Title: FM & HM**	**Course Code:**	**ME-403**

Course description:

This course introduces the fundamentals of fluid mechanics and hydraulic machines, emphasizing fluid properties, fluid statics, dynamics, and various flow phenomena. It covers hydraulic turbines and pumps, ensuring students understand theoretical concepts and gain hands-on experience through laboratory experiments. The course also integrates modern computational tools for fluid flow analysis, preparing students for applications in Mechanical Engineering.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite course(s):

Course objectives:

The objective of this course is to:

1. Providing fundamental knowledge of fluid properties, fluid statics, and kinematics.
2. Understanding the principles governing fluid flow, momentum transfer, and energy conservation.
3. Analyzing the working and performance characteristics of hydraulic machines (pumps, turbines).
4. Applying Bernoulli's principle, Navier-Stokes equations, and dimensional analysis in engineering problems.
5. Enhancing problem-solving skills using experimental, numerical, and computational methods.

Course outcomes:

After successful completion of this course the student will be able to:

1. Understand and analyze the properties of fluids, fluid statics, and stability of bodies.
2. Analyze fluid flow problems using continuity, momentum, and energy principles.
3. Understand and Solve practical problems related to laminar and turbulent flow in pipes and dimensional analysis.
4. Understand and evaluate the performance of hydraulic turbines and its performance characteristics.
5. Understand and analyze the performance of centrifugal pump and hydraulic systems.

COURSE CONTENT

Fluid Mechanics & Hydraulic Machines		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE):	**40 marks**

Unit–I: Fluid Properties and Fluid Statics	**No. of Lectures: 09 Hours**	**Marks: 12**

Properties of fluids: Density, viscosity, surface tension, Classification of fluids: Ideal, real, Newtonian, and non-Newtonian fluids.
Fluid statics: Pressure variation in static fluids, Pascal's law, Hydrostatic force on submerged surfaces vertical & inclined, Buoyancy and stability of floating bodies, Flotation, Center of pressure.

Unit–II: Fluid Kinematics and Dynamics	**No. of Lectures: 09 Hours**	**Marks: 12**

Types of fluid flow: Steady/unsteady, uniform/non-uniform, laminar/turbulent, Streamlines, path lines, and streak lines, Continuity equation in Cartesian and cylindrical coordinates, Euler's and Bernoulli's equation and applications, Flow measurement devices: Venturi meter, Orifice meter, Pitot tube

Unit–III: Viscous Flow and Dimensional Analysis	**No. of Lectures: 09 Hours**	**Marks: 12**

Laminar and turbulent flow in pipes (Reynolds number), Flow through circular pipes: Hagen-Poiseuille equation, Darcy-Weisbach equation, Major and minor losses in pipe flow, Dimensional analysis and similitude (Buckingham π theorem, Reynolds, Froude, Mach numbers).

Unit–IV: Hydraulic Turbines and Energy Conversions	**No. of Lectures: 09 Hours**	**Marks: 12**

Impulse moment Principle, Introduction of Impact of Jet, Classification of turbines: Impulse and reaction turbines, Working principles of Pelton wheel, Francis, and Kaplan turbines, Velocity triangles , Efficiency and power calculations. Theory of Draft tube and cavitation in turbines, Performance characteristics and efficiency of turbines.

Unit–V: Hydraulic Pumps and Systems	**No. of Lectures: 09 Hours**	**Marks: 12**

Classification and working principles of pumps, Centrifugal pumps: Components, velocity triangles, performance curves, Principle, layout and working of reciprocating pump.
Hydraulic systems: Hydraulic accumulator, intensifier, hydraulic press, fluid coupling.

Text Books:

1. Fluid Mechanics and Hydraulic Machines – R.K. Bansal, ,Laxmi Publications.

Reference Books:

1. Fluid Mechanics and Hydraulic Machines – R.K. Bansal, Comprehensive guide covering fluid mechanics concepts and applications.
2. Hydraulics and Fluid Mechanics – P.N. Modi & S.M. Seth, Covers theoretical and practical aspects of hydraulic engineering.
3. Introduction to Fluid Mechanics – Robert W. Fox, Alan T. McDonald, Provides insights into real-world fluid dynamics applications.
4. Fluid Mechanics and Machinery – C.S.P. Ojha, P.N. Chandramouli, Focuses on applied fluid mechanics in engineering fields.
5. Fluid Mechanics: Fundamentals and Applications – Yunus A. Çengel & John Cimbala, Explores computational and analytical fluid mechanics.

NPTEL Links:

1. Fluid Mechanics – Prof. S.K. Som (IIT Kharagpur) https://nptel.ac.in/courses/112105249
2. Hydraulic Machines – Prof. S.K. Som (IIT Kharagpur) https://nptel.ac.in/courses/112105046
3. Introduction to Fluid Mechanics – Prof. Arindam Banerjee (IIT Madras)

https://nptel.ac.in/courses/112106179

4. Fluid Mechanics and Hydraulic Machines – Prof. Subashisa Dutta (IIT Guwahati) https://nptel.ac.in/courses/105103193

FLUID MECHANICS & HYDRAULIC MACHINES LAB (PCC)					
LAB COURSE OUTLINE					
FLUID MECHANICS & HYDRAULIC MACHINES LAB		**Semester:**	**IV**	**Course Code:**	**ME-404**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**			**25 marks**
Semester Credits:	**1**	**End semester exam (ESE) (UA):**			**25 marks**
End Semester Exam (ESE) Pattern:		**Practical (PR)**			

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. **Determination of kinematic viscosity of a fluid.**
   To determine Kinematic Viscosity of a given fluid by using Redwood Viscometer.
2. **Verification of Bernoulli's theorem**
   To verify Bernoulli's theorem for determination of total energy possess by fluid.
3. **Measurement of Coefficient of Discharge of given Orifice and Venturi meters.**
   To determine the Cd, Cv, Cc for respective flow meters.
4. **Determination of major and minor losses for flow through pipes**
   To Decide the Frictional Losses and Different Minor losses in pipes.
5. **Determination of the performance characteristics of a centrifugal pump.**
   To calculate efficiency and different performance parameter of centrifugal Pump**.**
6. **Determination of the performance characteristics of Pelton Wheel**.
   To calculate efficiency and different performance parameter of Pelton Wheel Turbine.
7. **Determination of the performance characteristics of a Francis Turbine**
   To calculate efficiency and different performance parameter of Francis Turbine
8. **Determination of the performance characteristics of a Kaplan Turbine**
   To calculate efficiency and different performance parameter of Kaplan Turbine
9. **To study the flow patterns by using Reynolds's apparatus**
   To decide different types of flow.

Text Books

1. Fluid Mechanics and Hydraulic Machines – R.K. Bansal, Comprehensive guide covering fluid mechanics concepts and applications.

Reference Books:

1. Hydraulic Machines – Jagdish Lal, Focuses on different hydraulic machinery and their real-world applications.
2. Fluid Mechanics and Hydraulic Machines – R.K. Bansal, Comprehensive guide covering

fluid mechanics concepts and applications.
3. Hydraulics and Fluid Mechanics – P.N. Modi & S.M. Seth, Covers theoretical and practical aspects of hydraulic engineering.
4. Introduction to Fluid Mechanics – Robert W. Fox, Alan T. McDonald, Provides insights into real-world fluid dynamics applications.
5. Fluid Mechanics and Machinery – C.S.P. Ojha, P.N. Chandramouli, Focuses on applied fluid mechanics in engineering fields.

Guide lines for ICA:

Students must submit ICA in the form of journal. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. Evaluation will be based on oral, paper work and performance in the ESE.

METROLOGY AND QUALITY CONTROL LAB (PCC)				
LAB COURSE CONTENT				
Course Title:	**METROLOGY AND QUALITY CONTROL LAB**	**Short Title: MQC Lab**	**Course Code:**	**ME-405**

Course description:

This course introduces undergraduate students to Metrology and Quality Control. The background required includes a sound knowledge to Measurements, (calculus), applied thermodynamics, Industrial management

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	01	15	15	02
Practical	02	15	30	

Prerequisite course(s):

Course objectives:

1. Familiarizing students with basic and advanced measurement techniques used in engineering.
2. Providing hands-on experience with precision instruments and metrology equipment.
3. Developing skills in calibration, error analysis, and uncertainty measurement.
4. Understanding national and international standards in metrology.
5. Applying measurement techniques in quality control and inspection processes.

Course outcomes:

After successful completion of this course the student will be able to:

1. Use and operate precision measuring instruments effectively.
2. Perform calibration and error analysis in measurement systems.
3. Apply metrology techniques to ensure product quality in manufacturing.
4. Conduct various mechanical and optical measurements.
5. Interpret and follow national and international metrology standards.

COURSE CONTENT

Metrology And Quality Control Lab		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Lectures:	**1 hours/week**	**Internal Continuous Assessment (ICA) CA:**	**25 marks**
Practical	**2 hours/week**	**End semester exam (ESE) (UA):**	**25 marks**
End Semester Exam (ESE) Pattern:		**Practical (PR)**	

1. Overview of Metrology and Linear Measurement- Definition of Metrology, objective and types of Metrology, Need of inspection, Methods of measurements, terminologies, units of measurement, selection of instruments, concept of error (systematic and random), sources of error.

2. Linear Tolerancing and GD&T- Limits, fits and tolerances: Interchangeability, selective assembly, limits, fit and tolerances, limit gauging, design of limit gauges, computer aided tolerancing.

3. Gauges and Comparators - Comparators: Definition, Requirement of a good comparator, Classification, Use of comparators, Working principle (Merits and Demerits) of Dial indicator and Pneumatic Comparator (Air Gauge), Selective Assembly, Interchangeability. 2.2 Gauges: Limit gauges. Taylor's principle of Gauge design, Plug, Ring Gauges, Snap gauges. 2.3 Slip gauges: Wringing of Slip Gauges (Numerical). Precautions.

4. Angular, Screw Thread, and Gear Measurement – Angle measurement: Instruments

used in Angular Measurements: Angle Gauges (No Numerical), Bevel Protractor, sine bar. Principle of Working of Angle Dekkor.
Screw thread Measurements: Screw thread terminology, measurement of different elements such as major diameter, minor diameter, effective diameter, pitch, thread angle. Best wire size, Two wire method, Working principle of floating carriage micrometer.
Gear Measurement: Parkinson Gear tester, Gear tooth Vernier, Profile projector.
CMM: Introduction to Coordinate Measurement Machine (CMM) and its merits
5. Measurement of surface finish: Introduction, terminology, specifying roughness on drawings, surface roughness parameters, factors affecting surface roughness, ideal surface roughness, methods, precautions, surface microscopy.
Quality Control: - Introduction, Factors controlling quality of design and conformance, balance between cost of quality and value of quality, Introduction to quality tools: Deming's PDCA, PDSA cycles & Juran triology approach, Seven quality tools, Pareto.

Concerned faculty member should suitably frame SIX laboratory assignments from the Following list.

1. Measurement of dimensions of component using vernier caliper, vernier height gauge, vernier depth gauge, micrometer and inside micrometer.
2. Roundness checking of given component using dial indicator / dial gauge.
3. Measurement of unknown angle of a component using Sine bar and verify by using Bevel protractor.
4. Measurement of the gear tooth elements by using gear tooth vernier caliper and verification by optical profile projector.
5. Measurement of the surface roughness of machined surface by using surface roughness tester.
6. Study and use of control charts
7. Demonstration on Coordinate Measuring Machine.
8. Measurement of screw parameters.
9. Study of surfaces using optical flat.
10. Machine tool alignment tests on any machine tool like Lathe, Drilling, Milling

Text Books:

1. R. K. Jain – Engineering Metrology (Khanna Publishers)

Reference Books:

1. Galyer & Shotbolt – Metrology for Engineers (Springer)
2. C. Gupta – A Textbook of Engineering Metrology (Dhanpat Rai Publications)
3. J.P. Holman – Experimental Methods for Engineers (McGraw-Hill).
4. Bewoor & Kulkarni – Metrology & Measurement (McGraw Hill)

NPTEL Links:

1. Metrology By Prof. Dr. Kanakuppi Sadashivappa Dept. of Industrial & Production engg, Bapuji Institute of Engineering & Technology, Davangere
   https://archive.nptel.ac.in/courses/112/106/112106179/
2. Engineering Metrology By Prof. J. Ramkumar, Prof. Amandeep Singh | IIT Kanpur
   https://onlinecourses.nptel.ac.in/noc22_me75/preview
3. Principles of Mechanical Measurement By Prof. Dipankar N Basu Dept. of Mechanical Engineering IIT Guwahati
   https://archive.nptel.ac.in/courses/112/103/112103261/

Guide lines for ICA:

Students must submit ICA in the form of journal. Faculty in charge will assess the assignments

continuously and grade or mark each assignment on completion date declared for each assignment.
Guide lines for ESE:
ESE will be based on practical assignment submitted by the student in the form of journal. Evaluation will be based on oral, paper work and performance in the ESE.

BIOLOGY FOR ENGINEERS (MDM)				
COURSE CONTENT				
Course Title:	**BIOLOGY FOR ENGINEERS**	**Short Title: BFE**	**Course Code:**	**ME - 406**

Course description:

This course describes basics and introduction of Biology for various engineering disciplines. It enables students to identify different cell types, functions and biomolecules with their roles. The students were acquainted with the concept of Biomimicry in engineering. After studying the course, student is able to demonstrate the human organ systems and bio-designs.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	02	15	30	02

Prerequisite course(s):

Course objectives:

Objectives of the course are:
1. To get introduced to different cell types and functions.
2. To understand the biomolecules and their roles.
3. To identify the concept of Biomimicry in engineering.
4. To demonstrate the knowledge of human organ system and bio-designs.
5. To analyze Bioengineering concepts.

Course outcomes:

After successful completion of this course the student will be able to:
1. Identify cell types and their functions and chemistry of cells.
2. Understand Biomolecules with their applications.
3. Identification & applications of Biomimicry in engineering.
4. Correlate the human organ system and bio-designs.
5. Analyze Bioengineering concepts and their applications across different engineering disciplines.

COURSE CONTENT			
BIOLOGY FOR ENGINEERS		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme:**	
Lectures:	**2 hours/week**	**End semester exam (ESE) UA:**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE) CA:	**40 marks**
		Internal Continuous Assessment (ICA) CA:	**25 marks**

Unit–I:	No. of Lectures: 06 Hours	Marks: 12

Introduction to Biology: The cell: the basics of a cell. Prokaryotic and Eukaryotic cell, The Plant Cell and animal cell, Chemistry of cells. Cell Division: Cell cycle, mitosis, meiosis, cell division, cell cycle check points, cell death.

Unit–II:	No. of Lectures: 06 Hours	Marks: 12

Biomolecules: Properties and functions of Carbohydrates, Nucleic acids, proteins, lipids. Application of Biomolecules in water filters production, Proteins in food production, lipids in biodiesel and detergents production, Enzymes in biosensors fabrication, food processing

Unit–III:	No. of Lectures: 06 Hours	Marks: 12

Biomimicry: Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic

leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swim suits), Kingfisher beak (Bullet train). Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perfluorocarbons (PFCs).

Unit–IV:	No. of Lectures: 06 Hours	Marks: 12

Human Organ Systems and Bio Designs: Brain as a CPU system (signal transmission, BCI, EEG). Eye as a Camera system (rod and cone cells, optical corrections, lens materials, bionic eye). Heart as a pump system (electrical signaling - ECG monitoring, design of stents, pacemakers, defibrillators). Lungs as purification system (spirometry, Ventilators, Heart-lung machine, artificial lungs). Kidney as a filtration system.

Unit–V:	No. of Lectures: 06 Hours	Marks: 12

Bioengineering: Muscular and Skeletal Systems as scaffolds (architecture, mechanisms, bioengineering solutions for muscular dystrophy and osteoporosis), scaffolds and tissue engineering, Bioprinting techniques and materials, 3D printing of ear, bone and skin. 3D printed foods. Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis.

Text Books:

1. Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
2. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
3. Biology for Engineers, Rajendra Singh C and Rathnakar Rao N, Rajendra Singh C and Rathnakar Rao N Publishing, Bengaluru, 2023

Reference Books:

1. Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.
2. Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C. Mattiussi, MIT Press, 2008
3. 3D Bioprinting: Fundamentals, Principles and Applications by Ibrahim Ozbolat, Academic Press, 2016.
4. Electronic Noses and Tongues in Food Science, Maria Rodriguez Mende, Academic Press, 2016
5. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2000). Lehninger principles of biochemistry. New York: Worth Publishers.

NPTEL Links:

NPTEL Course on Biology for engineers and other non-biologists (4 weeks UG Course) By Prof. G.K. Suraish kumar & Prof. Madhulika Dixit (IIT. Madras)

Guidelines for ICA:

Students must submit ICA in the form of journal. Concerned faculty member should suitably frame **FIVE** assignments based on the above syllabus. Faculty in charge will assess the assignments continuously, and grade or mark each assignment on completion date declared for each assignment.

ADVANCED WELDING PROCESSES (VSEC)				
COURSE OUT LINE				
Course Title:	**ADVANCED WELDING PROCESSES**	**Short Title: AWP**	**Course Code:**	**ME-408**

Course description:

Advanced Welding provides students with opportunities to effectively perform cutting and welding applications of increasing complexity used in the advanced manufacturing industry.

	Hours/week	No. of weeks	Total hours	Semester credits
Practical	02	15	30	01

Prerequisite course(s):

Engineering Workshop

Course objectives:

Objectives of the course are:

1. To learn various concepts related to welding, its application
2. To have practical purview of various welding process, welding standards, advanced welding process.

Course outcomes:

After successful completion of this course the student will be able to:

1. Discriminate the knowledge of principles, operations and applications of different welding Processes
2. Analyze the effects of process parameters on the quality of weld products
3. Able to understand the requirement of welding power sources.
4. Students will understand the theoretical aspects of welding technology in depth.
5. Able to understand the different advanced welding techniques.

COURSE CONTENT

ADVANCED WELDING PROCESSES		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Practicals	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**	**25 marks**

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. **MIG Welding – Effect of Welding Parameters on Bead Geometry**
   Objective: To study / perform the influence of welding parameters (voltage, current, and gas flow rate) on the weld bead geometry in MIG welding.
2. **Spot Welding – Study of Spot Weld Strength and Process Parameters**
   Objective: To Study / perform spot welding and analyze the effect of current, pressure, and time on the strength and quality of spot welds.
3. **Gas Welding – Study of Flame Characteristics and Weld Quality**
   Objective: To perform an experiment to study different types of flames (neutral, oxidizing, and carburizing) in oxy-acetylene welding and analyze their effect on weld quality.
4. **Welding Metallurgy:** Microstructure Analysis of Welded Joints
   Objective: To Study the microstructural changes in welded joints and understand the heat-affected zone (HAZ) characteristics.

5. **Comparison of AC and DC Welding Power Sources**
   Objective: To study the difference between AC and DC welding power sources and their effects on arc characteristics, penetration, and weld bead formation.
6. **Metal Transfer and Melting Rate Analysis in Welding**
   Objective: To Study / examine different types of metal transfer (globular, spray, short-circuit) and analyze the effect of polarity on melting rate using MIG welding.
7. **Friction Welding – Solid State Joining Process**
   Objective: To understand the principles and mechanism of solid-state welding by study / performing a friction welding experiment on dissimilar metals.
8. **Electron Beam and Laser Welding – Simulation & Theoretical Study**
   Objective: To study the working principle and applications of electron beam welding (EBW) and laser welding through software simulations and case studies.
9. **Underwater Welding – Process and Safety Considerations**
   Objective: To study and understand the challenges, techniques, and safety measures involved in underwater welding or practical demonstrations of simulated underwater welding.

Text Books:

1. Parmer R. S., 'Welding Engineering and Technology', Khanna Publishers, 1997
2. Welding technology, R.L. Little, TMH

Reference Books:

1. Dr.R.S.Parmar "Welding processes and technology" Khanna Publishers
2. Welding technology, R.L. Little, TMH
3. American society for metals, metal hand book vol.6
4. Welding process technology-Houldcraft PT-cambridge univ.press

NPTEL Links:

1. Introduction to OR by Prof. Kusum Deep, IIT, Roorkee
2. https://youtu.be/MrOwmSYqkiE?si=7NkUL4scAdw9q9mQ
3. Game Theory by Prof. Kusum Deep, IIT, Roorkee
   https://youtu.be/YdygmCARKpI?si=pBa1d1VjygrLts3r
4. Transportation Problem by Prof. Kusum Deep, IIT, Roorkee
5. https://youtu.be/RrS_j4nqX1s?si=8Ckh01ObE9lIWm9v

Guidelines for ICA:

Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on the completion date declared for each assignment.

ABILITY ENHANCEMENT COURSE					
COURSE OUTLINE					
Course Title:	**ABILITY ENHANCEMENT COURSE**	**Short Title:**	**AEC**	**Course Code:**	**CS - 409**

Course description:

The Course Provides students English proficiency across four key skills: **Listening, Reading, Writing, and Speaking**. It is used for study, work, and migration purposes in English-speaking countries.

Practical	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	02	**15**	**30**	**01**

Course Objectives:

The objectives of this course are:

1. Evaluate English proficiency for academic, professional, and migration purposes.
2. Provide an internationally recognized standard for English language assessment.
3. Develop language skills necessary for effective communication in diverse environments.
4. Prepare candidates for real-life language use in academic and work-related.
5. To equip students with **test-taking strategies** to maximize their scores.

Course Outcomes:

After successful completion of this course, the student will be able to:

1. Demonstrate a high level of English proficiency for academic, professional, or migration purposes.
2. **Develop leadership and teamwork** skills in collaborative environments.
3. Apply effective strategies for all Ability Enhancement modules.
4. Develop confidence in using English in real-life and test situations.
5. Achieve the required Ability Enhancement score for university admissions, work, or immigration.

COURSE CONTENT

ABILITY ENHANCEMENT COURSE		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Practical	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**	**25 Marks**

Concerned faculty member should suitably frame **FOUR** assignments in the form of interactive Practice Sessions based on the following modules.

Listening:

1. **Activity 1:** Podcasts, news, speeches, conversations, storytelling, News websites, BBC CNN, NBC
2. **Practice 1:** Practice with audio materials (podcasts, TED Talks, movies)
3. **Practice 2:** Cornell Method, Mind Mapping, Key Points and Summarization
4. **Practice 3:** Listening tests and quizzes, Practical exercises

Reading:

1. **Activity 3:** Fiction, short stories, novels: News articles, essays, reports, Research papers, textbooks, Blogs, social media posts, online articles
2. **Practice 1:** Self-assessment and comprehension quizzes
3. **Practice 2:** Note-taking strategies for effective retention
4. **Practice 3:** Understanding idioms and figurative language
5. **Practice 4:** Context clues and word recognition

Writing:

1. **Activity 4:** Write a daily journal, Letters to an English speaker, Make lists of the things you see every day, Write descriptions of your family and friends.
2. **Practice 1:** Common writing mistakes and how to fix them.
3. **Practice 2:** Unity in writing (sticking to one main idea)
4. **Practice 3:** Poetry, short stories, scripts
5. **Practice 4:** Storytelling techniques, point of view, dialogue

Text Books:

1. Barron's, IELTS Practice Exam, New Age International Private Limited, 2nd Edition.

Reference Books:

1. IELTS 19 Academic, Authentic Practice Tests, Cambridge University Press,2024
2. Pauline Cullen, IELTS Academic and General Training, Cambridge University Press,2014

NPTEL Links:

1. Skills by Prof. Binod Mishra, IIT Roorkee, https://nptel.ac.in/courses/109107121
2. Skills Development by Prof. P. Patnaik, Prof. V.N. Giri, Prof. D. Suar, IIT Kharagpur, https://nptel.ac.in/courses/109105110

Links: (for online practice)

1. A noticeboard message | Learn English (britishcouncil.org)
2. Free IELTS on Computer familiarisation test (ieltsidpindia.com)

Guide lines for ICA:

Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on the completion date declared for each assignment.

OPERATION RESEARCH (HSSM)				
COURSE OUT LINE				
Course Title:	**OPERATION RESEARCH**	**Short Title: OR**	**Course Code:**	**ME-410**

Course description:

Operations research helps in solving problems in different environments that needs decisions. The module cover topics that include: linear programming, Transportation, Assignment techniques. Analytic techniques and computer packages will be used to solve problems facing business managers in decision environments.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	02	15	30	02

Prerequisite course(s):

Mathematics

Course objectives:

The objectives of this course are:

1. Introducing students to quantitative methods and techniques for effective decision-making in business.
2. Developing skills in model formulation and problem-solving for real-world business applications.
3. Applying quantitative analysis to optimize business decisions and improve operational efficiency.

Course outcomes:

After successful completion of this course the student will be able to:

1. Be able to design new simple models to improve decision –making and develop critical thinking.
2. Be able to build and solve Linear Programming method.
3. Be able to build and solve Transportation Models and Assignment Models.
4. Be able to understand the characteristics of different types of decision-making environments and the appropriate decision-making approaches and tools to be used in each type.
5. Be able to build and solve Replacement & Sequencing problems

COURSE CONTENT

OPERATION RESEARCH		**Semester:**	**IV**
Teaching Scheme:			
Lectures:	**2 hours/week**		

Unit–I:	**No. of Lectures: 06 Hours**

Introduction, Definition, Features, of OR, models and modeling in OR, OR approach to problem solving.

Linear Programming- Introduction, general Structure of LP model, steps of LP Model formulation, Graphical solution methods of LP problem. Solving LP Assignment Problems using Software.

Unit–II:	**No. of Lectures: 06 Hours**

Linear programming – The simplex method Introduction, standard form of an LP problem, simplex algorithm (maximization, minimization case)

Duality in Linear programming, formulation of dual LPP, Basics of LPP, Introduction of sensitivity Analysis in LP. Solving LP Assignment Problems using Software.

Unit–III:	**No. of Lectures: 06 Hours**

Transportation problem introduction, Initial Solution Methods (Northwest Corner, Least Cost,

Vogel's Approximation), MODI Method.
Assignment problem- introduction, Hungarian method of optimal solution, travelling salesman problem. Solving Transportation Assignment using Software.

Unit–IV:	**No. of Lectures: 06 Hours**

Decision Theory- Introduction, steps in decision making process types of decision-making Environments, Decision tree.
Theory of games- introduction, Two-person Zero sum game, pure strategies, Maximin & Minimax Principles, Saddle Point, and Dominance Rule (Only for 2x2 & 2x3 Games). Solving Game theory Problems using Software.

Unit–V:	**No. of Lectures: 06 Hours**

Replacement Problems: Gradual vs. Sudden Failures, Simple models for machines and equipment, Individual vs. Group Replacement Policy.
Sequencing Problems : Basic terminology and assumptions, Solving n jobs on 2 machines using Johnson's Rule.

Text Books:

1. S.D. Sharma, "Operation Research", Khanna Publication
2. Manohar Mahajan, "Operation Research.
3. J. K. Sharma," Operation Research, Problem and Solution", Macmillan

Reference Books:

1. Hira, Gupta," Operation Research
2. Taha," Operation Research"
3. N. D. Vohra," Quantitative Techniques in Management", TATA McGraw Hill
4. Ravindran," Operation Research Principles and Practice", Wiley India Pvt. Ltd. New Delhi.

NPTEL Links:

1. Introduction to OR by Prof. Kusum Deep, IIT, Roorkee
2. https://youtu.be/MrOwmSYqkiE?si=7NkUL4scAdw9q9mQ
3. Game Theory by Prof. Kusum Deep, IIT, Roorkee https://youtu.be/YdygmCARKpI?si=pBa1d1VjygrLts3r
4. Transportation Problem by Prof. Kusum Deep, IIT, Roorkee
5. https://youtu.be/RrS_j4nqX1s?si=8Ckh01ObE9lIWm9v

Guide lines for ICA:

Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on the completion date declared for each assignment.

ENVIRONMENTAL SCIENCES					
COURSE OUTLINE					
Course Title:	**ENVIRONMENTAL SCIENCES**	**Short Title:**	**EVS**	**Course Code:**	**ME - 411**

Course description:
The course aims to percolate the importance of environmental science and environmental studies.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	02	15	30	02

Prerequisite course(s):

Course objectives:

The objective of this course is to impart knowledge so that the student will:

1. Integrate the knowledge on human interactions with the environment and problems associated with it
2. Analyze the importance of renewable and non-renewable natural resources
3. Learn the fundamentals of ecosystem
4. Learn and conserve the biodiversity and its conservation
5. Analyze the relation between social issues and the environment

Course outcomes:

After successful completion of this course the student will be able to:

1. Evaluate the effectiveness of various environmental policies and practice them as life-long learning
2. Develop the strategies for effective waste management and resource conservation
3. Articulate the interconnected, and interdisciplinary nature of environmental studies
4. Evaluate the local and global scale of environmental problems
5. Communicate complex environmental information to both technical and non-technical audiences.

COURSE CONTENT

ENVIRONMENTAL SCIENCES		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**End Semester Examination (ESE) UA:**	**25 marks**

Unit I	**No. of Lectures: 08 Hours**	**5 Marks**

Multidisciplinary Nature of Environmental Studies and Social Issues

Definition, scope and importance multidisciplinary nature of environmental studies and need for public awareness, From Un sustainable to Sustainable development, Water conservation, rain water harvesting, water shed management, Resettlement and rehabilitation of people; its problems and concerns. Case Studies, Environmental ethics: Issues and possible solutions.
Climate change, global warming, acid rain, ozone layer depletion, nuclear
Accidents and holocaust. Case Studies. Waste land reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act Wild life Protection Act Forest Conservation Act Issues involved in enforcement of environmental legislation. Public awareness.

Unit II	**No. of Lectures: 05 Hours**	**5 Marks**

Natural Resources

Renewable and non-renewable resources

Natural resources and associated problems.
Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction,

mining, dams and their effects on forest and tribal people

Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.

Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Role of an individual in conservation of natural resources.

Equitable use of resources for sustainable lifestyles

Unit III	**No. of Lectures: 08 Hours**	**5 Marks**

Ecosystems, Biodiversity and their Conservations

Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the ecosystem like Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries), Introduction–Definition: genetic, species and ecosystem diversity, Bio geographic classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-sports of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity

Unit IV	**No. of Lectures: 05 Hours**	**5 Marks**

Environmental Pollution

Definition, Cause, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.

Unit V	**No. of Lectures: 04 Hours**	**5 Marks**

Human, Population and the Environment

Population growth, variation among nations. Population explosion–Family Welfare Program, Environment and human health, Human Rights, Value Education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environment and human health, Case Studies.

Reference Books:

1. Agarwal, K. C.2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd. Ahmedabad – 380 013, India, Email: mapin@icenet.net (R)
3. BrunnerR.C.,1989, Hazardous Waste Incineration, McGrawHillInc.480p
4. Clark R. S., Marine Pollution, Clanderson Press Oxford (TB)
5. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
6. De A. K. Environmental Chemistry, Wiley Eastern Ltd.
7. Down to Earth, Centre for Science and Environment (R)
8. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev. Environment & Security. Stockholm Env. Institute Oxford Univ. Press. 473p

9. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
10. Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p.
11. Jadhav, H & Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284 p.
12. Mckinney, M. L. & School, R. M.1996.EnvironmentalSciencesystems&Solutions, Web Enhanced edition.639p.
13. Mhaskar A. K. Matter Hazardous, Techno-Science Publication (TB)
14. Miller T. G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
15. Odum, E. P.1971. Fundamentals of Ecology.W.B.SaundersCo.USA,574p
16. Rao M N. &Datta, A.K. 1987. Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd. 345p.
17. SharmaB.K.,2 001.Environmental Chemistry. Geol Publ. House, Meerut
18. Survey of the Environment, The Hindu (M)
19. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (TB)

Kavayitri Bahinabai Chaudhari NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Second Year Bachelor of Engineering

in

(Common for all)

(As per NEP 2020 Guidelines)

Faculty of Science and Technology



COURSE OUTLINE FOR OPEN ELECTIVE - II

For Affiliated Colleges

Semester – IV

W.E.F. 2025 – 26

Open Elective - II

A Student can opt for any one subject out of available institute wide subjects defined in the following list as Open Elective provided, he/she has not taken that particular subject in his/her Programme core, Programme elective, Multidisciplinary Minor, other Open elective and Vocational and Skill Enhancement courses etc. throughout his / her four years of UG Engineering Programme. The student must opt a subject that is compulsorily from faculty other than that of the Major discipline.

Course Code	Name of the Subject / Course	Faculty Offered by	Department Offered by
Open Elective - II (w.e.f. 2025 - 26 at Semester - IV, Second Year Engineering)			
OE – 407 A	Human Resource Management	Comm. & Mgmt.	Management
OE – 407 B	Logical Reasoning and Problem Solving	Sci. & Tech.	Mathematics
OE – 407 C	Retail Management	Comm. & Mgmt.	Commerce
OE – 407 D	Public Health and Hygiene	Sci. & Tech.	Zoology
OE – 407 E	Agricultural Pest Management	Sci. & Tech.	Zoology
OE – 407 F	Basics of Stock Markets	Comm. & Mgmt.	Commerce
OE – 407 G	Problems of Philosophy	Humanities	Philosophy
OE – 407 H	Social and Preventive Pharmacy	Sci. & Tech.	Pharmacy

HUMAN RESOURCE MANAGEMENT (Open Elective – II)				
COURSE OUTLINE				
Course Title:	**HUMAN RESOURCE MANAGEMENT**	**Short Title: HRM**	**Course Code:**	**OE – 407 A**

Course description:

This course provides a comprehensive understanding of Human Resource Management (HRM), including key functions such as talent acquisition, performance management, training and development, and compensation management. It also covers emerging trends like AI in HR, digital HR, people analytics and sustainable HRM practices.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	03	15	45	03

Prerequisite course(s):

Course objectives:

The objective of this course is to impart knowledge so that the student will:

1. To understand the fundamental principles and functions of HRM.
2. To analyse workforce planning, recruitment, selection, and retention strategies.
3. To evaluate performance management systems, appraisal techniques, and key HR metrics.
4. To assess training and development programs to enhance employee skills and productivity.
5. To explore digital HR, work-life balance, compensation strategies, and sustainable HRM practices.

Course outcomes:

After successful completion of this course the student will be able to:

1. Explain HRM concepts and their significance in business operations.
2. Apply talent acquisition and retention strategies in an organizational context.
3. Implement performance appraisal and feedback systems effectively.
4. Develop employee training and development programs for career growth.
5. Utilize modern HR tools and technologies to enhance organizational efficiency.

COURSE CONTENT

HUMAN RESOURCE MANAGEMENT		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Lectures:	**4 hours/week**	**End semester exam (ESE) UA:**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE) CA:	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Basics of Human Resource Management

Introduction to HRM: Meaning, Definitions, Nature and Objectives,
Functions of HRM: Managerial and Operative Functions
Differences between HRM, Personnel Management, and HRD
Role of HR Managers: Skills, Qualities, and Future Challenges
Emerging Trends: AI in HR, Digital HR, and People Analytics

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Talent Acquisition and Management

Human Resource Planning (HRP): Concept, Need, Characteristics, Benefits, Process.
Recruitment: Concept, Purpose, Sources, and Process
Selection: Concept, Process, Selection Tests, and Barriers
Placement: Concept and Problems

Induction/Orientation: Concept, Objectives, Steps, Problems
Promotion, Demotion, Transfer, Layoff, Downsizing, Rightsizing, and
Voluntary Retirement Scheme (VRS)

Unit–III:	No. of Lectures: 09 Hours	Marks: 12

Performance Management and Appraisal

Performance Management: Concept, Objectives, and Modern Approaches
Performance Appraisal: Concept, Need, and Importance
Performance Appraisal: Traditional Methods and Modern Methods
Key Performance Indicators (KPIs) and Balanced Scorecard Approach
Bias in Performance Appraisal: Types and Ways to Mitigate
Legal and Ethical Issues in Performance Appraisal

Unit–IV:	No. of Lectures: 09 Hours	Marks: 12

Training and Development

Definitions, Need, and Objectives of Training & Development
Concept and Importance of Executive Development
Training Methods: On-the-Job and Off-the-Job Methods, Virtual Learning and
E-Learning Platforms
Evaluating Training Effectiveness: Tools and Models
Difference between Training, Development, and Education
Career Development and Succession Planning

Unit–V:	No. of Lectures: 09 Hours	Marks: 12

Advanced HRM Practices

HRM in the Digital Age: HRIS (Human Resource Information System) and Digital Transformation
Work-Life Balance: Flexible Work Models, Hybrid Work, and Employee Wellbeing
Compensation Management: Wage and Salary Administration, Incentives, and Benefits
Sustainable HRM: Green HRM, Corporate Social Responsibility (CSR) in HR, and Ethical HRM

Text Books:

1. "Human Resource Management: Text and Cases" by Dr. V.S.P. Rao (Excel Books)

Reference Books:

1. Human Resource Management By Dr. Shikha Kapoor - Taxmann
2. Human Resource Management By Dr K. Ashwathappa – Tata McGraw Hill
3. Essentials of Human Resource Management By P. SubbaRao – Himalaya Publishing House
4. HR From the Outside In: Six Competencies for the Future of Human Resources –
5. Boudreau & Cascio - McGraw-Hill Education- ISBN: 978-0071790351

NPTEL Links:

1. Principles of HRM by Prof. Aradhna Malik
   https://archive.nptel.ac.in/courses/110/105/110105069/
2. Talent Acquisition and Management by Prof. Santosh Rangnekar
   http://kcl.digimat.in/nptel/courses/video/110107152/L19.html
3. Performance & Reward Management by Prof Susmita Mukhopadhyay
   https://archive.nptel.ac.in/courses/110/105/110105137/
4. Training and Development by Prof. Susmita Mukhopadhyay and Prof. S. Srinivasan
   https://onlinecourses.nptel.ac.in/noc22_hs63/preview

LOGICAL REASONING AND PROBLEM SOLVING (Open Elective – II)

COURSE OUTLINE

Course Title:	**LOGICAL REASONING AND PROBLEM SOLVING**	**Short Title: LRPS**	**Course Code:**	**OE – 407 B**

Course description:

The Logical Reasoning course is designed to enhance a student's ability to think critically and make reasoned judgments through structured and logical thought processes. This course focuses on developing key skills required to analyze patterns, relationships, and arguments, which are essential for solving complex problems. Throughout the course, students will be exposed to various types of logical reasoning problems, including deductive and inductive reasoning, analogies, sequences, and puzzles.

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	03	**15**	**45**	**03**

Prerequisite course(s):

Course objectives:

1. Course will provide an introduction to logical and philosophical reasoning.
2. To enhance the analytical skill and problem solving skill of the students.
3. To improve verbal and non-verbal reasoning ability skill of the students

Course outcomes:

After successful completion of this course the student will be able to:

1. Choose analogy and classification, and perform coding and decoding on data
2. Evaluate arguments, identify assumptions, and recognize logical fallacies, strengthening their ability to think critically and make informed decisions.
3. Recognize logical reasoning applicable to real-life situations and solve real-life problems
4. Apply critical thinking in analyzing number patterns, ranks, and time sequences, fostering decision-making skills that are crucial for problem-solving.
5. Develop the ability to identify and interpret visual patterns and sequences.

COURSE CONTENT

LOGICAL REASONING AND PROBLEM SOLVING		**Semester:**	**IV**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE) UA:**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE) CA:	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Analogy : Completing the analogous pair, Direct/ Simple Analogy, Choosing the analogous pair, Double Analogy Choosing a similar word, Detecting Analogies, Multiple word analogy, Number analogy, Alphabet Analogy

Classification : Choosing the odd word, Choosing the odd pair of word, Choosing the odd numeral, Choosing the odd numeral pair/ group

Coding and Decoding : Letter coding, Direst letter coding, Number/ Symbol Coding, Matrix Coding , Substitution, Deciphering message word codes, Deciphering number and symbol codes for messages.

Blood relations: Deciphering jumbled up descriptions, Relation puzzle, Coded relations		
Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**
Direction sense Test : Directions and Cardinal Directions , Direction puzzle **Logical Sequence of words :** Sequence in process , Sequence in object formation **Data Sufficiency** : Yes/No Questions, Value Questions **Verification of Truth of the Statement:** Relationship with the thing mentioned. **Sequential Output Tracing**		
Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**
Logic : Logical Reasoning, Logical Deduction , Two- Premise Arguments, Three-Premise Arguments **Statement – Arguments :** Strong arguments and weak Arguments **Statement –assumption :** Type 1- implicit statement, Type2-Implicit in Context **Statement –Conclusions :** Direct / indirect implications of conclusions **Cause and Effect Reasoning**		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Logical Venn Diagrams: Type 1, Type 2 **Number, Ranking and Time Sequence Test:** Type 1: Number Test, Type 2: Ranking Test, Type 3: Time Sequence Test **Mathematical Operations** Type 1: Problem-Solving by Substitution, Type 2: Interchange of Signs and Numbers, Type 3: Deriving the Appropriate Conclusions **Arithmetical Reasoning:** Type 1: Calculation-Based Problems, Type 2: Data-Based Questions, Type 3: Problems on Ages, Type 4: Venn-Diagram Based Questions		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
NON-VERBAL REASONING: **Classification:** Choosing the Odd Figure, Choosing a Similar Figure, Finding Figures with the Same Characteristics, **Analytical Reasoning** **Mirror-Images** : Mirror-Images of Capital letters, Small letters, Numbers and figures **Water-Images :** Water-Images of Capital letters, Small letters, Numbers and figures **Cubes and Dice :** 2D and 3D cubes, Number opened dice and Letter opened dice		
Text Books:		
1. Dr. R.S. Aggarwal "A Modern Approach to Verbal & Non-Verbal Reasoning" by S. Chand Publication.		

RETAIL MANAGEMENT (Open Elective – II)				
COURSE OUTLINE				
Course Title:	**RETAIL MANAGEMENT**	**Short Title: RM**	**Course Code:**	**OE – 407 C**

Course description:

This course provides an in-depth understanding of retail management, covering key concepts such as retail formats, consumer behavior, supply chain management, and e-retailing. It explores the role of technology in retail, sustainable business practices, and emerging retail trends. The course equips students with the knowledge and skills required to manage retail operations efficiently and explore entrepreneurial opportunities in the retail sector.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	**03**	**15**	**45**	**03**

Prerequisite course(s):

Course objectives:

The objective of this course is to:

6. Understand the fundamentals of retailing, consumer behavior, and key retail formats.
7. Analyze retail operations, supply chain management, and technology integration in retail.
8. Apply e-retailing strategies and digital innovations to enhance customer experience.
9. Evaluate sustainable and ethical retail practices and their impact on business.
10. Develop entrepreneurial skills by exploring emerging trends and business opportunities in retail.

Course outcomes:

After successful completion of this course the student will be able to:

1. Explain the core concepts, significance, and evolution of retailing.
2. Analyze retail supply chain, store operations, and digital retail transformations.
3. Apply technology-driven solutions like AI, IOT, and block chain in retail management.
4. Evaluate sustainable retail models and ethical business practices.
5. Develop innovative retail business strategies and entrepreneurial ventures.

COURSE CONTENT

RETAIL MANAGEMENT		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE) UA:**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE) CA:	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Fundamentals of Retailing

Retailing: Definition, significance, and evolution
Retail formats, business models, and ownership structures
Consumer behavior and purchase decision-making
Key drivers of retail growth in India and globally

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Retail Organization and Supply Chain Management

Store location, layout, and visual merchandising

Inventory control, logistics, and warehouse management POS systems, cash handling, Role of automation in retail operations		
Unit-III	**No. of Lectures: 09 Hours**	**Marks: 12**
E-Retailing and Digital Transformation		
Growth of e-commerce and omnichannel retailing AI, IoT, and blockchain applications in retail Customer data management and personalized marketing strategies Role of AR/VR in enhancing customer experience Cybersecurity and data privacy in online retailing		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Sustainable and Ethical Retailing		
Sustainability and green retailing practices Ethical sourcing and fair trade in retail Waste management and circular economy in retail Impact of government policies and regulations on retailing		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Future Trends and Entrepreneurship in Retail		
Retail analytics and business intelligence for decision-making Startups and innovation in retail entrepreneurship Franchising and global retail expansion Emerging trends: Quick commerce, Direct-to-Consumer (DTC) models Case studies on innovative retail success stories		
Text Books:		
1. "Retailing Management – Text and Case" (7th Edition) by Swapna Pradhan, Tata McGraw Hill		
Reference Books:		
1. Suja Nair, Retail Management, 2011 Edition, Generic, 2015. 2. R. S. Tiwari, Retail Management, Himalaya Publishing House. 3. Francois Chaubard, AI for Retail: A Practical Guide to Modernize Your Retail Business with AI and Automation, Wiley, 2023 4. Michael Levy, Barton A. Weitz and, Dhruv Grewal Professor Retailing Management, McGraw Hill; 10th edition (4 January 2018) 5. Gibson G. Vedamani, "Retail Management- Functional Principles and Practices", Jaico Publishing House, Mumbai.		
NPTEL Links: 1. Retail Management by By Prof. Swagato Chatterjee, IIT Kharagpur. https://onlinecourses.nptel.ac.in/noc25_mg56/preview		

PUBLIC HEALTH AND HYGIENE (Open Elective – II)				
COURSE OUTLINE				
Course Title:	**PUBLIC HEALTH AND HYGIENE**	**Short Title: PHH**	**Course Code:**	**OE – 407 D**

Course description:

This course provides a comprehensive understanding of public health and hygiene practices, exploring their significance in preventing disease, promoting well-being, and improving the quality of life for individuals and communities. Students will learn about the principles and strategies involved in maintaining public health, the role of hygiene in disease prevention, and the impact of environmental and behavioral factors on health.

	Hours/week	No. of weeks	Total hours	Semester credits
Lecture	**03**	**15**	**45**	**03**

Prerequisite course(s):

Course objectives:

1. Gain knowledge of common food-borne and water-borne diseases (causes, symptoms, transmission), and apply strategies for prevention and control.
2. To impart basic and technical knowledge on nursery management for strengthening of horticulture sector.
3. To study the disease and pest controlling nursery with practical experience.

Course outcomes:

1. Demonstrate the ability to design balanced meal plans considering calorie needs and dietary requirements for different individuals and life stages.
2. Effectively communicate the causes, symptoms, and prevention strategies for common food-borne and water-borne diseases.
3. Competently demonstrate essential personal hygiene practices and advocate for social hygiene initiatives in the community.
4. Articulate the negative health consequences of unhealthy habits and positively promote physical activities like cycling and walking, stress management techniques (yoga), and responsible family planning methods.
5. Develop an understanding of nutrition principles, balanced diets, and dietary needs for different life stages (infants, children, adults, pregnancy, lactation), promoting healthy eating practices for disease prevention.

COURSE CONTENT

PUBLIC HEALTH AND HYGIENE		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE) UA:**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE) CA:	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Nutrition and health:

Introduction: Scope and importance of Public health and hygiene. Balanced diet, diet control for diabetics and cholesterol, etc. Concept of energy, calories, daily food intake as per occupation, pregnancy and lactation. Dietary requirements of infants, pre-school children, schoolchildren, adults.

Unit–II:	No. of Lectures: 09 Hours	Marks: 12
Health Hazards:		
Health dynamicity – definition, factors influencing health, health as a medium of socio-economic development. Diseases – Common food borne and water borne diseases (jaundice, cholera, diarrhea and typhoid) – causative agents, symptoms, mode of transmission, prevention and control.		
Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**
Health hygiene:		
Personal hygiene, body odour, oral hygiene and sexual hygiene, grooming, feminine hygiene, sleep hygiene, hand washing, toiletry. Social hygiene – clean living movements, occupational hygiene, food and cooking hygiene, medical hygiene, excessive hygiene.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Health Education:		
Definition, objectives, principles ,effects of smoking, alcoholism and drug abuse (hashish, opium, brown sugar).Population control and family welfare- use of contraceptives Importance of Body fitness Importance of cycling and walking exercise. Stress reduction management – Importance of yoga Sickle Cell Disorder.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Healthy Lifestyle:		
Lifestyle habits ,Balanced Diet , Stress Management**,** Benefits of a Healthy Lifestyle, Excessive usage of T.V., computer, mobile phones, two wheelers, and their impacts on health.		
Text Books:		
1. "Essentials of Public Health and Sanitation – Part I- IV" by Jatin V. Modi and Renjith S. Chawan.		
Reference Books:		
1. Murray, C. J. L. and A.D. Lopez. (1996), The Global Burden Of Disease. World Health Organization. 2. Park, J.E. and Park, K. Textbook of Community Health for Nurses. 3. Swaminathan S. Principles of Nutrition and Dietetics.		
NPTEL Links: 1. **One Health-**By One Health Instructors ICMR - Regional Medical Research Centre, Bhubanesw (One Health - Course (nptel.ac.in) 2. **Basics of Health Promotion and Education Intervention** By Dr. Arista Lahiri, Dr. Sweety Suman Jha, Dr. Madhumita Dobe, Dr. Chandrashekhar Taklikar | IIT Kharagpur, IIT Kharagpur, AIIH&PH, Kolkata, AIIH&PH, Kolkata (Basics of Health Promotion and Education Intervention - Course (nptel.ac.in))		

AGRICULTURAL PEST MANAGEMENT (Open Elective – II)				
COURSE OUTLINE				
Course Title:	**AGRICULTURAL PEST MANAGEMENT**	**Short Title: APM**	**Course Code:**	**OE – 407 E**

Course description:

This course provides a comprehensive understanding of the tactics and practices of managing pests in agricultural systems. It covers the identification, biology, and ecology of common agricultural pests. Students will learn integrated pest management (IPM) strategies that combine biological, cultural, physical, and chemical control methods to minimize pest damage while promoting environmental sustainability and economic viability**.**

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	**03**	**15**	**45**	**03**

Prerequisite course(s):

Biology, Environmental Science

Course objectives:

The objective of this course is to:
1. To understand agricultural pest management.
2. To learn economic impacts of integrated pest management and decision making.
3. To improve the biological precepts and sampling for detection convey.
4. To learn management of insect pests of cotton and rice.
5. To understand management of insect pests of vegetable crops and oilseeds.

Course outcomes:

After successful completion of this course the student will be able to:
1. Apply the concept of agricultural pest management.
2. Co-relate the economic impacts of integrated pest management and decision making.
3. Acquire skill of the biological precepts and sampling for detection.
4. Illustrate the management of insect pests of Cotton and rice.
5. Demonstrate and analyse the management of insect pests of vegetable crops and oilseeds.

COURSE CONTENT

AGRICULTURAL PEST MANAGEMENT		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE) UA:**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE) CA:	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

The IPM paradigm: concepts, strategies and tactics and Economic impacts of IPM

Historical perspectives, Early conceptual efforts in Integrated Pest Management (IPM} development, Kinds of pests, Pest management strategies and tactics, Funding IPM research and implementation, Measuring IPM implementation. Economic impacts of IPM: Measuring IPM adoption, Individual economic impacts to the IPM user, Analyzing typical adoption cases using budgets, Analyzing optimal IPM decisions, Aggregate or market-level economic impacts of IPM, 1 Capturing price effects when IPM impacts are large, Aggregating economic impacts over time, Valuing health and environmental impacts.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Economic decision rules for IPM and Decision making and economic risk in IPM

Economic decision rules for IPM: Economic decision levels, The EIL, The ET, Development of EILs and ETs, Current approaches, Limitations to EILs and ETs. Decision making and economic risk in IPM: Defining IPM within a management context, Economic injury level (EIL) and economic threshold (ET), Risk and IPM, Representing risky situations, Decision making criteria and tools, Risk preferences defined.

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

IPM as applied ecology-the biological precepts and Sampling for detection, estimation and IPM decision making

IPM as applied ecology-the biological precepts: Life systems, Pest population dynamics, Stochastic models and meta populations, Population structure and life tables, Population stability and species diversity, Open and closed ecosystems, Scale and ecologically based pest management Sampling for detection, estimation and IPM decision making: Basics of sampling, Necessary sample size, Detection sampling, Estimation sampling, Decision sampling.

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Management of Insect Pest of Cotton and Rice

Management of Insect Pests of Cotton: Introduction Changing Insect Pest Scenario, Cultural, Mechanical, and Physical Control, Microbial Control, Biological Control, Botanical Control, Chemical Control, Integrated Pest Management. Management of Insect Pests of Rice: Introduction, Component of Integrated Pest Management, Cultural Methods, Biological Control, Behavior modifying chemicals, Botanical Bio pesticides.

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**

Management of Insect Pests of Vegetable Crops and Oilseeds

Management of Insect Pests of Vegetable Crops in Net House: Introduction, Physical Control, Cultural Control, Mechanical Control, Biological Control, Botanical Control. Management of Insect Pests of Oilseeds Crops: Rapeseed-Mustard, Sunflower, Groundnut, Sesamum, Linseed.

Textbooks:

1. "Integrated Pest Management, Concepts, Tactics, Strategies and Case Studies" by Edward B. Radcliffe, William D. Hutchison, Rafael E. Cancelado, Cambridge Publishing.
2. “Theory and Practice of Integrated Pest Management” by Ramesh Arora, Balwinder Singh, A.K. Dhawan, Scientific Publisher.

Reference Books:

1. “Integrated Pest Management for Crops and Pastures” by Paul Horne, Jessica Page, Land Links Publishing
2. “Encyclopedia of Pest Management” Volume II, by Devid Pimentel, CRC Press Taylor and Francis Group Publishing.

NPTEL Links:

1. Integrated Pest Management (IPM) by IIT Kanpur.
   https://archive.nptel.ac.in/courses/126/104/126104003/

BASICS OF STOCK MARKETS (Open Elective – II)				
COURSE OUTLINE				
Course Title:	**BASICS OF STOCK MARKETS**	**Short Title: BSM**	**Course Code:**	**OE – 407 F**

Course description:

This course introduces students to the fundamental concepts of stock markets, investment avenues, and trading mechanisms. It covers the structure and functioning of Indian financial markets, types of securities, stock trading strategies, mutual funds, and regulatory frameworks. The course also emphasizes investor protection measures, risk management, and financial literacy to enable informed decision-making in stock market investments.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	**03**	**15**	**45**	**03**

Prerequisite course(s):

Course objectives:

The objective of this course is to:

1. Remember and define the fundamental concepts of stock markets and various investment instruments.
2. Understand the structure, organization, and functioning of financial markets in India.
3. Apply knowledge of primary and secondary market operations, trading mechanisms, and investment avenues.
4. Analyze stock trading strategies, risk-return factors, and investor protection measures.
5. Evaluate the role of regulatory bodies and ethical investment practices in the stock market.

Course outcomes:

1. After successful completion of this course the student will be able to:
2. Describe the functioning and significance of stock markets in the Indian financial system.
3. Classify different types of investment instruments and explain their characteristics.
4. Examine stock trading mechanisms, market indices, and risk-return factors.
5. Develop basic investment strategies and assess stock market operations.

COURSE CONTENT

BASICS OF STOCK MARKETS		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE) UA:**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE) CA:	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction

Saving vs Investment – Understanding the Need for Investment
Types of Investment Instruments – Equity Shares, Preference Shares, Bonds, Debentures, Government Securities, Sovereign Gold Bonds
Overview of Stock Exchanges – BSE, NSE & Their Indices
Difference Between Trading & Investment in Stock Market

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Types of Market and Derivatives

Types of Markets – Primary & Secondary Markets
Primary Market – IPO, Credit Rating Agencies, Underwriting, Grey Market
Secondary Market – Stock Brokers, Sub Brokers, Listing of Shares, Depositories
Basics of Derivatives – Futures, Options, Call & Put, Commodity & Financial Derivatives

Unit–III:	No. of Lectures: 09 Hours	Marks: 12

Mutual Funds and Investment Avenues

Concept and Advantages of Mutual Funds
Types of Mutual Funds – Equity, Debt, Liquid, Hybrid, Growth, Income, Tax-Saving, Pension Funds
Role of Asset Management Companies (AMCs) and Fund Managers
Factors to Consider Before Investing in Mutual Funds

Unit–IV:	No. of Lectures: 09 Hours	Marks: 12

Stock Trading and Investment Strategies

Basics of Stock Trading – How to Open a Demat & Trading Account
Stock Order Types – Market Order, Limit Order, Stop Loss, Intraday Trading
Understanding Stock Market Indices and Their Importance
Risk & Return Analysis – Concept of Diversification, Systematic vs. Unsystematic Risk

Unit–V:	No. of Lectures: 09 Hours	Marks: 12

Regulatory Framework & Investor Protection

Role of SEBI (Securities and Exchange Board of India) in Stock Market Regulation
Investor Protection Mechanisms – Grievance Redressal, Investor Rights & Duties
Common Stock Market Frauds & Scams – Insider Trading, Pump & Dump Schemes
Overview of Taxation on Stock Market Investments – Capital Gains Tax, Securities Transaction Tax

Text Books:

1. Prasanna Chandra, "Investment Analysis and Portfolio management", Tata McGraw Hill,3rd Edn., 2008
2. Julian Walmsley, "New Financial Instruments", John Wiley & Sons, 2nd edition, Inc 1998
3. PunithavathyPandian, Security Analysis and Portfolio Management, 2nd edition, Vikas Publishing House Pvt. Ltd., 2013
4. Dhanesh Khatri, Security Analysis and Portfolio Management, 1st edition, MacMillan Publishers, 2010

Reference Books:

1. Bharati V. Pathak, " The Indian Financial System: Markets, Institutions and Services", Pearson education, 3rd edn.
2. Bhole I. M.: "Financial Markets and Institutionals": Tata McGraw Hill, New Delhi.
3. Chandler M. V. and Goldfeld S. M: Economics of Money and Banking: Harper and Row, New York.
4. Edwin J. Elton, Martin J. Gruber, Modern Portfolio Theory and Investment Analysis, 8 th edition, John Wiley & Sons, 2010
5. SEBI Manual, 33rd edition, Taxmann Publications, 2019
6. Shashi K Gupta, Security Analysis Portfolio Management, 1st edition, Kalyani Publishers, 2010

NPTEL Links:

1. **Financial Institution and Market**
   https://archive.nptel.ac.in/courses/110/105/110105121/

PROBLEMS OF PHILOSOPHY (Open Elective – II)				
COURSE OUTLINE				
Course Title:	**PROBLEMS OF PHILOSOPHY**	**Short Title: POP**	**Course Code:**	**OE – 407 G**

Course description:

This course explores some of the central questions and issues in philosophy, designed to introduce students to fundamental philosophical problems and to develop their critical thinking skills. The course covers a broad range of topics, including metaphysics, epistemology, ethics, philosophy of mind, philosophy of language, and political philosophy. Students will examine classic and contemporary texts by influential philosophers, critically analyze their arguments, and engage with different philosophical traditions.

	Hours/week	No. of weeks	Total hours	Semester credits
Lecture	**03**	**15**	**45**	**03**

Prerequisite course(s):

Course objectives:

1. To provide knowledge of philosophical Theories
2. To create awareness about Indian and western Philosophy .
3. To understand Theory's Problem of Change, Problem of Self,Problem of Values
4. To understanding various Self of Philosophy
5. Help students understand key ethical dilemmas and encourage thinking about how philosophy informs moral decisions, ethical theory, and the application of ethical principles in real-world situations.

Course outcomes:

1. Students will understand knowledge of philosophical Theories
2. Students will understand about Problem of Change, Problem of Self.
3. Students will to understand Values
4. Students will to understand theory of causation
5. Developing the ability to critically analyze and evaluate philosophical arguments, identifying strengths and weaknesses in reasoning.

COURSE CONTENT

PROBLEMS OF PHILOSOPHY		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE) UA:**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE) CA:	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Nature of Philosophy:

Concept and definition of Philosophy according to Empiricism, Rationalism, Advait Vedanta, Buddhism. Scope of Philosophy in relation to Natural Sciences, Social Sciences, Political Science, Economics and Sociology, Religion.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Problem of Knowledge:

Western approach of Empiricism and Rationalism (Locke and Leinbnitz) , Indian approach of Empiricism and Rationalism (Charvaka and Nyaya) ,Sources of knowledge, Perception , Inference , Intuition , Testimony.

Unit–III	No. of Lectures: 09 Hours	Marks: 12

Problem of Change:

Concept of change and permanence , Theories of change and causation Satkaryavad (Samkhya) Arambhavada (Nyaya), Aristotle's four fold theory of causation, Hume's theory of causation, and Mill's concept of causation.

Unit–IV	No. of Lectures: 09 Hours	Marks: 12

Problem of Self

Nature of Self, Concept of self-according to Plato ,Descartes ,Samkhya ,Buddhism

Unit–V:	No. of Lectures: 09 Hours	Marks: 12

Problem of Values

Nature of values and their role in human life, Kinds of values ,Moral ,Aesthetic Problem of Truth, Correspondence Theory of Truth ,Coherence Theory of Truth ,Pragmatic Theory of Truth.

Text Books:

1. "The problems of philosophy" by Russell, B. (1959) New York, Oxford University Press.

Reference Books:

1. Moore G. E.-Some Main Problemsof Philosophy
2. Durant Will-The Pleasures of Philosophy
3. Hawking W. E- Types of Philosophy
4. Ewing A. C.-The Fundamental Questions of Philosophy
5. Ayer A. J.-The Central Questions of Philosophy

NPTEL Links:

1. **Philosophy and Critical Thinking-**By Prof. Gyan Prakash | Indian Institute of Technology (Indian School of Mines), Dhanbad, India
   Philosophy and Critical Thinking - Course (nptel.ac.in)
2. **Indian Philosophy-Prof. Satya Sundar Sethy** is a Professor in the Department of Humanities and Social Sciences, IIT Madras.
   Indian Philosophy - Course (nptel.ac.in)

SOCIAL & PREVENTIVE PHARMACY (Open Elective – II)				
COURSE OUTLINE				
Course Title:	**SOCIAL & PREVENTIVE PHARMACY**	**Short Title: SPP**	**Course Code:**	**OE – 407 H**

Course description:

This course is designed to impart basic knowledge on public health, epidemiology, preventive care and other social health related concepts. Also, to emphasize the roles of students in the public health programs.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	**03**	**15**	**45**	**03**

Prerequisite course(s):

Course objectives:

1. The objective of this course is to:
2. Preventive healthcare.
3. Public health and national health programs.
4. Food and nutrition related health issues.
5. Health education & social promotion of maintenance of health.

Course outcomes:

1. After successful completion of this course the student will be able to:
2. Describe various sources of health hazards and disease preventive measures.
3. Discuss the health care issues associated with food and nutritional substances.
4. Describe the general roles and responsibilities of students in public health.
5. Create awareness so that health status of society can be raised.

COURSE CONTENT

SOCIAL & PREVENTIVE PHARMACY		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE) UA:**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE) CA:	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to social Pharmacy

Definition & Scope: Social Pharmacy as a discipline & its scope in improving public health. Concept of health: WHO definition, various dimensions, determinants and health indicators. Public and private health system in India, national health mission.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Environment and Health

Water pollution, importance of safe drinking water, waterborne diseases, air pollution, noise pollution, sewage and solid waste disposal, occupational illness. Psychosocial Pharmacy: Drugs of misuse and abuse- psychotropic, narcotics, alcohol, tobacco products. Social impact of these habits on social health and productivity and suicidal behaviors.

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

First Aid

Need for emergency treatment, emergency treatment in shock, snake bite, burns, poisoning, fractures, resuscitation methods.

Unit–IV:	No. of Lectures: 09 Hours	Marks: 12
Nutrition and Health		
Basics of nutrition: Macronutrients and Micronutrients, Importance of water & fiber in diet, Balanced diet, Malnutrition, nutrition deficiency diseases, ill effects of junk foods, caloric & nutrients values of various foods, fortification of food, Introduction to food safety, adulteration of foods, effects of artificial ripening, use of pesticides, genetically modified foods, Dietary supplements, nutraceuticals, food supplements, indications, benefits, Drug –Food interactions.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Epidemiology		
Introduction to epidemiology, and its applications. Understanding the terms epidemic, pandemic, endemic, mode of transmission, outbreak, quarantine, isolation, incubation period, contact tracing, morbidity, mortality, Causative agents, mode of transmission and prevention of following communicable diseases, Respiratory infections- Mumps, Influenza(including Avian-Flu, H1N1, SARA,COVID-19), whooping cough, tuberculosis., Intestinal infections- Viral hepatitis, acute diarrheal disease, typhoid, food poisoning, Arthropod-borne disease- dengue, malaria, chikungunya, STDs, HIV/AIDS.		
Text Books:		
1. New approach to Social Pharmacy, S.P.S. Khurana Pee Vee publications. 2. A text book of Health Education & Community Pharmacy, Dr. Anees Siddique, Birla publications		
Reference Books: 1. Social Pharmacy: Tayler, Geoffrey. Pharmaceutical Press. London. 2. Social Pharmacy: Innovation and Development. Geoff Harding, Sarah Nettleton and Kevin Taylor. The Pharmaceutical Press. 3. Community Pharmacy Handbook- Jonathan Waterfield. 4. Essentials of Community Medicine- Apracical approach, Hiremath Lalita D, Hiremath Dhananjaya A 2nd Edition, 2012,ISBN: 9789350250440, JAYPEE Publications.		

EXIT COURSE

Internship / Apprenticeship:

Internship / Apprenticeship / OJT shall be corresponding to the programme (Major) subject. Internship / Apprenticeship / OJT shall be monitored jointly by faculty and Industry / organization mentor.

The role of a Mentor, nominated by institute, shall be to provide professional/research guidance to the student during the internship. They shall also facilitate networking with other subject matter experts/professionals, which will enhance the internship experience and learning of the students.

Internship / Apprenticeship / OJT corresponding to the programme (Major) subject in Exit course with an external organization / entity is desirable. External organization may be industries, research institutions, University research centers or CSIR laboratories. Internship / Apprenticeship / OJT shall be preferably in offline mode, however online mode may also be permitted.

Preferably the Mini Project in Exit course shall be based on Internship / Apprenticeship / OJT.

Activities under Internship / Apprenticeship / OJT include Project work, Seminar, Industrial Training (excluding credits for Advanced Courses). This can be Industrial / Govt. / NGO/MSME/ Rural Internship/ Innovation / Entrepreneurship / academic / industry research project.

After completion of Internship, students shall prepare a comprehensive report highlighting their learnings and takeaways during the internship period. The students are mandated to give a seminar based on the internship undertaken before an expert committee constituted by the concerned department and the assessment of internship shall be based on the following criteria:

1) Quality and effectiveness of presentation
2) Depth of knowledge and demonstrated skills
3) Variety and relevance of learning experience
4) Practical applications and relationships with concepts taught in the course
5) Internship Report
6) Attendance record, student diary (log), supervisor evaluation

Attendance record shall include daily attendance with IN and OUT time. It shall be signed by Industry supervisor.

Student Diary (log) shall include daily activities carried out by the student during Internship with Task assigned, Activities performed, key learnings etc. It shall be signed by Industry supervisor.

Supervisor evaluation form shall include the following with ratings in FIVE-point scale.

1) Behaviours
2) Performs in a dependable manner
3) Cooperates with co-workers and supervisors
4) Shows interest in work
5) Learns quickly
6) Shows initiative
7) Produces high quality work
8) Accepts responsibility
9) Accepts criticism
10) Demonstrates organizational skills
11) Uses technical knowledge and expertise
12) Shows good judgment
13) Demonstrates creativity/originality
14) Analyzes problems effectively
15) Is self-reliant
16) Communicates well
17) Writes effectively
18) Has a professional attitude
19) Gives a professional appearance
20) Is punctual
21) Uses time effectively

Supervisor evaluation form shall be signed by Industry supervisor.

Mini project:

The student shall carry out a Mini project based on the knowledge acquired during the degree course and/or Internship. The project may be either fully theoretical/practical or involving both theoretical and practical work to be assigned by the guide / mentor / department. The work may also be Study/Survey/Design or R&D work. The work may also be on specified task or project assigned to the students during Internship. The project may also be a sponsored project. The project shall be corresponding to the programme (Major) subject.

Upon completion of the Mini project, the student shall submit project report in the form of hard bound. Assessment for the Mini project shall also include presentation by the student. Assessment of Mini project shall be based on the following criteria:

1) Problem Identification / Project Objectives
2) Methodology / Design
3) Implementation
4) Results and Discussion
5) Conclusion
6) Report
7) Depth of Understanding

Kavayitri Bahinabai Chaudhari
NORTH MAHARASHTRA UNIVERSITY,
JALGAON (M.S.)

Bachelor of Engineering – Honors
in
Robotics
for Second Year Bachelor of Engineering
offered by
Mechanical
(As per NEP 2020 Guidelines)

Faculty of Science and Technology



SYLLABUS STRUCTURE & COURSE OUTLINE
For Affiliated Colleges
Semester – III & IV
W.E.F. 2025 – 26

Honors in Robotics

Syllabus Structure for Honors in Robotics: Additional Credit (Semester – III) (w.e.f. 2025 – 26)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ME -311A	Principles of Robotics	PCC	3			3	40	60			100	3
ME -312A	Principles of Robotics lab	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for Honors in Robotics: Additional Credit (Semester – IV) (w.e.f. 2025 – 26)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ME -414A	Mechanics of Robots	PCC	3			3	40	60			100	3
ME -415A	Mechanics of Robots lab	PCC			2	2			25	25 (OR)	50	1

PRINCIPLE OF ROBOTICS (PCC)				
COURSE OUT LINE				
Course Title:	**PRINCIPLE OF ROBOTICS**	**Short Title: POR**	**Course Code:**	**ME - 311A**

Course description:

This course covers the basics of robotics, focusing on how robots are built, controlled, and used in different industries. Students will learn about key parts of robots, like sensors, motors, and controllers, and how robots can do tasks on their own. Topics also include how robots move, plan their actions, and use smart technology like AI. This course helps students understand the technology behind robots and how they are used in the real world.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite course(s):

Basic Engineering, Introduction to Programming or Computer Science, Basic Math (Algebra and Calculus), Basic Physics (Understanding Motion)

Course objectives:

The objective of this course is to:
1. To enlighten the students about the fundamentals of robotic systems.
2. To impart knowledge about various drive systems and its selection for particular applications.
3. To impart knowledge about kinematic and dynamic analysis of robot manipulators.
4. To enlighten the students about the use of robot programming for various applications.
5. To familiarize the students in the various applications of robot.

Course Outcomes:

Upon completing the course, students will be able to:
1. Explain the fundamentals of robotic systems.
2. Describe about various drive systems and its selection for particular applications.
3. Explain about kinematic and dynamic analysis of robot manipulators.
4. Understand and explore the various end effectors, sensors and its applications for robot.
5. Understand the significance and use of robot programming & control for various applications.

COURSE CONTENT

Principle of Robotics		**Semester:**	**III**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE):	**40 marks**

Unit–I: Introduction	**No. of Lectures: 9Hours**	**Marks: 12**

Classification of robots, Basic components of robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom.
Mechanisms and transmission, End effectors, Grippers-different methods of gripping, Mechanical Grippers-Slider crank mechanism, Screw type, Rotary actuators, Cam type gripper, Magnetic grippers, Vacuum grippers, Air operated grippers; Specifications of robot.

Unit–II: Drive system	**No. of Lectures: 09 Hours**	**Marks: 12**

hydraulic, pneumatic and electric systems Sensors in robot – Touch sensors, Tactile sensor, Proximity and range sensors, Robotic vision sensor, Force sensor, Light sensors, Pressure

sensors.		
Unit–III: Kinematics & Dynamics of Robots	**No. of Lectures: 09 Hours**	**Marks: 12**
2D, 3D Transformation, Scaling, Rotation, Translation, Homogeneous coordinates, multiple transformation, Simple problems. Matrix representation, Forward and Reverse Kinematics of Three Degree of Freedom, Homogeneous Transformations, Inverse kinematics of Robot, Robot Arm dynamics, D-H representation of robots, Basics of Trajectory Planning.		
Unit–IV: End effectors, sensors and vision systems	**No. of Lectures: 09 Hours**	**Marks: 12**
End effectors Types of end effectors, mechanical grippers, vacuum, magnetic, adhesive grippers, tools as end effectors, Gripper selection and design, force analysis of gripper mechanism, Introduction to Sensors: Need of sensors in a robotic system, selection of sensors, classification of sensor, photo sensors, limit switches. Range sensors, force/ torque sensors, proximity sensors, touch sensors, tactile sensors. Vision Systems: concept of low level and high-level vision in a robotic system.		
Unit–V: Robot Control & Programming	**No. of Lectures: 09 Hours**	**Marks: 12**
Robot controls-Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT, Motion Interpolations, Adaptive control. Introduction to Robotic Programming, On-line and off-line programming, programming examples.		
Text Books:		
1. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics: Technology Programming and Applications, McGraw Hill, 2012.		
Reference Books:		
1. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic Engineering - 2. Groover Industrial Robotics , McGraw Hill Publication Co. Ltd 3. John J. Craig, “Introduction to Robotics Mechanics and Control” Pearson Education Inc., 4. M. P. Groover, Industrial Robotics - Technology, Programming and Application 5. Mark R. Miller, Robots and Robotics: Principles, Systems, and Industrial Applications, Mc Graw Hill.		
NPTEL Links:		
1. Introduction to Robots and Robotics by Prof. Dilipkumar Pratihar, IIT, Kharagpur https://www.youtube.com/watch?v=xrwz9IxpMJg&t=14s 2. Robots Kinematics by Prof. Dilipkumar Pratihar, IIT, Kharagpur https://www.youtube.com/watch?v=wcy0Y3Jgf14&t=1296s 3. Sensors by Prof. Dilipkumar Pratihar, IIT, Kharagpur https://www.youtube.com/watch?v=sCTgZv33tuA		

PRINCIPLE OF ROBOTICS LAB (PCC)					
LAB COURSE OUTLINE					
PRINCIPLE OF ROBOTICS LAB		**Semester:**	**III**	**Course Code:**	**ME - 312A**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**			**25 marks**
Semester Credits:	**1**	**End semester exam (ESE) (UA):**			**25 marks**
End Semester Exam (ESE) Pattern:		**Oral (OR)**			

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Determination of maximum and minimum position of links
2. Estimation of accuracy, repeatability and resolution
3. To study an introduction to Robot configuration.
4. Identify and selection of Sensors such as IR sensors, Proximity Sensor, Ultrasonic Sensor, White line sensor, Temperature Sensor, Touch sensor, Tilt Sensor, Accelerometer, etc. based on given application
5. Assemble different components used in line follower robot.
6. Design and selection of Gripper / End effector
7. To perform pick and place operation by using robotic arm.
8. Verification of transformation (Position and orientation) with respect to gripper and world Coordinate system.

Text Books

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2017.

Reference Books:

1. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic Engineering -
2. An Integrated Approach", Prentice Hall India, 2002
3. Groover Industrial Robotics , McGraw Hill Publication Co. Ltd
4. John J. Craig, “Introduction to Robotics Mechanics and Control” Pearson Education Inc.,
5. M. P. Groover, Industrial Robotics - Technology, Programming and Application
6. Niku, Introduction to Robotics: Analysis System and Application , Pearson Education

NPTEL Links:

1. Introduction to Robotics by Dr. T Asokan, IIT Madras https://www.youtube.com/watch?v=P_PP76flZfw&list=PLyqSpQzTE6M_XM9cvjLLO_Azt1FkgPhpH
2. Main Elements of Robot, IIS Bengaluru https://www.youtube.com/watch?v=TQwCbKwO-a0&list=PLgMDNELGJ1CZT9pdEEkDylXFPLdcqxn0t&index=3

Guide lines for ICA:

Students must submit ICA in the form of journal. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. Evaluation will be based on oral and performance in the ESE.

MECHANICS OF ROBOTS (PCC)				
COURSE OUT LINE				
Course Title:	**MECHANICS OF ROBOTS**	**Short Title: K&SM**	**Course Code:**	**ME-414 A**

Course description:

This course provides a comprehensive introduction to the fundamental concepts of mechanisms, machines, and robotics. It covers the principles of kinematic and dynamic analysis, spatial transformations, and trajectory planning for robotic manipulators. Students will gain a solid understanding of the theoretical foundations and practical applications of mechanical systems and robotics.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s):

Basic knowledge of **Engineering Mechanics** and **Mathematics.**

Course objectives:

The student will able to:

1. Understand the basic concepts of mechanisms, kinematic pairs, and degrees of freedom.
2. Analyze spatial descriptions and transformations in robotic systems.
3. Perform forward and inverse kinematic and velocity analyses.
4. Study the dynamics of manipulators using Lagrange-Euler and Newton-Euler formulations.
5. Plan trajectories for robotic systems in joint space and Cartesian space.

Course Outcomes:

After successful completion of this course the student will be able to:

1. Identify and analyze different types of mechanisms and kinematic chains.
2. Apply spatial transformations to describe positions, orientations, and frames in robotic systems.
3. Perform kinematic and dynamic analyses of robotic manipulators.
4. Develop dynamic models for robotic systems using Lagrange-Euler and Newton-Euler formulations.
5. Plan and optimize trajectories for robotic manipulators in various applications.

COURSE CONTENT

Mechanics of Robots		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE):	**40 marks**

Unit–I: Introduction to Mechanism and Machine	**No. of Lectures: 09 Hours**	**Marks: 12**

Links, Kinematic pairs, Degree of freedom, Kinematic Chain, Binary, Ternary, Quaternary Links and Joints, types of mechanism, Mechanical Manipulators, Open kinematic Chain, Inversions of slider crank mechanism.

Unit–II: Spatial descriptions and transformations	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction, Descriptions: Positions, orientation and frames; Mappings: Changing description from frame to frame; Operators: translations, rotations, and transformations; Interpretations, Transformation Arithmetic, Transform equations, representation of orientation, transformation of free vectors, computational considerations

Unit–III: Kinematics	**No. of Lectures: 09 Hours**	**Marks: 12**

Forward Position Analysis, Inverse Position Analysis, Velocity Analysis: The Jacobian Matrix, Link Velocities, Forward and Inverse Velocity Analyses, Acceleration Analysis		
Unit–IV: Manipulator Dynamics	**No. of Lectures: 09 Hours**	**Marks: 12**
Introduction, Lagrange's equation kinetic and potential energy. Link inertia Tensor, link Jacobian Manipulator inertia tensor. Gravity, Generalized forces, Lagrange-Euler Dynamic model, Dynamic model of a Two-axis planar robot, Newton Euler formulation, Lagrange - Euler formulation, problems.		
Unit–V: Trajectory Planning	**No. of Lectures: 09 Hours**	**Marks: 12**
Workspace Analysis, work envelope of a Four axis SCARA robot and five axis articulated robot workspace fixtures, the pick and place operations, Joint space technique – continuous path motion, Interpolated motion, straight line motion and Cartesian space technique in trajectory planning.		
Text Books:		
1. S. K. Saha, Introduction to Robotics TATA McGraw Hill 2. Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning, 2009		
Reference Books:		
1. "Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines **",**Robert L. Norton, McGraw-Hill Education 2. John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson Education International		
NPTEL Links: 1. Kinematic Diagram by Prof. Anirva Dasgupta, IIT, Kharagpur https://www.youtube.com/watch?v=jr71xn7PYOc&list=PL4kd_zHeKfEm_TScGvdASw_jeli_4qpxb&index=3 2. Parallel Manipulator Velocity Analysis by Prof. Anirva Dasgupta, IIT, Kharagpur https://www.youtube.com/watch?v=jOEIx3yWEVg&list=PL4kd_zHeKfEm_TScGvdASw_jeli_4qpxb&index=32 3. Coordinate transformation by Prof. Anirva Dasgupta, IIT, Kharagpur 4. https://www.youtube.com/watch?v=z8MXf8GQ6hE&list=PL4kd_zHeKfEm_TScGvdASw_jeli_4qpxb&index=38		

MECHANICS OF ROBOTS LAB (PCC)					
LAB COURSE CONTENT					
MECHANICS OF ROBOTS LAB		**Semester:**	**IV**	**Course Code:**	**ME - 415A**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**			**25 marks**
Semester Credits:	**1**	**End semester exam (ESE) (UA):**			**25 marks**
End Semester Exam (ESE) Pattern:		**Oral (OR)**			

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Simulation of Mathematical Model of Robot.
2. Determination of holding torque in epicyclic gear train.
3. Experiment on Robot forward kinematic analysis
4. Experiment on Robot inverse kinematic analysis
5. Determination of mass moment of inertia and radius of gyration of robotic links.
6. Experiment on balancing of mass.
7. Forward and Inverse Dynamic Analysis of a 2-DOF Robotic Manipulator using Software Tools.
8. Computer program for analysis and synthesis of any mechanism and test it.
9. MATLAB program for simple and inverse kinematics of simple robot configuration
10. To draw a triangle in particular frame by using robotic arm.

Text Books:

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2017.

NPTEL Links:

1. Kinematic Parameter by Dr. T Asokan, IIT Madras https://www.youtube.com/watch?v=LfHD3l_DbsE&list=PLyqSpQzTE6M_XM9cvjLLO_Azt1FkgPhpH&index=7
2. Experimental Robotics, IIT Kharagpur https://www.youtube.com/watch?v=wFxrXd7HqbI

Guide lines for ICA:

Students must submit ICA in the form of journal. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. Evaluation will be based on oral and performance in the ESE.

Kavayitri Bahinabai Chaudhari
NORTH MAHARASHTRA UNIVERSITY,
JALGAON (M.S.)

Bachelor of Engineering – Honors
in
3D Printing
for Second Year Bachelor of Engineering
offered by
Mechanical
(As per NEP 2020 Guidelines)

Faculty of Science and Technology



SYLLABUS STRUCTURE & COURSE OUTLINE
For Affiliated Colleges
Semester – III & IV
W.E.F. 2025 – 26

Honors in 3D Printing

Syllabus Structure for Honors in 3D Printing: Additional Credit (Semester – III) (w.e.f. 2025 – 26)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ME -311B	Additive Manufacturing	PCC	3			3	40	60			100	3
ME -312B	Additive Manufacturing lab	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for Honors in 3D Printing: Additional Credit (Semester – IV) (w.e.f. 2025 – 26)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ME -414B	Prototyping & Product Development	PCC	3			3	40	60			100	3
ME -415B	Prototyping & Product Development lab	PCC			2	2			25	25 (OR)	50	1

ADDITIVE MANUFACTURING (PCC)

COURSE OUT LINE

Course Title:	ADDITIVE MANUFACTURING	Short Title: AM	Course Code:	ME -311B

Course description:

This course introduces students to Additive Manufacturing (AM), commonly known as 3D Printing. It covers fundamental principles, different AM technologies, materials, process parameters, post-processing techniques, and real-world applications. The course will also highlight design for additive manufacturing (DfAM), sustainability, and future trends in digital manufacturing. Hands-on sessions will provide experience with 3D modeling, slicing software, and operating 3D printers.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite course(s):

Engineering Graphics, Manufacturing Processes, Material Science, Computer-Aided Design (CAD)

Course objectives:

The objective of this course is to:

1. Understand the basic principles and classifications of Additive Manufacturing.
2. Explore various 3D printing technologies and their applications in industries.
3. Study materials, process parameters, and design considerations in AM.
4. Introduce post-processing techniques, quality control, and testing methods.
5. Provide hands-on experience in 3D modeling, slicing, and 3D printing.

Course outcomes:

Upon completing the course, students will be able to:

1. Explain the fundamentals of Additive Manufacturing and compare AM with conventional methods.
2. Classify and describe different AM technologies and their working principles.
3. Select appropriate AM materials and optimize process parameters for desired properties.
4. Apply design for additive manufacturing (DfAM) principles and post-processing techniques.
5. Operate, troubleshoot, and evaluate 3D printing systems for real-world applications.

COURSE CONTENT

Additive Manufacturing		**Semester:**	**III**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE):	**40 marks**

Unit–I: Introduction to Additive Manufacturing	**No. of Lectures: 09 Hours**	**Marks: 12**

History & evolution of Additive Manufacturing (AM), Traditional vs. Additive Manufacturing, AM Process Chain: CAD modeling → Slicing → Printing → Post-processing, Types of AM Technologies (ISO/ASTM 52900 Standard), Applications of AM in automotive, aerospace, healthcare, and consumer products

Unit–II: Additive Manufacturing Technologies	**No. of Lectures: 09 Hours**	**Marks: 12**

Material Extrusion (FDM/FFF), Vat Photopolymerization (SLA, DLP, CLIP), Powder Bed

Fusion (SLS, SLM, EBM), Binder Jetting & Material Jetting, Directed Energy Deposition (DED), Hybrid Additive Manufacturing, Selection criteria for different AM processes

Unit–III: Materials and Process Optimization in AM	**No. of Lectures: 09 Hours**	**Marks: 12**

Polymers, Metals, Ceramics, and Composite Materials, Effect of process parameters on mechanical properties, Material characterization & testing, Influence of printing speed, layer thickness, temperature, and infill density, Defects in AM parts and optimization strategies

Unit–IV: Post-Processing, Quality Control, and DfAM	**No. of Lectures: 09 Hours**	**Marks: 12**

Post-processing techniques: Cleaning, curing, surface finishing, machining, Quality control & testing in AM: Dimensional accuracy, tensile testing, CT scanning, Design for Additive Manufacturing (DfAM): Lattice structures, topology optimization, Case studies on real-world applications of DfAM

Unit–V: Advanced Topics & Future Trends in Additive Manufacturing	**No. of Lectures: 09 Hours**	**Marks: 12**

4D Printing & Smart Materials, Bioprinting & Medical Applications, Aerospace & Automotive Industry Trends, Sustainability & Circular Economy in AM, AI, Machine Learning, and IoT in AM Process Optimization.

Text Books:

1. "Fundamentals of Additive Manufacturing" – Andreas Gebhardt
2. "The 3D Printing Handbook" – Ben Redwood, Filemon Schöffer, Brian Garrett

Reference Books:

1. "Additive Manufacturing Technologies" – Ian Gibson, David W. Rosen, Brent Stucker, Covers all 3D printing technologies, materials, and applications.
2. "Rapid Prototyping: Principles and Applications" – Chua C.K., Leong K.F., Lim C.S., Comprehensive guide on AM techniques & process optimization.
3. "Additive Manufacturing: Materials, Processes, Quantifications and Applications" – T.S. Srivatsan, T.S. Sudarshan, Focuses on material science, process optimization, and case studies.
4. "3D Printing and Additive Manufacturing: Principles and Applications" – Chee Kai Chua, Kah Fai Leong, Industrial and practical insights into 3D printing technologies.
5. "Advances in 3D Printing & Additive Manufacturing Technologies" – D. Dutta, B. Kumar, J. Paulo Davim, Covers future trends, hybrid AM, and new applications.

NPTEL Links:

1. "Additive Manufacturing" – Prof. Ramesh Singh (IIT Bombay)
   https://nptel.ac.in/courses/112107258
2. "Rapid Manufacturing" – Prof. Shantanu Bhattacharya (IIT Kanpur)
   https://nptel.ac.in/courses/112104265
3. "3D Printing and Additive Manufacturing" – Prof. Pradeep Kumar (IIT Roorkee)
   https://nptel.ac.in/courses/112105295

ADDITIVE MANUFACTURING LAB (PCC)					
LAB COURSE OUTLINE					
ADDITIVE MANUFACTURING LAB		**Semester:**	**III**	**Course Code:**	**ME-312B**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**		**25 marks**	
Semester Credits:	**1**	**End semester exam (ESE) (UA):**		**25 marks**	
End Semester Exam (ESE) Pattern:		**Oral (OR)**			

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Introduction to 3D Printing Workflow (CAD Modeling → Slicing → Printing → Post-Processing).
2. FDM Printing: Printing and analyzing mechanical properties of PLA, ABS, or PETG.
3. SLA Printing: Resin-based printing and surface finishing techniques.
4. SLS/SLM Powder-Based Printing: Understanding metal/ceramic sintering principles.
5. Support Structure Analysis: Printing with different orientations & minimizing material waste.
6. Material Testing of 3D Printed Parts (Tensile, Hardness, Impact testing).
7. Multi-Material & Composite 3D Printing (Using Carbon fiber-infused polymers).
8. Reverse Engineering & 3D Scanning for Additive Manufacturing.
9. Design for Additive Manufacturing (DfAM) using lattice & topology optimization.
10. Industrial Case Study & Capstone Project: 3D printing an optimized mechanical component.

Text Books

1. "Fundamentals of Additive Manufacturing" – Andreas Gebhardt
2. "The 3D Printing Handbook" – Ben Redwood, Filemon Schöffer, Brian Garrett

Reference Books:

1. "Additive Manufacturing Technologies" – Ian Gibson, David Rosen, Brent Stucker, Covers 3D printing technologies, machines, and industrial applications.
2. "The 3D Printing Handbook" – Ben Redwood, Filemon Schöffer, Brian Garrett, Industry-focused insights on 3D printing systems and applications.
3. "Rapid Prototyping: Principles and Applications" – Chua C.K., Leong K.F., Lim C.S., Detailed explanation of machine operations and rapid prototyping techniques.
4. "3D Printing and Additive Manufacturing: Principles and Applications" – Chee Kai Chua, Kah Fai Leong, Covers hardware, software, and control systems of 3D printers.
5. "Fundamentals of 3D Printing and Additive Manufacturing" – Kalani Kirk Hausman, Richard Horne, Beginner-friendly book on machine components and operation.

Guide lines for ICA:

Students must submit ICA in the form of journal. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. Evaluation will be based on oral and performance in the ESE.

PROTOTYPING & PRODUCT DEVELOPMENT (PCC)

COURSE OUT LINE

Course Title:	**PROTOTYPING & PRODUCT DEVELOPMENT**	**Short Title: 3DPMS**	**Course Code:**	**ME-414B**

Course description:

This course provides a comprehensive understanding of prototyping and product development methodologies used in mechanical engineering. It covers traditional and modern prototyping techniques, rapid prototyping, design thinking, product innovation, and commercialization strategies. Students will gain hands-on experience in designing, fabricating, testing, and refining prototypes using different tools and techniques.

	Hours/week	**No. of weeks**	Total hours	Semester credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite course(s):

Engineering Graphics, Manufacturing Processes, Material Science, Computer-Aided Design (CAD), Basics of Product Design

Course objectives:

The objective of this course is:

1. Understand fundamental concepts of prototyping and its role in product development.
2. Explore various prototyping methods, including traditional, CNC, and rapid prototyping.
3. Study product design methodologies, design thinking, and user-centered development.
4. Analyze product lifecycle, testing, validation, and commercialization strategies.
5. Develop practical skills in prototyping, testing, and iterative product improvement.

Course outcomes:

Upon completing the course, students will be able to:

1. Explain the importance of prototyping in product development and different prototyping techniques.
2. Select appropriate prototyping methods based on design requirements.
3. Apply design thinking principles and user-centric approaches to develop innovative products.
4. Analyze product lifecycle management (PLM) strategies, testing, and validation techniques.
5. Develop and refine prototypes for mechanical and interdisciplinary applications.

COURSE CONTENT

Prototyping & Product Development		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE):	**40 marks**

Unit–I: Introduction to Prototyping & Product Development	**No. of Lectures: 09 Hours**	**Marks: 12**

Concept of Prototyping: Why prototypes are essential in product development, Types of Prototypes: Physical vs. Virtual Prototyping, Low-fidelity vs. High-fidelity Prototypes, Product Development Process: Idea generation → Conceptualization → Prototyping → Testing → Manufacturing, Stages of Product Development: Feasibility analysis, concept development, functional design

Unit–II: Prototyping Methods & Tools	**No. of Lectures: 09 Hours**	**Marks: 12**

Traditional Prototyping Techniques: Hand-built models, CNC machining, casting, sheet metal forming, Digital Prototyping & Virtual Simulation: CAD modelling, Finite Element Analysis (FEA), Computational Fluid Dynamics (CFD), Rapid Prototyping vs. Traditional Prototyping, Hybrid Approaches: Combining traditional and digital techniques for prototype development

Unit–III: Design Thinking & User-Centered Development	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to Design Thinking: Empathy → Define → Ideate → Prototype → Test, User-Centered Design (UCD): Identifying user needs and market demands, Iterative Product Development: Design feedback loops, failure analysis, continuous improvement, Case Studies: Successful product prototypes and their evolution

Unit–IV: Testing, Validation & Product Lifecycle Management (PLM)	**No. of Lectures: 09 Hours**	**Marks: 12**

Testing Prototypes: Functional, mechanical, and durability testing, Quality Standards & Regulations: ISO, ASTM, and industry-specific standards, Product Lifecycle Management (PLM): Conceptualization → Design → Engineering → Production → End-of-life, Economic & Time Considerations in Prototyping, Sustainability & Eco-friendly Product Development

Unit–V: Commercialization, Manufacturing, and Future Trends	**No. of Lectures: 09 Hours**	**Marks: 12**

From Prototype to Mass Production: Scaling up designs for manufacturing, Manufacturing Readiness Levels (MRL) and Technology Readiness Levels (TRL), Cost Analysis & Market Feasibility Studies, Emerging Trends: AI-driven design optimization, Smart Materials, Digital Twin Technology, Industry 4.0 & Internet of Things (IoT) in Product Development

Text Books:

1. "Manufacturing Processes for Engineering Materials" – Kalpakjian & Schmid
2. "Introduction to Product Design and Development" – Edward B. Magrab

Reference Books:

1. "Product Design and Development" – Karl T. Ulrich, Steven D. Eppinger, Covers design process, prototyping methods, and development strategies.
2. "Prototyping and Modelmaking for Product Design" – Bjarki Hallgrimsson, Comprehensive book on physical and digital prototyping techniques.
3. "Design Thinking: A Guide to Creating Innovative Solutions" – Idris Mootee, Introduction to design thinking and user-centric product development.
4. "The Lean Startup" – Eric Ries, Explains iterative design and rapid prototyping in business environments.
5. "Innovation and Entrepreneurship" – Peter Drucker, Covers commercialization, feasibility studies, and product scaling strategies.

NPTEL Links:

1. "Product Design & Manufacturing" – Prof. G. S. Mani (IIT Madras)
   https://nptel.ac.in/courses/112106248
2. "Design Thinking - A Primer" – Prof. B. Gurumoorthy (IISc Bangalore)
   https://nptel.ac.in/courses/110106141
3. "Product Design & Innovation" – Prof. Shantanu Bhattacharya (IIT Kanpur)
   https://nptel.ac.in/courses/112104263

PROTOTYPING & PRODUCT DEVELOPMENT LAB (PCC)					
LAB COURSE OUTLINE					
PROTOTYPING & PRODUCT DEVELOPMENT LAB		**Semester:**	**IV**	**Course Code:**	**ME-415B**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**		**25 marks**	
Semester Credits:	**1**	**End semester exam (ESE) (UA):**		**25 marks**	
End Semester Exam (ESE) Pattern:		**Oral (OR)**			

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Sketching and Conceptualizing a Product Idea.
2. Basic Prototyping using Hand Tools and Traditional Techniques.
3. Developing a CAD Model for a Prototype.
4. CNC Machining for Prototype Development.
5. 3D Printing as a Rapid Prototyping Technique.
6. Finite Element Analysis (FEA) for Virtual Prototyping.
7. Testing & Evaluating a Physical Prototype (Material & Strength Analysis)
8. Iterative Design Improvement based on User Feedback.
9. Cost and Feasibility Analysis for a Product Idea.
10. Capstone Project: Developing and Presenting a Market-Ready Prototype.

Text Books

1. "Manufacturing Processes for Engineering Materials" – Kalpakjian & Schmid
2. "Introduction to Product Design and Development" – Edward B. Magrab

Reference Books:

1. "Product Design and Development" – Karl T. Ulrich, Steven D. Eppinger, Covers design process, prototyping methods, and development strategies.
2. "Prototyping and Modelmaking for Product Design" – Bjarki Hallgrimsson, Comprehensive book on physical and digital prototyping techniques.
3. "Design Thinking: A Guide to Creating Innovative Solutions" – Idris Mootee, Introduction to design thinking and user-centric product development.
4. "The Lean Startup" – Eric Ries, Explains iterative design and rapid prototyping in business environments.
5. "Innovation and Entrepreneurship" – Peter Drucker, Covers commercialization, feasibility studies, and product scaling strategies.

Guide lines for ICA:

Students must submit ICA in the form of journal. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. Evaluation will be based on oral and performance in the ESE.

Kavayitri Bahinabai Chaudhari
NORTH MAHARASHTRA UNIVERSITY,
JALGAON (M.S.)

Bachelor of Engineering – Honors
in
Energy Engineering
for Second Year Bachelor of Engineering
offered by
Mechanical
(As per NEP 2020 Guidelines)

Faculty of Science and Technology



SYLLABUS STRUCTURE & COURSE OUTLINE
For Affiliated Colleges
Semester – III & IV
W.E.F. 2025 – 26

Honors in Energy Engineering

Syllabus Structure for Honors in Energy Engineering: Additional Credit (Semester – III) (w.e.f. 2025 – 26)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ME -311C	Fuels and combustion	PCC	3			3	40	60			100	3
ME -312C	Fuels and combustion lab	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for Honors in Energy Engineering: Additional Credit (Semester – IV) (w.e.f. 2025 – 26)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ME -414C	Solar Photovoltaic Systems Design	PCC	3			3	40	60			100	3
ME -415C	Solar Photovoltaic Systems Design lab	PCC			2	2			25	25 (OR)	50	1

FUELS AND COMBUSTION (PCC)				
COURSE OUT LINE				
Course Title:	**FUELS AND COMBUSTION**	**Short Title: FC**	**Course Code:**	**ME- 311C**

Course description:

The course covers the chemical and physical properties of fuels, combustion mechanisms, and the engineering aspects of energy conversion. Students will explore the types of fuels—fossil, biofuels, and alternative sources—and examine their environmental impacts, energy efficiency, and economic considerations. The course also delves into the theoretical and practical aspects of combustion, including combustion thermodynamics, kinetics, and flame dynamic

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite course(s):

Basic Concepts of Physics and Chemistry

Course objectives:

The objective of this course is:

1. Classify fuels, differentiate fossil and renewable types, and analyze calorific value through proximate and ultimate analysis.
2. Understand combustion fundamentals, balance equations, and analyze air-fuel ratios for efficiency and emission control.
3. Study combustion characteristics of solid, liquid, and gaseous fuels for different applications.
4. Evaluate efficiency factors, perform heat balance calculations, and interpret flue gas analysis.
5. Assess emissions' effects, explore pollution control methods, and study carbon capture technologies.

Course outcomes:

After successful completion of this course the student will be able to:

1. Understand the classification and characteristics of different fuels (solid, liquid, and gaseous fuels).
2. Analyze combustion reactions and balance combustion equations.
3. Examine the efficiency of combustion processes and factors affecting combustion efficiency.
4. Evaluate the environmental impacts of combustion, including air pollution and greenhouse gas emissions.
5. Explore alternative fuels and sustainable combustion techniques for reducing environmental harm.

COURSE CONTENT

Fuels and combustion		**Semester:**	**III**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**

		Internal Sessional Exam (ISE):	**40 marks**
Unit–I: Introduction to Fuels	**No. of Lectures: 09 Hours**	**Marks: 12**	
Definition and Classification of Fuels Solid, liquid, and gaseous fuels Fossil fuels vs. renewable fuels Calorific Value of Fuels Gross and net calorific value Determination of calorific value, Proximate and Ultimate Analysis of Fuels Components.			
Unit–II: Combustion Fundamentals	**No. of Lectures: 09 Hours**	**Marks: 12**	
Combustion Reaction Basic principles of combustion Stoichiometry of combustion reactions Balancing combustion equations Air-Fuel Ratio Theoretical and actual air-fuel ratio Excess air and its effect on combustion efficiency Types of Combustion, Complete and incomplete combustion, Flame propagation and ignition temperatures			
Unit–III: Combustion of Different Fuels	**No. of Lectures: 09 Hours**	**Marks: 12**	
Combustion of Different Fuels: Combustion of Solid Fuels, Coal combustion: analysis, kinetics, and combustion process, Biomass combustion Combustion of Liquid Fuels Petroleum fuels (e.g., gasoline, diesel, and kerosene), Liquid biofuels (e.g., biodiesel, bioethanol). Combustion of Gaseous Fuels Natural gas and LPG Biogas.			
Unit–IV: Combustion Efficiency and Control	**No. of Lectures: 09 Hours**	**Marks: 12**	
Factors Affecting Combustion Efficiency Temperature, pressure, and fuel properties Air-fuel mixing and combustion chamber design Combustion Efficiency Calculations Heat balance, combustion efficiency formulas Effect of excess air on efficiency Flue Gas Analysis Measurement of gases like CO_2, CO, O_2, NOx, Sox, Use of flue gas analyzers and interpretation of results.			
Unit–V: Environmental Impact of Combustion	**No. of Lectures: 09 Hours**	**Marks: 12**	
Air Pollution from Combustion Emissions: CO_2, CO, NOx, SOx, particulate matter, Impact on health, environment, and climate change, Control of Pollutant,s Scrubbing, filtration, and catalytic converters, Regulations and standards for emissions Carbon Capture and Storage (CCS) .			
Text Books:			
1. Fuels and Combustion" by H.S. Mukunda, Universities Press 2. Thermal Engineering" by R.K. Rajput,Laxmi Publications.			
Reference Books:			
1. Chemical Engineering: Volume 2 by J.M. Coulson, J.F. Richardson 2. Combustion Engineering by Gary L. Borman and Kenneth W. Ragland 3. Combustion Physics" by C.K. Law, Cambridge University Press. 4. Fuels and Combustion" by B.K. Sarkar, Tata McGraw Hill. 5. Energy, the Environment, and Combustion by Annamalai and Puri, CRC Press. 6. Combustion and Gasification in Fluidized Beds by Prabir Basu, CRC Press. 7. Fuels, Energy, and the Environment by Ghazi A. Karim,CRC Press. 8. Combustion Engineering and Gas Utilization by British Gas, E & FN Spon.			

FUELS AND COMBUSTION LAB (PCC)					
LAB COURSE OUTLINE					
FUELS AND COMBUSTION LAB		**Semester:**	**III**	**Course Code:**	**ME-312C**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**			**25 marks**
Semester Credits:	**1**	**End semester exam (ESE) (UA):**			**25 marks**
End Semester Exam (ESE) Pattern:		**Oral (OR)**			

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Proximate and Ultimate Analysis of Fuels

Objectives: To determine the moisture, volatile matter, fixed carbon, and ash content in solid fuels through proximate analysis.

2. Determination of Calorific Value

Objectives: To measure the gross calorific value (GCV) and net calorific value (NCV) of solid & liquid / gaseous fuels.

3. Stoichiometric Combustion Analysis

Objectives: To balance combustion equations for One Solid and One Liquid fuel and Calculate the theoretical air-fuel ratio for complete combustion.

4. Effect of Excess Air on Combustion Efficiency

Objectives: To study the impact of **excess air** on combustion efficiency.

Performance: **S**tudy / perform the combustion unit with different air-fuel ratios and measure combustion temperature and flue gas composition also compare results and determine the optimal air-fuel ratio for efficient combustion. Use simulation for this study.

5. Flame Propagation and Ignition Temperature

Objectives: To study flame propagation speed, ignition temperature and factors affecting flame stability in different fuels.

6. Combustion Characteristics of Solid and Liquid Fuels

Objectives: To study / analyze the combustion behavior, flame structure, burning rate, and heat release characteristics of solid and liquid fuels.

Performance: Perform by burning different fuels in a furnace or combustion chamber and Measure burning time, flame temperature, and residue formation**.**

Also Compare combustion efficiency and emissions for different fuels.

7. Combustion of Gaseous Fuels

Objectives:To study the combustion process of **LPG and biogas** and study / analyze **combustion efficiency , flame characteristics and emissions**.

8. Flue Gas Analysis

Objectives: To measure **CO_2, CO, O_2, NOx, SOx** in flue gases and interpret combustion efficiency using a flue gas analyzer.

9. Emission Control Techniques

Objectives: To study methods for reducing emissions from combustion process and demonstrate scrubbing, filtration, and catalytic converters. Study / To analyze the effectiveness of these techniques in reducing pollutants.

Text Books

1. Fuels and Combustion" by H.S. Mukunda, Universities Press

Reference Books:

1. Chemical Engineering: Volume 2 by J.M. Coulson, J.F. Richardson

2. Combustion Engineering by Gary L. Borman and Kenneth W. Ragland
3. Combustion Physics" by C.K. Law, Cambridge University Press.
4. Fuels and Combustion" by B.K. Sarkar, Tata McGraw Hill.
5. Energy, the Environment, and Combustion by Annamalai and Puri, CRC Press.
6. Combustion and Gasification in Fluidized Beds by Prabir Basu, CRC Press.
7. Fuels, Energy, and the Environment by Ghazi A. Karim,CRC Press.
8. Combustion Engineering and Gas Utilization by British Gas, E & FN Spon.

Guide lines for ICA:

Students must submit ICA in the form of journal. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. Evaluation will be based on oral and performance in the ESE.

SOLAR PHOTOVOLTAIC SYSTEMS DESIGN (PCC)

COURSE OUT LINE

Course Title:	SOLAR PHOTOVOLTAIC SYSTEMS DESIGN	Short Title: SPSD	Course Code:	ME-414 C

Course description:

This course provides a comprehensive understanding of solar photovoltaic (PV) systems, from fundamental principles to advanced design and applications. It covers the working of solar cells, PV module technologies, system design, installation, operation, and maintenance. The course also emphasizes practical skills through hands-on experiments using solar test rig. Students will learn to design and optimize solar PV systems for residential, commercial, and industrial applications, with a focus on sustainability and environmental impact.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite course(s):

Basics of physics

Course objectives:

The objective of this course is:

1. To understand the fundamentals of solar energy and photovoltaic technology, including the working principles of solar cells, PV module construction, and electrical characteristics.
2. To develop skills in designing solar PV systems, including load calculation, component selection, and system sizing for grid-tied, off-grid, and hybrid systems.
3. To gain practical knowledge of PV system installation, operation, and maintenance**,** including safety standards, performance testing, and troubleshooting.
4. To analyze the environmental and economic aspects of solar PV systems**,** including carbon footprint, lifecycle analysis, and cost-benefit evaluation.
5. To explore emerging trends and applications in solar PV technology**,** such as energy storage, grid integration, and advanced PV materials.

Course outcomes:

After successful completion of this course the student will be able to:

1. Explain the working principles of solar photovoltaic systems and analyze the electrical characteristics of PV modules using I-V and P-V curves.
2. Design and size solar PV systems for various applications, considering factors such as load demand, solar irradiance, and system efficiency.
3. Install and commission solar PV systems by following safety standards and guidelines, and demonstrate the ability to troubleshoot common issues.
4. Evaluate the performance of solar PV systems using monitoring tools and techniques, and propose solutions to improve efficiency.
5. Assess the environmental and economic impact of solar PV systems and discuss emerging trends in PV technology and applications.

COURSE CONTENT

Solar photovoltaic systems design		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**
Introduction to Solar Energy and Photovoltaic Systems: Solar energy: Basics, advantages, and limitations. Solar radiation: Measurement and estimation (global, diffuse, and direct radiation). Solar spectrum and its relevance to PV systems. Overview of photovoltaic (PV) technology: History, types, and applications. Components of a PV system: Solar panels, inverters, batteries, charge controllers, and mounting structures.		
Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**
Solar Photovoltaic Principles and Technologies: Working principle of solar cells: Photovoltaic effect.Types of solar cells: Monocrystalline, polycrystalline, thin-film, and emerging technologies (e.g., perovskite, organic PV).PV module construction: Cell, module, and array configurations.Electrical characteristics of PV modules: I-V and P-V curves, efficiency, fill factor, and temperature effects.Standards and testing of PV modules (e.g., IEC 61215, IEC 61730).		
Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**
Design of Solar PV Systems: Types of PV systems: Grid-tied, off-grid, and hybrid systems. Sizing of PV systems: Load calculation, energy demand, and system sizing. Selection of components: Panels, inverters, batteries, and charge controllers. Design considerations: Shading analysis, tilt angle, orientation, and spacing. Economic analysis: Cost estimation, payback period, and lifecycle analysis.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Installation, Operation, and Maintenance of PV Systems: Installation of PV systems: Site assessment, mounting structures, and electrical wiring. Safety standards and guidelines for installation (e.g., NEC, IEC). Commissioning and performance testing of PV systems. Operation and maintenance: Cleaning, troubleshooting, and performance monitoring. Monitoring tools: Data loggers, energy meters, and software tools.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Applications and Future Trends in Solar PV Systems: Applications of PV systems: Residential, commercial, industrial, and rural electrification. Grid integration: Net metering, feed-in tariffs, and grid stability. Energy storage solutions: Batteries, super-capacitors, and hydrogen storage. Emerging trends: Bifacial solar panels, floating PV systems, and solar tracking. Environmental impact and sustainability of PV systems.		
Text Books:		
1. "Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers, and Engineers" by Chetan Singh Solanki, PHI Learning.		
Reference Books:		
1. "Solar Energy: Principles of Thermal Collection and Storage" by S.P. Sukhatme and J.K. Nayak,Tata McGraw Hill. 2. "Renewable Energy Sources and Emerging Technologies" by D.P. Kothari, K.C. Singal, and Rakesh Ranjan, PHI Learning. 3. "Solar Photovoltaics: Fundamentals, Technologies, and Applications" by CHETAN SINGH SOLANKI, PHI Learning. 4. "Solar Energy: Fundamentals, Design, Modelling, and Applications" by G.N. Tiwari and M.K. Ghosal, Narosa Publishing House. 5. "Photovoltaic Systems Engineering" by Roger A. Messenger and Jerry Ventre**,**CRC Press. 6. "Solar Electricity Handbook: A Simple, Practical Guide to Solar Energy" by Michael Boxwell,Greenstream Publishing. 7. "Photovoltaic Design and Installation For Dummies" by Ryan Mayfield, Wiley.		

8. "Solar Photovoltaic Systems: A Manual for Technicians and Engineers" by T.R. Jagadeesh and M.R. Patel**,** TERI Press.
9. "Solar Energy Conversion Systems" by Jeffrey R.S. Brownson,Academic Press.

NPTEL Links:

1. Prof. Soumityra Satapathi, IIT Roorkee,

NPTEL :: Physics - NOC:Solar Photovoltaics Fundamentals, Technology And Applications

SOLAR PHOTOVOLTAIC SYSTEMS DESIGN (PCC)					
LAB COURSE OUTLINE					
SOLAR PHOTOVOLTAIC SYSTEMS DESIGN		**Semester:**	**IV**	**Course Code:**	**ME-415C**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**			**25 marks**
Semester Credits:	**1**	**End semester exam (ESE) (UA):**			**25 marks**
End Semester Exam (ESE) Pattern:		**Oral (OR)**			

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. **Measurement of Solar Radiation**
   Objective**:** To measure solar irradiance at different times of the day using a pyranometer and understand the variation in solar radiation due to time, weather, and geographical factors.
2. **I-V and P-V Characterization of a Solar Panel**
   Objective**:** To plot the I-V (current-voltage) and P-V (power-voltage) curves of a solar panel under varying irradiance and temperature conditions.
3. **Efficiency Calculation of a Solar Panel**
   Objective**:** To measure the electrical output of a solar panel and calculate its efficiency under standard test conditions (STC).
4. **Sizing of a Solar PV System**
   Objective**:** To perform load calculation and design a solar PV system for a household.
5. **Installation of a Solar PV System**
   Objective**:** To study the assembly and installation of a solar PV system on the test rig, including panels, inverters, and batteries.
6. **Testing of a Charge Controller**
   Objective**:** To test the performance of a charge controller under different load and battery conditions.
7. **Grid-Tied Inverter Operation**
   Objective**:** To demonstrate the operation of a grid-tied inverter and measure its efficiency.
8. **Performance Monitoring of a PV System**
   Objective**:** To learn and understand the monitoring tools to track the performance of the solar PV system over a period of time.
9. **Troubleshooting and Maintenance**
   Objective**:** To study, identify and resolve common issues in a solar PV system, such as shading, wiring faults, and inverter failures.

Text Books

1. "Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers, and Engineers" by Chetan Singh Solanki, PHI Learning.

Reference Books:

1. "Photovoltaic Systems Engineering" by Roger A. Messenger and Jerry Ventre**,**CRC Press.
2. "Solar Electricity Handbook: A Simple, Practical Guide to Solar Energy" by Michael

Boxwell,Greenstream Publishing.
3. "Photovoltaic Design and Installation For Dummies" by Ryan Mayfield, Wiley.
4. "Solar Photovoltaic Systems: A Manual for Technicians and Engineers" by T.R. Jagadeesh and M.R. Patel**,** TERI Press.
5. "Solar Energy Conversion Systems" by Jeffrey R.S. Brownson,Academic Press.

Guide lines for ICA:

Students must submit ICA in the form of journal. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

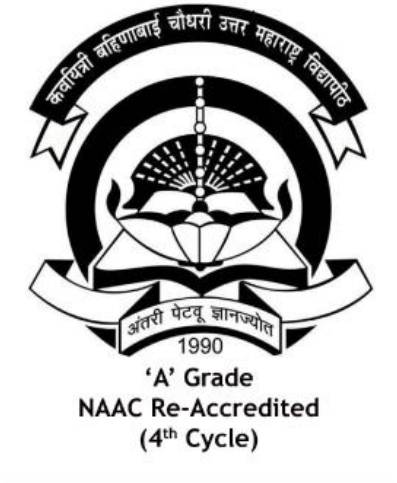
Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. Evaluation will be based on oral and performance in the ESE.

Kavayitri Bahinabai Chaudhari
NORTH MAHARASHTRA UNIVERSITY,
JALGAON (M.S.)

Bachelor of Engineering – Minor
in
Robotics
for Second Year Bachelor of Engineering
offered by
Mechanical
(As per NEP 2020 Guidelines)

Faculty of Science and Technology



SYLLABUS STRUCTURE & COURSE OUTLINE
For Affiliated Colleges
Semester – III & IV
W.E.F. 2025 – 26

Specialization Minor in Robotics

Syllabus Structure for specialization minor in Robotics: Additional Credit (Semester – III) (w.e.f. 2025 – 26)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ME -313A	Theory of Robotics	PCC	3			3	40	60			100	3
ME -314A	Theory of Robotics lab	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for specialization minors in Robotics: Additional Credit (Semester – IV) (w.e.f. 2025 – 26)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ME - 416A	Robot Kinamatics	PCC	3			3	40	60			100	3
ME - 417A	Robot Kinamatics lab	PCC			2	2			25	25 (OR)	50	1

THEORY OF ROBOTICS (PCC)				
COURSE OUT LINE				
Course Title:	**THEORY OF ROBOTICS**	**Short Title: TOR**	**Course Code:**	**ME - 313A**

Course description:

This course covers the basics of robotics, focusing on how robots are built, controlled, and used in different industries. Students will learn about key parts of robots, like sensors, motors, and controllers, and how robots can do tasks on their own. Topics also include how robots move, plan their actions, and use smart technology like AI. This course helps students understand the technology behind robots and how they are used in the real world.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite course(s):

Basic Engineering, Introduction to Programming or Computer Science, Basic Math (Algebra and Calculus), Basic Physics (Understanding Motion)

Course objectives:

The objective of this course is to:
1. Understand the basic concepts of mechanisms, kinematic pairs, and degrees of freedom.
2. Analyze spatial descriptions and transformations in robotic systems.
3. Perform forward and inverse kinematic and velocity analyses.
4. Study the dynamics of manipulators using Lagrange-Euler and Newton-Euler formulations.
5. Plan trajectories for robotic systems in joint space and Cartesian space.

Course Outcomes:

Upon completing the course, students will be able to:
1. Explain the fundamentals of robotic systems.
2. Describe about various drive systems and its selection for particular applications.
3. Explain about kinematic and dynamic analysis of robot manipulators.
4. Understand and explore the various end effectors, sensors and its applications for robot.
5. Understand the significance and use of robot programming & control for various applications.

COURSE CONTENT

THEORY OF ROBOTICS		**Semester:**	**III**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE):	**40 marks**

Unit–I: Introduction	**No. of Lectures: 09 Hours**	**Marks: 12**

Classification of robots, Basic components of robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. Mechanisms and transmission: Overview of mechanical systems in robotics, Introduction to End effectors: -Slider crank mechanism, Rotary actuators, Cam type gripper, Magnetic grippers, Air operated gripper.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Drive system- hydraulic, pneumatic and electric systems Sensors in robot – Touch sensors, Tactile sensor, Proximity and range sensors, Robotic vision sensor, Force sensor, Light sensors, Pressure sensors.

Unit–III: Kinematics &	**No. of Lectures: 09 Hours**	**Marks: 12**

Dynamics of Robots		
2D, 3D Transformation, Scaling, Rotation, Translation, Homogeneous coordinates, multiple transformation, Simple problems. Matrix representation, Forward and Reverse Kinematics of Three Degree of Freedom, Homogeneous Transformations, Inverse kinematics of Robot, Robot Arm dynamics, Basics of Trajectory Planning.		
Unit–IV: End effectors and sensors	**No. of Lectures: 09 Hours**	**Marks: 12**
End effectors Types of end effectors, mechanical grippers, vacuum, magnetic, adhesive grippers, tools as end effectors, Gripper selection and design, force analysis of gripper mechanism, Introduction to Sensors: Need of sensors in a robotic system, selection of sensors, classification of sensor, photo sensors, limit switches. Range sensors, force/ torque sensors, proximity sensors, touch sensors, tactile sensors.		
Unit–V: Robot Control & Programming	**No. of Lectures: 09 Hours**	**Marks: 12**
Robot controls-Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT, Motion Interpolations, Adaptive control. Introduction to Robotic Programming, On-line and off-line programming, programming examples.		
Text Books:		
1. Chikesh Ranjan & Kaushik Kumar, Robotics, S Chand Publishing.		
Reference Books:		
1. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic Engineering - 2. Groover Industrial Robotics , McGraw Hill Publication Co. Ltd 3. John J. Craig, “Introduction to Robotics Mechanics and Control” Pearson Education Inc., 4. M. P. Groover, Industrial Robotics - Technology, Programming and Application 5. Mark R. Miller, Robots and Robotics: Principles, Systems, and Industrial Applications, Mc Graw Hill. 6. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics: Technology Programming and Applications, McGraw Hill, 2012.		
NPTEL Links:		
1. Introduction to Robots and Robotics by Prof. Dilipkumar Pratihar, IIT, Kharagpur https://www.youtube.com/watch?v=xrwz9IxpMJg&t=14s 2. Robots Kinematics by Prof. Dilipkumar Pratihar, IIT, Kharagpur https://www.youtube.com/watch?v=wcy0Y3Jgf14&t=1296s 3. Sensors by Prof. Dilipkumar Pratihar, IIT, Kharagpur https://www.youtube.com/watch?v=sCTgZv33tuA		

THEORY OF ROBOTICS LAB (PCC)					
LAB COURSE OUTLINE					
THEORY OF ROBOTICS LAB		**Semester:**	**III**	**Course Code:**	**ME - 314A**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**			**25 marks**
Semester Credits:	**1**	**End semester exam (ESE) (UA):**			**25 marks**
End Semester Exam (ESE) Pattern:		**Oral (OR)**			

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Determination of maximum and minimum position of links
2. Estimation of accuracy, repeatability and resolution
3. To study an introduction to Robot configuration.
4. Identify and selection of Sensors such as IR sensors, Proximity Sensor, Ultrasonic Sensor, White line sensor, Temperature Sensor, Touch sensor, Tilt Sensor, Accelerometer, etc. based on given application
5. Assemble different components used in line follower robot.
6. Design and selection of Gripper / End effector
7. To perform pick and place operation by using robotic arm.
8. Verification of transformation (Position and orientation) with respect to gripper and world Coordinate system.

Text Books

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2017.
2. JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009

Reference Books:

1. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic Engineering -
2. An Integrated Approach", Prentice Hall India, 2002
3. Groover Industrial Robotics , McGraw Hill Publication Co. Ltd
4. John J. Craig, “Introduction to Robotics Mechanics and Control” Pearson Education Inc.,
5. M. P. Groover, Industrial Robotics - Technology, Programming and Application
6. Niku, Introduction to Robotics: Analysis System and Application , Pearson Education

NPTEL Links:

1. Introduction to Robotics by Dr. T Asokan, IIT Madras https://www.youtube.com/watch?v=P_PP76flZfw&list=PLyqSpQzTE6M_XM9cvjLLO_Azt1FkgPhpH
2. Main Elements of Robot, IIS Bengaluru https://www.youtube.com/watch?v=TQwCbKwO-a0&list=PLgMDNELGJ1CZT9pdEEkDylXFPLdcqxn0t&index=3

Guide lines for ICA:
Students must submit ICA in the form of journal. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.
Guide lines for ESE:
ESE will be based on practical assignment submitted by the student in the form of journal. Evaluation will be based on oral and performance in the ESE.

ROBOT KINAMATICS (PCC)				
COURSE OUT LINE				
Course Title:	**ROBOT KINAMATICS**	**Short Title: RK**	**Course Code:**	**ME-416 A**

Course description:

This course provides a comprehensive introduction to the fundamental concepts of mechanisms, machines, and robotics. It covers the principles of kinematic and dynamic analysis, spatial transformations, and trajectory planning for robotic manipulators. Students will gain a solid understanding of the theoretical foundations and practical applications of mechanical systems and robotics.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	03	15	45	03

Prerequisite course(s):

Basic knowledge of **Engineering Mechanics** and **Mathematics.**

Course objectives:

The student will able to:

1. Understand the basic concepts of mechanisms, kinematic pairs, and degrees of freedom.
2. Analyze spatial descriptions and transformations in robotic systems.
3. Perform forward and inverse kinematic and velocity analyses.
4. Study the dynamics of manipulators using Lagrange-Euler and Newton-Euler formulations.
5. Plan trajectories for robotic systems in joint space and Cartesian space.

Course Outcomes:

After successful completion of this course the student will be able to:

1. Identify and analyze different types of mechanisms and kinematic chains.
2. Apply spatial transformations to describe positions, orientations, and frames in robotic systems.
3. Perform kinematic and dynamic analyses of robotic manipulators.
4. Develop dynamic models for robotic systems using Lagrange-Euler and Newton-Euler formulations.
5. Plan and optimize trajectories for robotic manipulators in various applications.

COURSE CONTENT

Robot Kinematics		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE):	**40 marks**

Unit–I: Introduction to Mechanism and Machine	**No. of Lectures: 09 Hours**	**Marks: 12**

Links, Kinematic pairs, Degree of freedom, Kinematic Chain, Binary, Ternary, Quaternary Links and Joints, types of mechanism, Mechanical Manipulators.

Unit–II: Spatial descriptions and transformations	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction, Descriptions: Positions, orientation and frames; Mappings: Changing description from frame to frame; Operators: translations, rotations, and transformations; Interpretations, Transformation Arithmetic, Transform equations, representation of orientation.

Unit–III: Kinematics	**No. of Lectures: 09 Hours**	**Marks: 12**

Forward Position Analysis, Inverse Position Analysis, Velocity Analysis: The Jacobian Matrix, Link Velocities, Forward and Inverse Velocity Analyses, Acceleration Analysis

Unit–IV: Manipulator Dynamics	**No. of Lectures: 09 Hours**	**Marks: 12**
Introduction, Lagrange's equation kinetic and potential energy. Link inertia Tensor, link Jacobian Manipulator inertia tensor. Gravity, Generalized forces, Lagrange-Euler Dynamic model, Dynamic model of a Two-axis planar robot.		
Unit–V: Trajectory Planning	**No. of Lectures: 09 Hours**	**Marks: 12**
Introduction to trajectory planning ,Workspace Analysis, work envelope of a Four axis SCARA robot and five axis articulated robot workspace fixtures, the pick and place operations.		
Text Books:		
1. S. K. Saha, Introduction to Robotics TATA McGraw Hill 2. Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning, 2009.		
Reference Books:		
1. "Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines **",**Robert L. Norton, McGraw-Hill Education 2. John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson Education International		
NPTEL Links: 1. Kinematic Diagram by Prof. Anirva Dasgupta, IIT, Kharagpur https://www.youtube.com/watch?v=jr71xn7PYOc&list=PL4kd_zHeKfEm_TScGvdASw_jeli_4qpxb&index=3 2. Parallel Manipulator Velocity Analysis by Prof. Anirva Dasgupta, IIT, Kharagpur https://www.youtube.com/watch?v=jOEIx3yWEVg&list=PL4kd_zHeKfEm_TScGvdASw_jeli_4qpxb&index=32 3. Coordinate transformation by Prof. Anirva Dasgupta, IIT, Kharagpur https://www.youtube.com/watch?v=z8MXf8GQ6hE&list=PL4kd_zHeKfEm_TScGvdASw_jeli_4qpxb&index=38		

ROBOT KINAMATICS LAB (PCC)					
LAB COURSE CONTENT					
ROBOT KINAMATICS LAB		**Semester:**	**IV**	**Course Code:**	**ME - 417A**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**			**25 marks**
Semester Credits:	**1**	**End semester exam (ESE) (UA):**			**25 marks**
End Semester Exam (ESE) Pattern:		**Oral (OR)**			

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Simulation of Mathematical Model of Robot.
2. Determination of holding torque in epicyclic gear train.
3. Experiment on Robot forward kinematic analysis
4. Experiment on Robot inverse kinematic analysis
5. Determination of mass moment of inertia and radius of gyration of robotic links.
6. Experiment on balancing of mass.
7. Forward and Inverse Dynamic Analysis of a 2-DOF Robotic Manipulator using Software Tools.
8. Computer program for analysis and synthesis of any mechanism and test it.
9. MATLAB program for simple and inverse kinematics of simple robot configuration
10. To draw a triangle in particular frame by using robotic arm.

Text Books:

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2017.
2. JohnJ.Craig, Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009

NPTEL Links:

1. Kinematic Parameter by Dr. T Asokan, IIT Madras https://www.youtube.com/watch?v=LfHD3l_DbsE&list=PLyqSpQzTE6M_XM9cvjLLO_Azt1FkgPhpH&index=7
2. Experimental Robotics, IIT Kharagpur https://www.youtube.com/watch?v=wFxrXd7HqbI

Guide lines for ICA:

Students must submit ICA in the form of journal. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

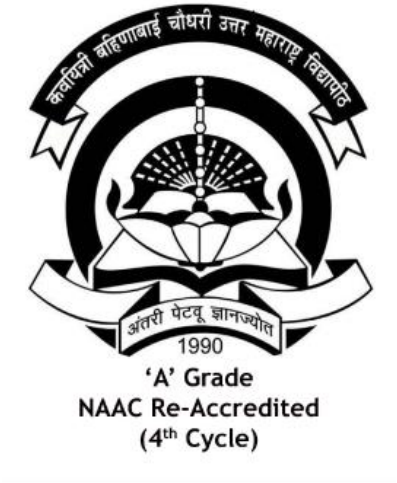
Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. Evaluation will be based on oral and performance in the ESE.

Kavayitri Bahinabai Chaudhari
NORTH MAHARASHTRA UNIVERSITY,
JALGAON (M.S.)

Bachelor of Engineering – Minor
in
3D Printing
for Second Year Bachelor of Engineering
offered by
Mechanical
(As per NEP 2020 Guidelines)

Faculty of Science and Technology



SYLLABUS STRUCTURE & COURSE OUTLINE
For Affiliated Colleges
Semester – III & IV
W.E.F. 2025 – 26

Specialization Minor in 3D Printing

Syllabus Structure for specialization minor in 3D Printing: Additional Credit (Semester – III) (w.e.f. 2025 – 26)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ME -313B	3D printing processes	PCC	3			3	40	60			100	3
ME -314B	3D printing processes lab	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for specialization minor in 3D Printing: Additional Credit (Semester – IV) (w.e.f. 2025 – 26)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ME -416B	3D printing machines and systems	PCC	3			3	40	60			100	3
ME -417B	3D printing machines and systems lab	PCC			2	2			25	25 (OR)	50	1

3D PRINTING PROCESSES (PCC)

COURSE OUT LINE

Course Title:	3D PRINTING PROCESSES	Short Title: 3DPP	Course Code:	ME-311B

Course description:

This course introduces 3D Printing Processes as a subset of Additive Manufacturing (AM), focusing on fundamental concepts, working principles, classifications, material considerations, and process parameters. Students will learn how different 3D printing processes function, their industrial applications, advantages, limitations, and future trends. The course integrates hands-on training in 3D printing hardware, slicing software, and post-processing techniques.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite course(s):

Engineering Graphics, Manufacturing Processes, Computer-Aided Design (CAD)

Course objectives:

The objective of this course is to:

1. Understand the fundamental principles of 3D Printing and Additive Manufacturing (AM).
2. Explore various 3D printing technologies, their applications, and process selection criteria.
3. Study materials, process optimization, and quality control in 3D printing.
4. Provide knowledge about post-processing, defects, and challenges in 3D printing.

Course outcomes:

Upon completing the course, students will be able to:

1. Explain the fundamental principles, workflow, and classifications of 3D printing technologies.
2. Compare and analyze various 3D printing processes and their applications.
3. Select appropriate 3D printing materials and optimize process parameters.
4. Apply quality control techniques, troubleshooting, and post-processing methods.
5. Operate and analyze 3D printing systems for real-world industrial applications.

COURSE CONTENT

3D printing processes		**Semester:**	**III**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE):	**40 marks**

Unit–I: Introduction to 3D Printing & Additive Manufacturing	**No. of Lectures: 09 Hours**	**Marks: 12**

History & evolution of Additive Manufacturing (AM), Traditional vs. Additive Manufacturing, AM Process Chain: CAD modeling → Slicing → Printing → Post-processing, Types of AM Technologies (ISO/ASTM 52900 Standard), Applications of AM in automotive, aerospace, healthcare, and consumer products

Unit–II Additive Manufacturing Technologies	**No. of Lectures: 09 Hours**	**Marks: 12**

Material Extrusion (FDM/FFF), Vat Photopolymerization (SLA, DLP, CLIP), Powder Bed Fusion (SLS, SLM, EBM), Binder Jetting & Material Jetting, Directed Energy Deposition

(DED), Hybrid Additive Manufacturing, Selection criteria for different AM processes.		
Unit–III: Materials and Process Optimization in AM	**No. of Lectures: 09 Hours**	**Marks: 12**
Polymers, Metals, Ceramics, and Composite Materials, Effect of process parameters on mechanical properties, Material characterization & testing, Influence of printing speed, layer thickness, temperature, and infill density, Defects in AM parts and optimization strategies		
Unit–IV: Post-Processing, Quality Control, and DfAM	**No. of Lectures: 09 Hours**	**Marks: 12**
Post-processing techniques: Cleaning, curing, surface finishing, machining, Quality control & testing in AM: Dimensional accuracy, tensile testing, CT scanning, Design for Additive Manufacturing (DfAM): Lattice structures, topology optimization, Case studies on real-world applications of DfAM		
Unit–V: Advanced Topics & Future Trends in Additive Manufacturing	**No. of Lectures: 09 Hours**	**Marks: 12**
4D Printing & Smart Materials, Bioprinting & Medical Applications, Aerospace & Automotive Industry Trends, Sustainability & Circular Economy in AM, AI, Machine Learning, and IoT in AM Process Optimization.		

Text Books:

1. "Introduction to Additive Manufacturing" – Andreas Gebhardt

Reference Books:

1. "Additive Manufacturing Technologies" – Ian Gibson, David W. Rosen, Brent Stucker, Covers all 3D printing technologies, materials, and applications.
2. "Rapid Prototyping: Principles and Applications" – Chua C.K., Leong K.F., Lim C.S., Comprehensive guide on AM techniques & process optimization.
3. "Additive Manufacturing: Materials, Processes, Quantifications and Applications" – T.S. Srivatsan, T.S. Sudarshan, Focuses on material science, process optimization, and case studies.
4. "3D Printing and Additive Manufacturing: Principles and Applications" – Chee Kai Chua, Kah Fai Leong, Industrial and practical insights into 3D printing technologies.
5. "Advances in 3D Printing & Additive Manufacturing Technologies" – D. Dutta, B. Kumar, J. Paulo Davim, Covers future trends, hybrid AM, and new applications.

NPTEL Links:

1. "Additive Manufacturing" – Prof. Ramesh Singh (IIT Bombay)
   https://nptel.ac.in/courses/112107258
2. "Rapid Manufacturing" – Prof. Shantanu Bhattacharya (IIT Kanpur)
   https://nptel.ac.in/courses/112104265
3. "3D Printing and Additive Manufacturing" – Prof. Pradeep Kumar (IIT Roorkee)
   https://nptel.ac.in/courses/112105295

3D PRINTING PROCESSES LAB (PCC)					
LAB COURSE OUTLINE					
3D PRINTING PROCESSES LAB		**Semester:**	**III**	**Course Code:**	**ME-314B**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**		**25 marks**	
Semester Credits:	**1**	**End semester exam (ESE) (UA):**		**25 marks**	
End Semester Exam (ESE) Pattern:		**Oral (OR)**			

Concerned faculty member should suitably frame SIX laboratory assignments from the Following list.

1. Introduction to CAD & Slicing Software.
2. Basic FDM Printing: Print a simple 3D model (e.g., a mechanical part)
3. SLA Printing: Resin-based 3D printing & UV curing
4. SLS/SLM Powder-Based Printing: Understanding sintering principles
5. Design for Additive Manufacturing (DfAM): Lattice structures & topology optimization
6. Post-Processing of 3D Printed Parts
7. Material Testing of 3D Printed Components (Tensile, Hardness, Impact testing)
8. Multi-Material & Composite 3D Printing
9. Reverse Engineering & 3D Scanning
10. Capstone Project: Printing a functional mechanical assembly

Text Books

1. "Introduction to Additive Manufacturing" – Andreas Gebhardt

Reference Books:

1. "Additive Manufacturing Technologies" – Ian Gibson, David Rosen, Brent Stucker, Covers 3D printing technologies, machines, and industrial applications.
2. "The 3D Printing Handbook" – Ben Redwood, Filemon Schöffer, Brian Garrett, Industry-focused insights on 3D printing systems and applications.
3. "Rapid Prototyping: Principles and Applications" – Chua C.K., Leong K.F., Lim C.S., Detailed explanation of machine operations and rapid prototyping techniques.
4. "3D Printing and Additive Manufacturing: Principles and Applications" – Chee Kai Chua, Kah Fai Leong, Covers hardware, software, and control systems of 3D printers.
5. "Fundamentals of 3D Printing and Additive Manufacturing" – Kalani Kirk Hausman, Richard Horne, Beginner-friendly book on machine components and operation.

Guide lines for ICA:

Students must submit ICA in the form of journal. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. Evaluation will be based on oral and performance in the ESE.

3D PRINTING MACHINES AND SYSTEMS (PCC)

COURSE OUT LINE

Course Title:	**3D PRINTING MACHINES AND SYSTEMS**	**Short Title: 3DPMS**	**Course Code:**	**ME-416B**

Course description:

This course provides a comprehensive understanding of prototyping and product development methodologies used in mechanical engineering. It covers traditional and modern prototyping techniques, rapid prototyping, design thinking, product innovation, and commercialization strategies. Students will gain hands-on experience in designing, fabricating, testing, and refining prototypes using different tools and techniques.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite course(s):

Engineering Graphics, Manufacturing Processes, Material Science, Computer-Aided Design (CAD), Basics of Product Design

Course objectives:

The objective of this course is:

1. Understand fundamental concepts of prototyping and its role in product development.
2. Explore various prototyping methods, including traditional, CNC, and rapid prototyping.
3. Study product design methodologies, design thinking, and user-centered development.
4. Analyze product lifecycle, testing, validation, and commercialization strategies.
5. Develop practical skills in prototyping, testing, and iterative product improvement.

Course outcomes:

Upon completing the course, students will be able to:

1. Explain the importance of prototyping in product development and different prototyping techniques.
2. Select appropriate prototyping methods based on design requirements.
3. Apply design thinking principles and user-centric approaches to develop innovative products.
4. Analyze product lifecycle management (PLM) strategies, testing, and validation techniques.
5. Develop and refine prototypes for mechanical and interdisciplinary applications.

COURSE CONTENT

3D PRINTING MACHINES AND SYSTEMS		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE):	**40 marks**

Unit–I: Introduction to Prototyping & Product Development	**No. of Lectures: 09 Hours**	**Marks: 12**

Concept of Prototyping: Why prototypes are essential in product development, Types of Prototypes: Physical vs. Virtual Prototyping, Low-fidelity vs. High-fidelity Prototypes, Product Development Process: Idea generation → Conceptualization → Prototyping → Testing → Manufacturing,

Unit–II: Prototyping Methods	**No. of Lectures: 09 Hours**	**Marks: 12**

& Tools		
Traditional Prototyping Techniques: Hand-built models, CNC machining, casting, sheet metal forming, Digital Prototyping & Virtual Simulation: CAD modelling, Finite Element Analysis (FEA), Computational Fluid Dynamics (CFD),		
Unit–III: Design Thinking & User-Centered Development	**No. of Lectures: 09 Hours**	**Marks: 12**
Introduction to Design Thinking: Empathy → Define → Ideate → Prototype → Test, User-Centered Design (UCD): Identifying user needs and market demands, Iterative Product Development		
Unit–IV: Testing, Validation & Product Lifecycle Management (PLM)	**No. of Lectures: 09 Hours**	**Marks: 12**
Testing Prototypes: Functional, mechanical, and durability testing, Quality Standards & Regulations: ISO, ASTM, and industry-specific standards, Product Lifecycle Management (PLM): Conceptualization → Design → Engineering → Production → End-of-life,		
Unit–V: Commercialization, Manufacturing, and Future Trends	**No. of Lectures: 09 Hours**	**Marks: 12**
From Prototype to Mass Production: Scaling up designs for manufacturing, Manufacturing Readiness Levels (MRL) and Technology Readiness Levels (TRL), Cost Analysis & Market Feasibility Studies,		
Text Books:		
1. "Manufacturing Processes for Engineering Materials" – Kalpakjian & Schmid 2. "Introduction to Product Design and Development" – Edward B. Magrab		
Reference Books:		
1. "Product Design and Development" – Karl T. Ulrich, Steven D. Eppinger, Covers design process, prototyping methods, and development strategies. 2. "Prototyping and Modelmaking for Product Design" – Bjarki Hallgrimsson, Comprehensive book on physical and digital prototyping techniques. 3. "Design Thinking: A Guide to Creating Innovative Solutions" – Idris Mootee, Introduction to design thinking and user-centric product development. 4. "The Lean Startup" – Eric Ries, Explains iterative design and rapid prototyping in business environments. 5. "Innovation and Entrepreneurship" – Peter Drucker, Covers commercialization, feasibility studies, and product scaling strategies.		
NPTEL Links: 1. "Product Design & Manufacturing" – Prof. G. S. Mani (IIT Madras) https://nptel.ac.in/courses/112106248 2. "Design Thinking - A Primer" – Prof. B. Gurumoorthy (IISc Bangalore) https://nptel.ac.in/courses/110106141 3. "Product Design & Innovation" – Prof. Shantanu Bhattacharya (IIT Kanpur) https://nptel.ac.in/courses/112104263		

3D PRINTING MACHINES AND SYSTEMS LAB (PCC)					
LAB COURSE OUTLINE					
3D PRINTING MACHINES AND SYSTEMS LAB		**Semester:**	**IV**	**Course Code:**	**ME-417B**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**			**25 marks**
Semester Credits:	**1**	**End semester exam (ESE) (UA):**			**25 marks**
End Semester Exam (ESE) Pattern:		**Oral (OR)**			

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Sketching and Conceptualizing a Product Idea.
2. Basic Prototyping using Hand Tools and Traditional Techniques.
3. Developing a CAD Model for a Prototype.
4. CNC Machining for Prototype Development.
5. 3D Printing as a Rapid Prototyping Technique.
6. Finite Element Analysis (FEA) for Virtual Prototyping.
7. Testing & Evaluating a Physical Prototype (Material & Strength Analysis)
8. Iterative Design Improvement based on User Feedback.
9. Cost and Feasibility Analysis for a Product Idea.
10. Capstone Project: Developing and Presenting a Market-Ready Prototype.

Text Books

1. "Manufacturing Processes for Engineering Materials" – Kalpakjian & Schmid
2. "Introduction to Product Design and Development" – Edward B. Magrab

Reference Books:

1. "Product Design and Development" – Karl T. Ulrich, Steven D. Eppinger, Covers design process, prototyping methods, and development strategies.
2. "Prototyping and Modelmaking for Product Design" – Bjarki Hallgrimsson, Comprehensive book on physical and digital prototyping techniques.
3. "Design Thinking: A Guide to Creating Innovative Solutions" – Idris Mootee, Introduction to design thinking and user-centric product development.
4. "The Lean Startup" – Eric Ries, Explains iterative design and rapid prototyping in business environments.
5. "Innovation and Entrepreneurship" – Peter Drucker, Covers commercialization, feasibility studies, and product scaling strategies.

Guide lines for ICA:

Students must submit ICA in the form of journal. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

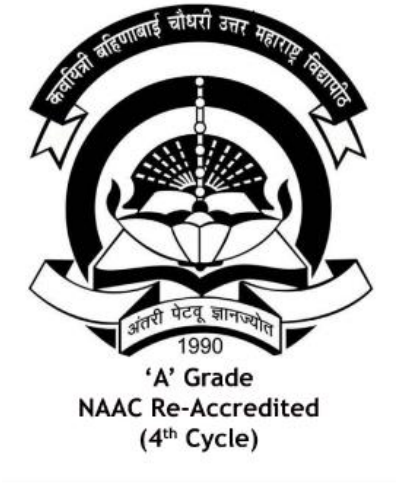
Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. Evaluation will be based on oral and performance in the ESE.

Kavayitri Bahinabai Chaudhari
NORTH MAHARASHTRA UNIVERSITY,
JALGAON (M.S.)

Bachelor of Engineering – Minor
in
Energy Engineering
for Second Year Bachelor of Engineering
offered by
Mechanical
(As per NEP 2020 Guidelines)

Faculty of Science and Technology



SYLLABUS STRUCTURE & COURSE OUTLINE
For Affiliated Colleges
Semester – III & IV
W.E.F. 2025 – 26

Specialization Minor in Energy Engineering

Syllabus Structure for specialization minor in Energy Engineering: Additional Credit (Semester – III) (w.e.f. 2025 – 26)
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ME -313C	Combustion Science	PCC	3			3	40	60			100	3
ME -314C	Combustion Science	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for specialization minor in Energy Engineering: Additional Credit (Semester – IV) (w.e.f. 2025 – 26)
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ME -416C	Energy Systems Engineering	PCC	3			3	40	60			100	3
ME -417C	Energy Systems Engineering Lab.	PCC			2	2			25	25 (OR)	50	1

COMBUSTION SCIENCE (PCC)

COURSE OUT LINE

Course Title:	COMBUSTION SCIENCE	Short Title: CS	Course Code:	ME-313C

Course description:

The course covers the chemical and physical properties of fuels, combustion mechanisms, and the engineering aspects of energy conversion. Students will explore the types of fuels—fossil, biofuels, and alternative sources—and examine their environmental impacts, energy efficiency, and economic considerations. The course also delves into the theoretical and practical aspects of combustion, including combustion thermodynamics, kinetics, and flame dynamic

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite course(s):

Course objectives:

The objective of this course is:

1. Classify fuels, differentiate fossil and renewable types, and analyze calorific value through proximate and ultimate analysis.
2. Understand combustion fundamentals, balance equations, and analyze air-fuel ratios for efficiency and emission control.
3. Study combustion characteristics of solid, liquid, and gaseous fuels for different applications.
4. Evaluate efficiency factors, perform heat balance calculations, and interpret flue gas analysis.
5. Assess emissions' effects, explore pollution control methods, and study carbon capture technologies.

Course outcomes:

After successful completion of this course the student will be able to:

1. Understand the classification and characteristics of different fuels (solid, liquid, and gaseous fuels).
2. Analyze combustion reactions and balance combustion equations.
3. Examine the efficiency of combustion processes and factors affecting combustion efficiency.
4. Evaluate the environmental impacts of combustion, including air pollution and greenhouse gas emissions.
5. Explore alternative fuels and sustainable combustion techniques for reducing environmental harm.

COURSE CONTENT

COMBUSTION SCIENCE		Semester:	III
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE):	**40 marks**

Unit–I: Introduction to Fuels	No. of Lectures: 09 Hours	Marks: 12

Definition and Classification of Fuels Solid, liquid, and gaseous fuels Fossil fuels vs. renewable fuels Calorific Value of Fuels Gross and net calorific value Determination of calorific value.		
Unit–II: Combustion Fundamentals	**No. of Lectures: 09 Hours**	**Marks: 12**
Combustion Reaction Basic principles of combustion Stoichiometry of combustion reactions Balancing combustion equations Air-Fuel Ratio Theoretical and actual air-fuel ratio Excess air and its effect on combustion efficiency Types of Combustion, Complete and incomplete combustion.		
Unit–III: Combustion of Different Fuels	**No. of Lectures: 09 Hours**	**Marks: 12**
Combustion of Different Fuels: Combustion of Solid Fuels- Coal combustion, and combustion process, Biomass combustion, Combustion of Liquid Fuels Petroleum fuels (e.g., gasoline, diesel, and kerosene), Liquid biofuels (e.g., biodiesel, bioethanol).		
Unit–IV: Combustion Efficiency and Control	**No. of Lectures: 09 Hours**	**Marks: 12**
Factors Affecting Combustion Efficiency Temperature, pressure, and fuel properties Air-fuel mixing, combustion efficiency formulas Effect of excess air on efficiency, Introduction to Flue Gas Analysis.		
Unit–V: Environmental Impact of Combustion	**No. of Lectures: 09 Hours**	**Marks: 12**
Air Pollution from Combustion Emissions: CO_2, CO, NOx, SOx, particulate matter, Impact on health, environment, and climate change, Control of Pollutant,s Scrubbing, filtration, and catalytic converters, Regulations and standards for emissions Carbon Capture and Storage (CCS) .		
Text Books:		
1. Thermal Engineering" by R.K. Rajput,Laxmi Publications		
Reference Books:		
1. Chemical Engineering: Volume 2 by J.M. Coulson, J.F. Richardson 2. Combustion Engineering by Gary L. Borman and Kenneth W. Ragland 3. Combustion Physics" by C.K. Law, Cambridge University Press. 4. Fuels and Combustion" by B.K. Sarkar, Tata McGraw Hill. 5. Energy, the Environment, and Combustion by Annamalai and Puri, CRC Press. 6. Combustion and Gasification in Fluidized Beds by Prabir Basu, CRC Press. 7. Fuels, Energy, and the Environment by Ghazi A. Karim,CRC Press. 8. Combustion Engineering and Gas Utilization by British Gas, E & FN Spon.		
NPTEL Links: 1. Dr. D.P. Mishra , IIT Kanpur, https://onlinecourses-archive.nptel.ac.in/noc18_ae01/preview Fundamentals Of Combustion (Part 1) - Course 2. Prof. S.R.Chakrovarty, IIT Kanpur , http//archive.nptel.ac.in/courses/101/106/101106037/ NPTEL :: Aerospace Engineering - Combustion		

COMBUSTION SCIENCE LAB (PCC)					
LAB COURSE OUTLINE					
COMBUSTION SCIENCE LAB		**Semester:**	**III**	**Course Code:**	**ME-314C**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**		**25 marks**	
Semester Credits:	**1**	**End semester exam (ESE) (UA):**		**25 marks**	
End Semester Exam (ESE) Pattern:		**Oral (OR)**			

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. To measure the gross calorific value (GCV) and net calorific value (NCV) of solid & liquid / gaseous fuels.

2. To balance combustion equations for One Solid and One Liquid fuel and Calculate the theoretical air-fuel ratio for complete combustion.

3. Study / perform the combustion unit with different air-fuel ratios and measure combustion temperature and flue gas composition also compare results and determine the optimal air-fuel ratio for efficient combustion. Use simulation for this study.

4. To study flame propagation speed, ignition temperature and factors affecting flame stability in different fuels.

5. To study / analyze the combustion behavior, flame structure, burning rate, and heat release characteristics of solid and liquid fuels.

6. To study the combustion process of LPG and biogas and study / analyze combustion efficiency, flame characteristics and emissions**.**

7. To measure and analyze the combustion efficiency and emissions (CO, CO_2, NOx, SOx, and particulate matter) of different fuels (solid, liquid, and gaseous) under varying combustion conditions.

8. To study methods for reducing emissions from combustion process and demonstrate scrubbing, filtration, and catalytic converters. Study / To analyze the effectiveness of these techniques in reducing pollutants.

Text Books

1. Thermal Engineering" by R.K. Rajput,Laxmi Publications

Reference Books:

1. Chemical Engineering: Volume 2 by J.M. Coulson, J.F. Richardson
2. Combustion Engineering by Gary L. Borman and Kenneth W. Ragland
3. Combustion Physics" by C.K. Law, Cambridge University Press.
4. Fuels and Combustion" by B.K. Sarkar, Tata McGraw Hill.
5. Energy, the Environment, and Combustion by Annamalai and Puri, CRC Press.
6. Combustion and Gasification in Fluidized Beds by Prabir Basu, CRC Press.
7. Fuels, Energy, and the Environment by Ghazi A. Karim,CRC Press.
8. Combustion Engineering and Gas Utilization by British Gas, E & FN Spon.

Guide lines for ICA:

Students must submit ICA in the form of journal. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. Evaluation will be based on oral and performance in the ESE.

ENERGY SYSTEMS ENGINEERING (PCC)				
COURSE OUT LINE				
Course Title:	**ENERGY SYSTEMS ENGINEERING**	**Short Title: ESE**	**Course Code:**	**ME-416 C**

Course description:

This course provides a comprehensive understanding of solar photovoltaic (PV) systems, from fundamental principles to advanced design and applications. It covers the working of solar cells, PV module technologies, system design, installation, operation, and maintenance. The course also emphasizes practical skills through hands-on experiments using solar test rig. Students will learn to design and optimize solar PV systems for residential, commercial, and industrial applications, with a focus on sustainability and environmental impact.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite course(s):

Basics of physics

Course objectives:

The objective of this course is:

1. To understand the fundamentals of solar energy and photovoltaic technology, including the working principles of solar cells, PV module construction, and electrical characteristics.
2. To develop skills in designing solar PV systems, including load calculation, component selection, and system sizing for grid-tied, off-grid, and hybrid systems.
3. To gain practical knowledge of PV system installation, operation, and maintenance**,** including safety standards, performance testing, and troubleshooting.
4. To analyze the environmental and economic aspects of solar PV systems**,** including carbon footprint, lifecycle analysis, and cost-benefit evaluation.
5. To explore emerging trends and applications in solar PV technology**,** such as energy storage, grid integration, and advanced PV materials.

Course outcomes:

After successful completion of this course the student will be able to:

1. Explain the working principles of solar photovoltaic systems and analyze the electrical characteristics of PV modules using I-V and P-V curves.
2. Design and size solar PV systems for various applications, considering factors such as load demand, solar irradiance, and system efficiency.
3. Install and commission solar PV systems by following safety standards and guidelines, and demonstrate the ability to troubleshoot common issues.
4. Evaluate the performance of solar PV systems using monitoring tools and techniques, and propose solutions to improve efficiency.
5. Assess the environmental and economic impact of solar PV systems and discuss emerging trends in PV technology and applications.

COURSE CONTENT

Energy Systems Engineering		**Semester:**	**IV**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to Solar Energy: Solar energy: Basics, advantages, and limitations. Solar radiation: Measurement and estimation (global, diffuse, and direct radiation). Solar spectrum and its relevance to PV systems.		
Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**
Solar Photovoltaic Principles and Technologies: Working principle of solar cells: Photovoltaic effect.Types of solar cells: Monocrystalline, polycrystalline, thin-film, and emerging technologies (e.g., perovskite, organic PV).PV module construction: Cell, module, and array configurations.		
Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**
Design of Solar PV Systems: Types of PV systems: Grid-tied, off-grid, and hybrid systems. Sizing of PV systems: Load calculation, energy demand, and system sizing. Selection of components: Panels, inverters, batteries, and charge controllers. Economic analysis: Cost estimation, payback period, and lifecycle analysis.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Installation & Operations: Installation, Operation, and Maintenance of PV Systems: Site assessment, mounting structures, and electrical wiring. Safety standards and guidelines for installation (e.g., NEC, IEC). Cleaning, troubleshooting, and performance monitoring.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
PV Applications and Future Trends: Applications of PV systems: Residential, commercial, industrial, and rural electrification. Grid integration: Net metering, feed-in tariffs, and grid stability. Energy storage solutions: Batteries, super-capacitors, and hydrogen storage. Emerging trends: Bifacial solar panels, floating PV systems, and solar tracking. Environmental impact and sustainability of PV systems.		

Text Books:

1. "Solar Energy: Principles of Thermal Collection and Storage" by S.P. Sukhatme and J.K. Nayak,Tata McGraw Hill.
2. "Renewable Energy Sources and Emerging Technologies" by D.P. Kothari, K.C. Singal, and Rakesh Ranjan, PHI Learning.
3. "Solar Photovoltaics: Fundamentals, Technologies, and Applications" by Chetan Singh Solanki, PHI Learning.

Reference Books:

1. "Photovoltaic Systems Engineering" by Roger A. Messenger and Jerry Ventre**,**CRC Press.
2. "Solar Electricity Handbook: A Simple, Practical Guide to Solar Energy" by Michael Boxwell,Greenstream Publishing.
3. "Photovoltaic Design and Installation For Dummies" by Ryan Mayfield, Wiley.
4. "Solar Photovoltaic Systems: A Manual for Technicians and Engineers" by T.R. Jagadeesh and M.R. Patel**,** TERI Press.
5. "Solar Energy Conversion Systems" by Jeffrey R.S. Brownson,Academic Press.

NPTEL Links:

1. Prof. V.V .Satyamurthy IIT Kharagpur, https://archive.nptel.ac.in/courses/112/105/112105051/

ENERGY SYSTEMS ENGINEERING LAB (PCC)					
LAB COURSE OUTLINE					
ENERGY SYSTEMS ENGINEERING LAB		**Semester:**	**IV**	**Course Code:**	**ME-417C**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**			**25 marks**
Semester Credits:	**1**	**End semester exam (ESE) (UA):**			**25 marks**
End Semester Exam (ESE) Pattern:		**Oral (OR)**			

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. To measure solar irradiance at different times of the day using a pyranometer and understand the variation in solar radiation due to time, weather, and geographical factors.
2. To plot the I-V (current-voltage) and P-V (power-voltage) curves of a solar panel under varying irradiance and temperature conditions.
3. To measure the electrical output of a solar panel and calculate its efficiency under standard test conditions (STC).
4. To Study / perform load calculation and design a solar PV system for a household.
5. To study the assembly and installation of a solar PV system on the test rig, including panels, inverters, and batteries.
6. To study / test the performance of a charge controller under different load and battery conditions.
7. To learn and understand the monitoring tools to track the performance of the solar PV system over a period of time.
8. To study / identify and resolve common issues in a solar PV system, such as shading, wiring faults, and inverter failures.

Text Books

1. "Solar Energy: Principles of Thermal Collection and Storage" by S.P. Sukhatme and J.K. Nayak,Tata McGraw Hill.

Reference Books:

1. "Photovoltaic Systems Engineering" by Roger A. Messenger and Jerry Ventre**,**CRC Press.
2. Renewable Energy Sources and Emerging Technologies" by D.P. Kothari, K.C. Singal, and Rakesh Ranjan, PHI Learning.
3. "Solar Photovoltaics: Fundamentals, Technologies, and Applications" by Chetan Singh Solanki, PHI Learning.
4. "Solar Electricity Handbook: A Simple, Practical Guide to Solar Energy" by Michael Boxwell,Greenstream Publishing.
5. "Photovoltaic Design and Installation For Dummies" by Ryan Mayfield, Wiley.
6. "Solar Photovoltaic Systems: A Manual for Technicians and Engineers" by T.R. Jagadeesh and M.R. Patel**,** TERI Press.
7. "Solar Energy Conversion Systems" by Jeffrey R.S. Brownson,Academic Press.