Estd. 1962
"A++" Accredited by NAAC (2021)
With CGPA 3.52

SHIVAJI UNIVERSITY, KOLHAPUR
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शिवाजी विद्यापीठ, कोल्हापूर
४१६ ००४, महाराष्ट्र
दूरध्वनी - इपीबीएक्स - २०६०९०००, अभ्यासमंडळे विभाग : ०२३१- २६०९०९४, २६०९४८७
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SU/BOS/Sci & Tech/ 445 **Date: 01/08/2024**

To,

The Director,
Departments of Technology,
Shivaji University, Kolhapur.

Subject: Regarding New syllabus of **B. Tech. Programme (Department of Technology)** Part - II (Sem-III-IV) under the Faculty of Science and Technology as per National Education Policy 2020.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the revised syllabus B. Tech. Part - II (Sem - III & IV) under the Faculty of Science & Technology as per National Education Policy 2020.

As per NEP 2020 **B. Tech (Deparment of Technolgy) Syllabus -2024-25**		
No.	**BOS/Ad-hoc Board**	**Course Syllabus**
1	Civil Engineering and Technology	B.Tech. Part-II, (Sem- III – IV) Civil Engineering
2	Mechanical Engineering and Technology	B.Tech. Part-II, (Sem- III – IV) Mechanical Engineering
3	Computer Science Engineering and Technology	B.Tech. Part-II, (Sem- III – IV) Computer Science and Technology
4	Chemistry & Chemical Engineering	B.Tech. Part-II, (Sem- III – IV) Chemcial Engineering
5	Electronics Sciences, Electronics Engineering and Technology	B.Tech. Part-II, (Sem- III – IV) Electronics and Telecommunication Engineering
6	Food Science and Technology	B.Tech. Part-II, (Sem- III – IV) Food Technolgy

B. Tech First Year (Sem – I & II) all Branches syllabus and Rules, Regulation, Guidelines, Structure and equivalence shall be implemented from the academic year 2023- 2024 onwards. A soft copy containing syllabus is attached herewith and it is available on university website **www.unishivaji.ac.in. (Student Online Syllabus).**

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,

Dr. S. M. Kubal
Dy. Registrar

Copy to:

1	The I/c Dean, Faculty of Science & Technology	6	Appointment Section A & B
2	The Chairpersan, Respective Board of Studies	7	Affiliation Section (T.1) (T.2)
3	OE 4	8	P.G.Admission Section, P.G Seminar Section
4	Eligibility Section,	9	Computer Centre

SHIVAJI UNIVERSITY, KOLHAPUR

Established: 1962
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New Syllabus for

Second Year B. Tech (Mechanical Engineering)

UNDER

Faculty of Science and Technology

B. Tech (Mechanical Engineering) –Semester III & IV

STRUCTURE AND SYLLABUS ACCORDING WITH NATIONAL EDUCATION POLICY – 2020 WITH MULTIPLE ENTRY AND MULTIPLE EXIT OPTIONS

(TO BE IMPLIMATED FORM ACADEMIC YEAR 2024-25 ONWORDS)

A. Engineering Graduate Attributes

1. Domain specific Engineering Knowledge
2. Problem Analysis Ability
3. Acquiring Skills that enable them to Design & Develop Solutions to the Problems
4. Capacity to investigate Complex Problems
5. Familiarity of using Modern Tools
6. Understanding Engineer's role and connectivity towards Society
7. Awareness about Environment & Sustainability
8. Practicing ethics and values
9. Ability to work as an Individual & in a Team also
10. Acquiring Communication skills
11. Becoming well verse with task of Project management & Finance aspects
12. Developing Lifelong Learning attitude

Note: For every program, there are its own Program Educational Objectives (PEOs) while there are 12 Program Outcomes (POs) which are aligned with these graduate attributes for the engineers.

B. Vision, Mission, PEO's and PO's

1. Vision To be a premier center of engineering education and industrial research that provides excellent academic ambience and nurtures innate talents of students to become technically sound, application oriented, innovative and successful mechanical engineers .

2. Mission To empower students with the fundamentals of Mechanical Engineering through innovative curriculum and effective teaching thereby enabling them for successful career by imparting knowledge, skills and right attitude and a spirit to serve the society with professional ethics.

3. Programme Educational Objectives (PEO's)

Graduate should:

1. Demonstrate successful professional careers with strong fundamental knowledge in Science, Mathematics, English and Engineering Sciences so as to enable them to analyze the Mechanical Engineering related problems leading to leadership, entrepreneurship or pursuing higher education

2. Acquire technical knowledge in specialized areas of Mechanical Engineering such as Materials, Design, Manufacturing and Thermal Engineering with a focus on research, innovation and gaining the technical skills in advanced software packages.

3. Work with multidisciplinary field of engineering and technology to enlarge the ability among the students to understand the different industrial environments.

4. Continuously learn, research and develop with strong professional, moral and ethical

values and with a zeal for life-long learning.

4. Programme Outcomes (PO's)

An engineering graduate of Mechanical Engineering Programme at Department of Technology by the time of graduation will achieve and demonstrate:

a) An ability to apply basic knowledge of science, mathematics and engineering fundamentals in the field of Mechanical Engineering.

b) An ability to identify, formulates, review research literature and analyze mechanical engineering problems using basics principles of science, mathematics and engineering.

C. Component wise distribution of credits

(Expected range of credits as per AICTE & NEP2020 guidelines is 160-176)

*Please note that most of the courses under HSMEC have been covered under audit courses.

Sr. No.	Category Suggested	Course Code	No. of Credits	Components %
1.	Humanities and Social Sciences including Management & Environment Courses	HSMEC	02	1.13
2.	Indian Knowledge System	IKS	03	1.70
3.	Ability Enhancement Course	AEC	03	1.70
4.	Value Education Courses	VEC	02	1.13
5.	Basic Science courses	BSC	20	11.37
6.	Engineering Science Courses including workshop, drawing, basics of civil/electrical/mechanical/computer etc.	ESC	34	19.32
7.	Professional Core Courses	PCC	65	36. 93
8.	Professional Elective Courses relevant to chosen specialization/branch	PEC	12	6.82
9.	Open subjects – Electives from other technical and /or emerging subjects	OEC	06	3.41
10.	Project , Seminar and Internship	PSI	17	9.65
11.	Multidisciplinary Minor	MDM	14	7.95
12.	Vocational and Skill Enhancement Courses	VSEC	Audit Courses	-
13.	Project Based Learning	PBL		
14.	Mandatory Audit Courses [Some other courses Decided at the Institute level but that do not get fit in the credits]	MAC (HSMEC)*		
	Total		176	**100**

Shivaji University,
Kolhapur
Department of Technology

Second Year B.Tech (Mechanical Engineering), Semester- III

Teaching & Evaluation Scheme

S.N.	Category	Course Code	Course Title	Hours per week			Contact Hours	Credits	Evaluation scheme	
									Theory	Practical
				L	T	P			ISE:ESE	IE:EE
1.	Basic Science Course	BSC211	Engineering Mathematics –III	03	-	-	03	03	30:70	00:00
2.	Professional Core Courses	PCC211	Metal Cutting and Machine Tools	03	-	-	03	03	30:70	00:00
3.	Professional Core Courses	PCC212	Fluid Mechanics	03	-	02	05	04	30:70	00:50
4.	Professional Core Courses	PCC213	Material Science and Engineering	03	-	02	05	04	30:70	00:50
5.	Professional Core Courses	PCC214	Engineering Thermodynamics	03	-	02	05	04	30:70	50:50
6.	Professional Core Courses	PCC215	Machine Drawing	-	-	02	02	01	00:00	00:50
7.	Ability Enhancement Courses	AEC211	Soft Skill Development	01	-	-	01	01	00:00	50:00
				-	-	-	-	20	500	300
8.	Project Based Learning	PBL211	Mini Project I & Industrial Visit	-	01	-	01	ISE at Course in charge end		
9.	Humanities, Social Sciences, Management, Environment	HSMEC 211	Environmental Studies	02	-	-	02	University Exam at the Even Semester End		
			Total Hours	**18**	**01**	**08**	**28**	**-**	**-**	**-**

Shivaji University, Kolhapur
Department of Technology

Second Year B.Tech (Mechanical Engineering), Semester- IV

Teaching & Evaluation Scheme

S.N.	Category	Course Code	Course Title	Hours per week			Contact Hours	Credits	Evaluation scheme	
									Theory	Practical
				L	T	P			ISE:ESE	IE:EE
1.	Professional Core Course	PCC 221	Fluid and Turbo Machinery	03	-	02	05	04	30:70	50:50
2.	Professional Core Course	PCC 222	Strength of Materials	03	-	-	03	03	30:70	00:00
3.	Professional Core Course	PCC 223	Manufacturing Processes	03	-	02	05	04	30:70	50:00
4.	Professional Core Course	PCC 223	Kinematics of Machines	03	-	02	05	04	30:70	00:50
5.	Professional Core Course	PCC 224	Machine Design I	03	-	02	05	04	30:70	00:50
6.	MDM Course	MDM311	Multidisciplinary Minor Course I*	03	-	-	03	03	30:70	00:00
7.	Indian Knowledge System	IKS221	Introduction to Performing Arts	01	-	-	01	01	00:00	50:00
				-	**-**	**-**	**-**	**23**	**600**	**300**
8.	Mandatory Audit Course	MAC 222	Aptitude Enhancement Course I	-	01	-	01	ISE at Course in charge end		
9.	Project Based Learning	PBL221	Mini Project II & Industrial Visit	-	01	-	01	ISE at Course in charge end		
10.	Humanities, Social Sciences, Management Environment	HSME C 221	Environmental Studies	02	-	-	02	University Exam at the Semester End		
			Total Hours	**21**	**02**	**08**	**31**	**-**	**-**	**-**

- Note :- The MDM course will be chosen from the Multidisciplinary Minor Title.

Year, Program, Semester	Second Year B. Tech (Mechanical Engineering) ,Semester III						
Course Code	BSC211						
Course Category	Engineering Science Course						
Course title	**Engineering Mathematics –III (Advanced Calculus for Engineers)**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-	-	03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	---	--	--	--	100
Pre-requisites(if any)	Knowledge of Differential Calculus and Integral Calculus						
Course Objectives	The course is aimed at - 1. To describe solution of LDE and its applications in mechanical engineering. 2. To introduce Partial Differential Equations and its Applications. 3. To introduce Laplace Transform & Inverse Laplace transform and its Applications. 4. To study Vector Differentiation and Vector Integration 5. The student must be able to formulate a mathematical model of a real life and engineering problem, solve and interpret the solution in real world.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Understand Linear Differential Equations and Apply them to realistic problems. 2. Understand Partial Differential Equations for solving problems in Mechanical Engineering fields. 3. Understand and apply knowledge of Laplace Transform in Mechanical Engineering 4. Apply knowledge of Vector Calculus to solve engineering problems.						

Unit No.	Course Content	Hours
I	**Linear Differential Equations** Linear Differential Equations with constant coefficients, Homogenous Linear differential equations, Method of variation of parameters.	7
II	**Applications of Linear Differential Equations** Applications of Linear Differential Equations with constant coefficients to oscillations of a spring (Free oscillations, Damped oscillations, Forced oscillations without damping) and Whirling of shafts.	7
III	**Partial Differential Equations** Introduction to partial differential equations, Four standard forms of partial differential equations of first order.	7
IV	**Applications of Partial Differential Equations** Introduction to second order partial differential equations, Classification, Wave Equation, One dimensional heat flow equations, The Laplace equation in two dimensional heat flow (Steady State), method of separation of variables, use of Fourier series.	7

V	**Laplace Transform** Definition- Laplace transform, Properties of Laplace transform, Laplace transform of derivatives, Laplace transform of integral, Inverse Laplace transforms, Convolution theorem, Applications of L.T. to solve LDE (Initial value problems)	7
VI	**Vector Calculus** Vector Differentiation: Differentiation of vectors, Gradient of scalar point function, Directional derivative, Divergence of vector point function, Curl of a vector point function. Solenoidal, Irrotational and Conservative field. Vector Integration: The line integral, Surface integral, volume integral, Gauss's Divergence theorem, Stoke's theorem, Green's theorem (Without proof).	6

Suggested list of Assignments:

1. To find solution of LDE with constant coefficients
2. To find Solution of Homogeneous LDE
3. Applications of LDE
4. To find solution of PDE
5. Applications Of PDE
6. Laplace Transform
7. Applications of Laplace transform
8. Vector differentiation
9. Vector Integration

General Instructions:

1. Each Student has to write at least 6 assignments on entire syllabus.
2. Batch wise tutorials are to be conducted. The number of students per batch should be as per the practical batches.
3. Students must be encouraged to solve engineering mathematics problems using different software's like MATLAB, Scilab etc.

Text Books

1.	B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw-Hill.
2.	Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons.
3.	Veerarajan T., Engineering Mathematics, Tata McGraw-Hill, New Delhi

Reference Books

1.	C. R. Wylie, "Advanced Engineering Mathematics", McGraw Hill Publication, New Delhi.
2.	B. S. Grewal, "Higher Engineering Mathematics", Khanna Publications, New Delhi.
3.	S. S. Sastry, "Engineering Mathematics (Volume-I)", Prentice Hall Publication, New Delhi.
4.	H. K. Dass, "Advanced Engineering Mathematics", S. Chand Publishing.
5.	N. P. Bali, Iyengar "A text book of Engineering Mathematics by", Laxmi Publications (P)Ltd., New Delhi.
6.	M. D. Greenberg, "Advanced Engineering Mathematics", Pearson Education.
7.	Merle C. Potter, "Advanced Engineering Mathematics", OXFORD University Press, 3rd Edition

Useful web links

1	https://nptel.ac.in/courses/111105121
2	https://nptel.ac.in/courses/111105134
3	https://nptel.ac.in/courses/111105035
4	https://nptel.ac.in/courses/111105167
5	https://nptel.ac.in/courses/111102133

<table>
<tr><td>Year, Program, Semester</td><td colspan="7">Second Year B. Tech (Mechanical Engineering),Semester III</td></tr>
<tr><td>Course Code</td><td colspan="7">PCC211</td></tr>
<tr><td>Course Category</td><td colspan="7">Professional Core Courses</td></tr>
<tr><td>Course title</td><td colspan="7">Metal Cutting and Machine Tools</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td colspan="2">Total Contact Hours</td><td colspan="2">Total Credits</td></tr>
<tr><td>03</td><td>-</td><td>-</td><td colspan="2">03</td><td colspan="2">03</td></tr>
<tr><td rowspan="2">Evaluation Scheme</td><td>ISE</td><td colspan="2">ESE</td><td>IOE</td><td>IPE</td><td>EOE</td><td>EPE</td><td>Total</td></tr>
<tr><td>30</td><td colspan="2">70</td><td>-</td><td>-</td><td>-</td><td>-</td><td>100</td></tr>
<tr><td>Pre-requisites(if any)</td><td colspan="7">Nil</td></tr>
<tr><td>Course Objectives</td><td colspan="7">The course is aimed at -
1. providing students the fundamental knowledge and principles in material removal processes.
2. study of metal cutting technology including the process, measurements, design and selection of various cutting tools.
3. developing knowledge and importance of metal-cutting parameters
4. application of the fundamentals and principles of metal cutting to practical applications.
5. demonstration of the fundamentals of machining processes and machine tools.
6. application of knowledge of basic mathematics to calculate the machining parameters for different machining processes.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">Upon completion of this course, a student will be able to –
1. understand the cutting tool geometry, mechanism of chip formation and mechanics of orthogonal cutting.
2. understand the basics of metal cutting and working of different types of machine tools
3. analyze and assess the use of various machine tools.
4. suitably select the appropriate machine tool for a given application.
5. identify and explain the basic components of machine tools and their applications.
6. select a machining operation and corresponding machine tool for a specific
application in real time</td></tr>
</table>

Unit No.	Course Content	Hours
I	**Machining Processes, Machine Tools – Lathe:** • Introduction, Manufacturing – Need and concept, Broad classification of Engineering Manufacturing Processes, Machining – Purpose, Principle and Definition, Machining requirements, Machine Tools and Basic functions of Machine Tools. • Basic functional principles of machine tool operations, Configuration of Basic Machine Tools and their use, Broad classification of Machine Tools • Primary and Auxiliary Motions in Machine Tools, Parameters defining working motions of a Machine Tool. **Lathe -** • Kinematic systems and operations of lathes, construction Working principles, types, specifications, principal parts, accessories and attachments. • Introduction to CNC lathe, 3d printing.	6
II	**Drilling and Milling Machines:** **a. Drilling Machines:** • Fundamentals of drilling processes, drill geometry, tool holder, types of drilling machines- construction and working, operations performed on drilling machines, type of drill. **b. Milling Machines** - • Fundamental aspects, cutter types and geometry, Operations performed on a milling machine, types of milling machines, up milling and down milling.	6
III	**Shaping, planning and broaching Machines:** • Construction, working and operations performed on the shaper, planer, and broaching machines, Reaming processes and reamer types.	6
IV	**Grinding and superfinishing:** **a. Grinding:** • Classification, grinding wheels, wheel marking, wheel selection, wheel mounting, wheel balancing, Grinding wheels- Abrasives, bonds and bonding processes, grit, grade and structure of wheels, types of grinding machines. **b. Superfinishing:** • Honing, lapping, super finishing, buffing and burnishing processes. • Safety and environmental aspects of various machine tools.	6
V	**Theory of Metal Cutting I :** • Introduction to metal cutting, wedge action, concept of speed, feed and depth of cut, orthogonal and oblique cutting. • Mechanics of metal cutting-chip formation, Types of chips, cutting ratio, Theories of shear angle, shear plane and shear angle, velocity relationships, force measurement by tool dynamometers, estimation of cutting forces, Merchant's circle of forces, cutting tool materials and their properties, machinability of metals- factors affecting, improvement and machinability index • Specific cutting energy and power; Machining parameters and material removal rate of various machine tools. • **Cutting Tool Materials:** Requirements of Tool materials and types, economics of machining. **(Note: This unit involves the numerical treatment of the appropriate topics**	6

	of this unit)	
VI	**Theory of Metal Cutting II:** • **Tool life -** Types of wear, relationship with cutting parameters, Taylor's equation and improvement measures. Surface finish- Factors affecting, the effect of cutting parameters, and improvements. • Heat generation in machining, its effect on cutting force, tool life and surface finish, types and selection criteria of cutting fluids. • **Tool geometry-** Parts, angles and types of single-point cutting tools, tool geometry of single-point cutting tools, tool geometry of multipoint cutting tools.-drills, milling cutters, reamers. **(Note: This unit involves the numerical treatment of the appropriate topics of this unit.)**	6

Important Note

Evaluation Pattern:
Assignments (CIE- 10 marks) – A minimum of 6 assignments will be given on the above course curriculum.

Text Books

1.	S.K Hajra Chaudhary, "Workshop Technology", Vol. I and II, Media Promoters and Publication, Mumbai.
2.	Bhattacharya "Metal Cutting Theory and Practice", New Central Book Agency (p) Ltd., Calcutta1984.
3.	Boothroyd .D.G. and Knight. W.A "Fundamentals of Machining and Machine tools", Marcel Dekker, New York, 1989.
4.	Production Technology, Jain R. K., I Khanna Publishers, SBN: 9788174090997, 9788174090997
5.	Sen and Bhattacharya, "Theory of Metal Cutting", New Central Book Agency, (1965)
6.	S. E. Rusinoff: "Manufacturing Processes", Times India Press. Doyle, Manufacturing Processes and Materials for engineers, Prentice Hall of India Press
7.	Workshop Technology: Part 1 - Manufacturing Processes" by W.A.J Chapman, CBS

Reference Books

1.	Materials and Processes in Manufacturing by E.Paul De Garmo, J.T.Black and Ronald A.Kohser.
2.	Machining and machining process by PN.Rao, TMH.
3.	Manufacturing Science by Ghosh & Mallick
4.	Metals Handbook. Vol. 16, Machining. Materials Park; OH: ASM International, 1995
5.	Kalpakjian, S "Manufacturing Process for Engineering Materials", MA:Addison-Wesley, 1997.
6.	"Production technology", P. C. Sharma., S. Chand and Company Ltd
7.	Mr. Arshinnov, "Metal Cutting Theory and Tool design", MIR Publication

8.	Metal Cutting Mechanics" by Viktor P. Astakhov, CRC Press.
9.	Machinery's Handbook and Guide, Erik Oberg, Franklin D. Jones, Holbrook L. Horton, and Henry H. Ryffel, Industrial Press.
Useful web links	
1.	Metal Cutting and Machine Tools By Prof. Asimava Roy Choudhury | IIT Kharagpur https://onlinecourses.nptel.ac.in/noc21_me04/preview

Year, Program, Semester	Second Year B. Tech (Mechanical Engineering),Semester III							
Course Code	PCC212							
Course Category	Professional Core Courses							
Course title	**Fluid Mechanics**							
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Total Credits		
	03	-	-	03		03		
Evaluation Scheme	ISE	ESE		IOE	IPE	EOE	EPE	Total
	30	70		---	----	----	----	100
Pre-requisites(if any)	In order to complete the course studies successfully, it is important to have a good command of English. Engineering Physics, Chemistry-I and Fluid Flow Operations.							
Course Objectives	The course is aimed at - 1. To identify various properties of fluids and Pascal's Law. 2. To state and illustrate fundamentals of Fluid Statics, Kinematics and Dynamics. 3. To demonstrate Bernoulli's Equation for various applications. 4. To understand the physics of fluid flow and conversant with Internal, External flows and its applications.							
Course Outcomes	Upon completion of this course, student should be able to – 1. Describe the significance of properties of fluid. 2. Apply the knowledge of fluid statics, kinematics and dynamics while addressing problems of mechanical engineering. 3. Estimate the discharge through a pipe or open channel. 4. Solve the practical problems in design of channels, openings.							

Unit No.	Course Content	Hours
I	**Introduction & Properties of Fluid** Definition of fluid, fluid properties such as viscosity, vapour pressure, compressibility, surface tension, capillarity, Mach number etc., pressure at a point in the static mass of fluid, variation of pressure, Pascal's law, pressure measurement by simple and differential manometers using manometric expression.	6
II	**Fluid Statics** Hydrostatic forces on the plane and curved surfaces, center of pressure, Buoyancy, center of buoyancy, stability of floating bodies, metacenter and metacentric height, its application in shipping.	6
III	**Kinematics of Fluid Flow** Velocity of fluid particle, types of fluid flow, description of flow, continuity equation, Coordinate free form, acceleration of fluid particle, rotational and irrotational flow, Laplace's equation in velocity potential and Poisson's equation in stream function. (Note: The chapter includes numerical treatment on the appropriate topics.)	6

IV	**Dynamics of Fluid Flow** Momentum equation, development of Euler's equation, Introduction to Navier-Stokes equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem , Application of Bernoulli's theorem such as venture meter, orifice meter, rectangular and triangular notch, pitot tube etc.	6
V	**Flow types** Laminar Flow: Flow through circular pipe, between parallel plates, Power absorbed in viscous flow in bearings, loss of head due to friction in viscous flow. Turbulent Flow: Reynolds's experiment, frictional loss in pipe flow, major and minor losses, HGL and TEL, flow through series and parallel pipes, Equivalent pipe, Syphon pipe.	6
VI	**Dimensional and Model Analysis** Dimensional Analysis: Dimensional homogeneity, Raleigh's method, Buckingham's theorem, Model analysis, similarity laws and dimensionless numbers. Introduction to boundary layer theory and its analysis. Forces on Submerged bodies: Drag and lift.	6
	Suggested list of Tutorials and Assignments: Each Student has to write at least 6 assignments on entire syllabus.	
	Text Books	
1.	"Fluid Mechanics and Hydraulic Machines - I",Dr. R.K. Bansal , Laxmi Publication Pvt. Ltd., New Delhi.	
2.	"Hydraulics and Fluid Mechanics including Hydraulic Machines", Dr. P.N. Modi and Dr. S.M. Seth, Standard Book House.	
3.	"Fluid Mechanics", Streeter, Wylie, Bedford , McGraw Hill Publication	
4.	"Introduction to Fluid Mechanics", Robert W. Fox , Alan T. McDonald , John W. Mitchell, Wiley Publication, 10th Edition	
5.	Fluid Mechanics-Fundamentals and Applications, Yunus Cengel , John Cimbala , McGraw Hill Education, 4th Edition	
	Reference Books	
1.	"Fluid Mechanics",White McGraw Hill Publication	
2.	"Advanced Fluid Engineering",Murlidhar, Narosa Publication.	
3.	"Fundamentals of fluid mechanics",G.S.Sawhney I.K. International Publishing House Pvt. Limited, New-Delhi, 2008 New York.	
4.	"Mechanics of Fluid",Irving Shames McGraw Hill Publication	
	Useful web links	
1.	**https://archive.nptel.ac.in/courses/112/105/112105269/#**	

Year, Program, Semester	Second Year B. Tech (Mechanical Engineering), Semester III						
Course Code	BSC111/ BSC121						
Course Category	Professional Core Courses						
Course title	**Fluid Mechanics (Practical)**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Credits		
	--	-	**02**	02	**01**		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	---	---	---	**----**	50	--	50
Pre-requisites(if any)	Laboratory work in Engineering Physics, Chemistry-I and Fluid Flow Operations.						
Course Objectives	1. To measure pressure using manometers. 2. To distinguish between different types of flows. 3. To understand the calibration of notches, orifice and venturi meter. 4. To demonstrate major and minor losses.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Work efficiently in a group, integrating skills and knowledge to make decisions in the performance of fluid mechanics tasks, adopting a responsible and organized attitude to work and a willingness to learn. 2. Apply the basic concepts of fluid mechanics to carry out professional engineering activities in the field of fluid and power plants. 3. Calibrate Venturi meter, Orifice meter and V-notch. 4. Measure pressure loss due to friction for pipe flow.						

Experiment No.	**Experiment Title/Objective (Any Eight)**	**Hours**
1.	Determination of viscosity using redwood viscometer.	02
2.	Study of manometers and the demonstration of the same in the laboratory.	02
3.	Determination of metacentric height of a floating body.	02
4.	Calibration of venturimeter	02
5.	Calibration of orifice meter	02
6.	Visualization of laminar and turbulent flow in the Halle Shaw apparatus.	02
7.	Determination of friction factor for flow through pipe.	02
8.	Verification of Bernoulli's Theorem.	02
9.	Calibration of V- notch or rectangular notch.	02
10.	Study of minor losses in the flow system.	02

General Instructions: Institute's Laboratory Course Manual and equipment wise Standard Operating Procedure to follow.

	Suggested Reference Books:
1.	Institute's Laboratory Course Manual and equipment wise Standard Operating Procedure to follow.

Year, Program, Semester	Second Year B. Tech (Mechanical Engineering),Semester III						
Course Code	PCC213						
Course Category	Professional Core Courses						
Course title	**Material Science and Engineering**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-	--	03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	---	---	--	--	100
Pre-requisites(if any)	To complete the course studies successfully, it is important to have a good command of English. Other Pre-requisites include Engineering Physics, Engineering Chemistry, Manufacturing Engineering - I						
Course Objectives	The course is aimed at : 1. Acquaint students with the basic concepts of metal structure. 2. Impart fundamental knowledge of ferrous and non-ferrous metal processing. 3. Study the various heat treatment processes for different metals and alloys. 4. Analyze and select various classes of materials for specific applications.						
Course Outcomes	Upon completion of this course, the student should be able to : 1. Understand the basic concept of metal structure. 2. Understand phase diagrams and heat treatments for ferrous and non- ferrous materials. 3. Understand the need for various heat treatment processes. 4. Evaluate the mechanical properties of materials for specific applications.						

Unit No.	Course Content	Hours
I	**Metals and Alloy Systems** Introduction to Metallic and Non-metallic materials and its classification (metals/alloys, polymers and composites) 1. Metals, Metallic bonds, Crystal structure (SC, BCC, FCC, HCP), Imperfections in crystals, Miller indices , indexing of lattice planes & directions, Lattice parameters (coordination number, no. of atoms per unit cell, atomic packing factor, density) 2. Alloy formation by crystallization, Nucleation and growth, Cooling curves, Dendritic structure and coring. Concept of solidification of pure metals & alloys, Nucleation : homogeneous and heterogeneous Cooling curves, Plotting of Equilibrium diagrams, Lever rule 3. Solid solutions and intermediate phases, Hume Ruthery's rule of solid solubility 4. Phases and Gibbs phase rule	06

	5. Construction of equilibrium diagrams from cooling curves, Isomorphous system (Solid Solution), Eutectic, Partial solubility Peritectic and Intermetallic Compounds Lever arm principles.	
II	**Study of Phase Diagrams** (Concerning typical compositions, Properties, and Applications for the following alloys.) 1. Fe- Fe3C equilibrium diagram - Ferrous alloys (Plain carbon steels, cast iron) 2. Alloy steels- Free cutting steels, HSLA high carbon low alloy steels, different types- Stainless steels, tool steels. 3. Selection of materials and Specifications based on -IS, BS, SAE, AISI, 4. Copper-based alloys brasses Cu- Zn, Bronzes Cu- Sn, Cu- Be, and Cu-Ni. 5. Aluminium based alloys Al- Cu(Duralumin) - Al-Si (Modification),	06
III	**Principles of Heat Treatment** Transformation of Pearlite into austenite upon heating, 1. Transformation of austenite into Pearlite, Bainite and Martensite on cooling. 2. TTT –Diagram and CCT - Diagrams - significance, Effect of alloying elements on TTT diagram and its significance.	06
IV	**Heat Treatment Processes** **a) Heat Treatment of Steels:** 1. Annealing – Types-Full, Partial and Sub critical annealing (Various types) and purposes 2. Normalising- Purposes 3. Hardening (Hardening types), Purposes, Austempering and Martempering, Mechanism of quenching and Quenching media, Hardenability- Concept and methods of determination of hardenability- Grossmans critical diameter method and Jominy end quench test. 4. Tempering Types, Structural transformations during tempering, purposes sub zero treatment 5. Surface hardening - Flame and Induction 6. Chemical heat treatments for case hardening - Carburising, Nitriding, Cyniding, Carbonitriding. **b) Heat treatment of Non-ferrous Alloys** 1. Annealing- Stress relief, Recrystallization and Process annealing 2. Precipitation hardening - Basic requirements, Stages, and Common alloys.	06
V	**Principles of Mechanical Testing** 1. Destructive Testing methods: Tensile, Compressive, Impact, Fatigue, Creep Hardness(Rockwell, Brinell and Vickers) 2. Non- Destructive Testing: Dye Penetrant, Magnetic, Ultrasonic, Radiography, Eddy Current testing	06
VI	**Powder Metallurgy** Advantages, Limitations, and Applications of Powder Metallurgy 1. Powder manufacturing types- Mechanical, Physical, Chemical and Electro-Chemical 2. Mixing/ Blending- (Double cone and Y- Cone mixers)	06

	4. Compaction- types- Conventional, Isostatic, HERF, Powder rolling and extrusion 5. Sintering- Types of liquid stage and solid stage sintering 6. Finishing operations: Sizing, Machining, Infiltration and Impregnation	
Text Books		
1.	“Introduction to physical metallurgy”, S.H.Avner, Mcgraw Hill Book Company Inc, Edition, 2nd, 1974.	
2.	“Physical metallurgy”,Vijendrasingh, Standard Publishers delhi	
3.	“Material science and engineering”, W. D Callister, Wiley India Pvt. Ltd., 5th Edition.	
4.	“Heat Treatments Principles and Practices”, T.V. Rajan / C.P. Sharma, Prentice Hall of India Pvt Ltd, New Delhi,	
5.	“Material Science and Engineering”, V Raghwan, Prentice Hall of India Pvt. Ltd., New Delhi , 3rd Edition, 1995.	
Reference Books		
1.	“Engineering Metallurgy”, R.A. Higgins, Viva Books Pvt. Ltd., New Delhi, 1st Edition ,1998	
2.	“Physical Metallurgy for Engineers ”, D.S.Clark, W. R. Varney, AN East West Press Pvt. Ltd. , New Delhi, 2nd Edition,1962	
3.	“Heat Treatment of Metals”, J L Smith and SC Bhatia , CBS Publishers and distributors, New Delhi, 1st edition, 2008.	
4.	"Heat treatment of Steels" Prabhudev, HMT Handbook 5 G.E. Dieter, Mechanical Metallurgy, Tata McGraw-Hill, New Delhi.	
Useful web links		
1.	**https://archive.nptel.ac.in/courses/113/102/113102080/**	

Year, Program, Semester	Second Year B. Tech (Mechanical Engineering),Semester III							
Course Code	PCC213							
Course Category	Professional Core Courses							
Course title	**Material Science and Engineering (Practical)**							
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Credits		
	-	-	02	02		1		
Evaluation Scheme	ISE	ESE		IOE	IPE	EOE	EPE	Total
	--	--		---	**--**	50	--	50
Pre-requisites(if any)	Laboratory work in Engineering Physics, Chemistry-I and Fluid Flow Operations.							
Course Objectives	The Course teacher will: 1. To evaluate mechanical properties through destructive testing. 2. To understand different heat treatment processes and hardenability tests. 3. To understand non-destructive testing methods and failure analysis. 4. To understand microstructural details of ferrous and non-ferrous materials.							
Course Outcomes	Students will be able to : 1. Interpret properties on the stress-strain diagram and select different hardness machines as per requirement. 2. Set process parameters for different heat treatment processes. 3. Select different NDT methods, depending on the types of defects. 4. Understand microstructural details drawing of ferrous and non-ferrous materials.							

Experiment No.	**Experiment Title/Objective**	**Hours**
1.	Study of the effect of a heat treatment process on the tensile strength of a sample, e.g. Mild steel.	02
2.	Study of the effect of a heat treatment process on the hardness of a test sample, e.g. Mild steel.	02
3.	Study of the effect of a heat treatment process on the Impact strength of a test sample, e.g. Mild Steel.	02
4.	Study of Non-Destructive tests: Magnaflux testing, Dye penetrant testing and Ultrasonic testing.	02
5.	Study and drawing of microstructures of mild steel, medium carbon steel, eutectoid steel and hypereutectoid steel.	02
6.	Study and drawing of microstructures of brass. Tin bronze, Al-bronze, Babbit metal.	02

7.	Study and drawing of microstructures of white malleable, gray and nodular cast irons.	02
8.	Study and drawing of microstructures of hardened steel, tempered steel.	02
Reference Books and web links		
1.	“Physical metallurgy”, Vijendrasingh, Standard Publishers delhi	
2.	“Heat Treatment of Metals”, J L Smith and SC Bhatia , CBS Publishers and distributors, New Delhi, 1st edition, 2008.	
3.	“Material Science and Engineering”,VRaghwan., Prentice Hall of India Pvt. Ltd., New Delhi ,3rd Edition, 1995.	
4.	“Material science and metallurgy for engineers”,V.D. Kodgire, Everest Publishers Pune,12th Edition.	

Year, Program, Semester	Second Year B. Tech (Mechanical Engineering),Semester III						
Course Code	PCC214						
Course Category	Professional Core Course						
Course title	**Engineering Thermodynamics**						
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**		
	03	-	-	03	03		
Evaluation Scheme	**ISE**	**ESE**	**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	30	70	----	----	----	----	100
Pre-requisites(if any)	Basic Physics, Basic Chemistry, Basic Mechanical Engineering						
Course Objectives	The course is aimed at - 1. To learn about work and heat interaction and balance of energy between systems and its surroundings. 2. To learn about applications of first law to various conversion devices. 3. To evaluate the changes in properties of substances in various processes. 4. To understand the difference between high grade and low-grade energies and second law limitations on energy conversion.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Explain fundamental knowledge of Thermodynamics. (understanding) 2. Explain various Gas & vapour power cycles and its representation.(Understanding) 3. Apply the various laws of thermodynamics to various processes and real systems.(Applying) 4. Analyze performance parameters of Thermodynamics systems. (Analyze)						

Unit No.	Course Content	Hours
1	**Fundamentals** – Review of Basic concepts of Thermodynamics, Thermodynamic Equilibrium, Quasi – static Process, Irreversible Process, Energy and its forms, Work and heat (sign convention), Zeroth law , Concept of Temperature and its' measurement, Temperature scales. First law of thermodynamics: Thermodynamic definition of work, Displacement work and flow work, Joules' experiment, First law analysis for closed system (non- flow processes), Internal energy and enthalpy. Limitations of first law of thermodynamics, PMM-I.(Numerical)	6
2	**Properties of Pure Substances:** Pure substance, Phases of pure substances, Phase change phenomenon of pure substance, Terminology of pure substances, property diagrams for phase change processes (T-v, p-T, p-V diagram, p-v-T surface), vapour pressure and phase equilibrium, property tables, ideal gas equation of states.	6

3	**Second law of thermodynamics:** Limitations of first law of thermodynamics, Thermal reservoirs, Heat engines, Reversed heat engine, Heat pump, Refrigerator, Kelvin Planck and Clausiu's statement of second law of thermodynamics, Equivalence of the two statements. Reversible and irreversible processes, PMM-II.(Numerical).	6
4	**Entropy:** concept and its applicability, Clausius' Theorem, Clausius Inequality, Entropy: A property of system, Property diagrams, Entropy Principle, Tds Relations: Entropy change for Ideal Gas, Entropy Change of Solids and Liquids, Third law of thermodynamics. Exergy analysis (case study),(Numerical).	6
5	**Available Energy, Availability and Irreversibility:** Available & unavailable Energy, available energy referred to cycle, availability in non-flow system, availability in steady flow system, Irreversibility, effectiveness, Second Law efficiency, (Numerical).	6
6	**Vapour Power Cycle: Carnot** Vapour power Cycle, Basic Rankine Cycle, Comparison of Rankine and Carnot cycle, Regeneration, Reheating, and Co-generation (Numerical).	6

Assignments

Students should write 6/8 questions on each Unit.

Text Books

1.	"Engineering Thermodynamics", P.K. Nag, Tata McGraw-Hill Publishing Co. Ltd.
2.	"Basic and Applied Thermodynamics", P.K. Nag ,Tata McGraw-Hill Publishing Co. Ltd.
3.	"Thermodynamics" , V. Ganesan , McGraw-Hill Publishing Co. Ltd.

Reference Books

1.	Engineering Thermodynamics", Hawkins G. A., John Wiley and Sons.
2.	"Thermodynamics" by J P Holman McGraw-Hill Education; 4th edition
3.	"Thermodynamics", Yunus Cengel and Michael Boles, McGraw-Hill Publishing Co. Ltd

Useful web links

1.	**https://archive.nptel.ac.in/courses/112/106/112106310/**

Year, Program, Semester	Second Year B. Tech, (Mechanical Engg. Program) ,Semester III							
Course Code	PCC214							
Course Category	Professional Core Course							
Course title	**Engineering Thermodynamics (Practical)**							
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Credits		
	---	---	**02**	02		**01**		
Evaluation Scheme	ISE		ESE	IOE	IPE	EOE	EPE	Total
	----		**----**	**---**	50	50	**--**	**100**
Pre-requisites(if any)	Basic Physics, Chemistry , Basics of Mechanical Engineering							
Course Objectives	The course is aimed at - 1. To understand properties of fuels and lubricating oils. 2. To understand properties of grease. 3. To understand working of different types of steam boilers along with its accessories and mountings. 4. To understand working of different types of heat exchangers.							
Course Outcomes	Upon completion of this course, Students will be able to 1. Compute the properties of fuels & lubricating oils using suitable tests. 2. Explain properties of grease and measure penetration of grease. 3. Explain working, mountings and accessories of different types of boilers. 4. Explain working of different types of heat exchangers.							

Experiment No.	**Experiment Title/Objective**	**Hours**
1.	Determination of flash and fire point of lubricating oil.	02
2.	Determination viscosity of lubricating oil using Redwoods Viscometer.	02
3.	Determination of Cloud and Pour Point of lubrication oil.	02
4.	Determination of penetration of grease.	02
5.	Determination of dropping point of grease.	02
6.	Determination of Aniline point of lubricating oil.	02
6.	Study and Demonstration of different types of steam boilers.	02
7.	Study and Demonstration of boiler mountings and accessories.	02
8.	Study and Demonstration on heat exchangers.	02
9.	Visit to an industry/sugar factory to study co-generation plant.	---
10.	Exergy analysis (Case study)	---

Reference Books and web links	
1.	"Engineering Thermodynamics", P.K. Nag, Tata McGraw-Hill Publishing Co. Ltd.
2.	“Basic and Applied Thermodynamics", P.K. Nag Tata McGraw-Hill Publishing Co. Ltd.
3.	"Thermodynamics" , V. Ganesan McGraw-Hill Publishing Co. Ltd.

Year, Program, Semester	Second Year B. Tech (Mechanical Engineering) ,Semester III						
Course Code	PCC215						
Course Category	Professional Core Course						
Course title	**Machine Drawing**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	-	-	02	02	01		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	--	--	---	--	50	--	50
Pre-requisites(if any)	--						
Course Objectives	1. To describe BIS conventions used in machine drawing 2. To describe the function of various machine components 3. To study assembly and detail drawings.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Use BIS conventions in machine drawings 2. Find lines/curves of intersection between two intersecting surfaces (or interpenetrating solids) 3. Sketch the various machine components 4. Read and interpret the given production drawings, understand significance of assembly and detail drawings						

Unit No.	Course Content	Hours
I	**Introduction to Machine Drawing** Dimensioning Techniques, Representation of standard components such as Screw Threads, Screw fasteners, keys, couplings, bearings, pulleys, brackets, gears, locking arrangements, Rivets and riveted joints, Welding symbols. Pipe Joints :- Expansion joints, stuffing box and glands, piping layouts, conventional representation of pipe fittings, valves, joints, etc.	6
II	**Limits, Fits and Tolerances** ISO system of tolerance, Tolerance charts, Hole - base and shaft -base system of tolerance, Types of fits, symbols and applications. Geometric Tolerances: Introduction, Nomenclature, Rules, Symbols, values obtained from various manufacturing processes.	4
III	**Surface Roughness and Production Drawing**	2
	Surface Textures, Roughness values and Roughness Grades, Machining symbols Conventional Representation on part drawings. Production Drawing: Assembly and part drawings, Blue print reading, study and preparation of bill of materials.	
IV	**Introduction to Computer Aided Drafting** Introduction to CAD software, Graphical User interface of CAD software, Selection of Drawing size and scale, Standard Toolbars, Menus, Tabs, navigational tools, Co-ordinate system and planes, Viewing Commands, Basic Commands to draw 2D and 3D objects	4

Experiment No.	Experiment Title/Objective	Hours
1	Intersection of solids	4
2	Introduction to Machine Drawing	4
3	Limits fits and Tolerances	8
4	Two- and three-dimensional designs/drawings using CAD software: One assembly of components (consisting at least five components)	8
Text Books		
1.	Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House	
2.	Engineering Drawing and Graphics by K. Venugopal, New Age Publication	
Reference Books		
1.	Engineering Drawing Practice for Schools and Colleges- BUREAU OF INDIAN STANDARDS	
2.	Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education	
Useful web links		
1.	https://nptel.ac.in/courses/112103019/ National Programme on Technology Enhanced Learning (NPTEL) - Phase II Course Name : Engineering Drawing	
2	https://nptel.ac.in/courses/112/104/112104172/	
3	http://moodle.unishivaji.ac.in/course/search.php?search=engineering+graphics Moodle Services, Shivaji University, Kolhapur	
4	http://web.iitd.ac.in/~achawla/public_html/201/lectures/sp46.pdf	

Year, Program, Semester	Second Year B. Tech (Mechanical Engineering) ,Semester III						
Course Code	AEC211						
Course Category	Ability Enhancement Course						
Course title	**Soft Skills Development**						
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**		
	01	-	-	01	--		
Evaluation Scheme	**ISE**	**ESE**	**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	--	--	50	----	----	----	50
Pre-requisites(if any)	--						
Course Objectives	**Course Objectives:** The teacher will 1. Help to enhance communication, teamwork, problem-solving skills. 2. Help to foster adaptability and resilience in engineering contexts.						
Course Outcomes	**Course Outcomes**: At the end of the course, the students will be- 1. Proficient in oral and written communication. 2. Effective as regards teamwork and collaboration skills. 3. Able to apply critical thinking to industrial problems. 4. Able to demonstrate adaptability and resilience in profession						

Unit No.	Course Content	Hours
1	**Written communication** • Email Writing • Technical Report	**3**
2	**Oral Communication** • Presentation Skills	2
3	**Soft Skills** • Importance of Soft Skills • Overview of Various Soft Skills	2
4	**Team Spirit & Leadership Ability** • Understanding team dynamics and roles • Building trust and rapport within team	2
5	**Assessment** • Discussion on incorporating soft skills development into daily practice • Case Studies or Role-Play	5

Course Assessment Method

For the internal assessment of the course, with a total evaluation is of 50 marks. Combination of different evaluation methods can be utilized to ensure comprehensive assessment of the students' performance. Following Evaluation Components are suggested:

1. **Quizzes/Tests (10 marks)**
   Periodic quizzes or tests to evaluate students' understanding of key concepts and their ability to apply them.

2. **Activity 1 (10 marks)**
   Group activity focusing application of creative thinking and teamwork; designed to assess both individual and group performance

3. **Activity 2 (20 marks)**
   Group activity focusing application of creative thinking and teamwork; designed to assess both individual and group performance

4. **Classroom Participation and Engagement (10 marks)**
   Demonstrating engagement with course material and Active participation in class discussions, group activities and question-answer sessions.

Reference Book

1.	Sharma R. & Krishna Mohan (2017), *Business Correspondence and Report Writing*, McGraw Hill Education
2.	P. D. Chaturvedi & Mukesh Chaturvedi (2013), *Business Communication: Skills, Concepts & Applications*, Pearson Publications, New Delhi, 3rd Edition, Seventh Impression
3.	K. K. Sinha (2006), *Business Communication*, 2nd Edition (Reprint), Galgotia Publishing, New Delhi
4.	Khera, S. (1998). "You Can Win: A Step by Step Tool for Top Achievers." New Delhi: Macmillan Publishers India.
5.	Covey, S. R. (2004). "The 7 Habits of Highly Effective People." New York: Free Press.
6.	Carnegie, D. (2009). "How to Win Friends and Influence People." New York: Pocket Books.
7.	Bradberry, T., & Greaves, J. (2009). "Emotional Intelligence 2.0." San Diego, CA: TalentSmart.
8.	Dweck, C. S. (2006). "Mindset: The New Psychology of Success." New York: Ballantine Books.

Year, Program, Semester	Second Year B. Tech, (Mechanical Engg. Program) ,Semester III							
Course Code	PBL211							
Course Category	Project Based Learning							
Course title	**Mini Project I & Industrial Visit**							
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Total Credits		
	-	01	**-**	01		**-**		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total	
	--	--	---	**--**	--	--	--	
Pre-requisites(if any)	Machine Tools and Processes, Tool Engineering, Machine drawing, Machine Design							
Course Objectives	The course is aimed at - 1. To understand the Product Development Process including budgeting through Mini Project. 2. To plan for various activities of the project and distribute the work amongst team of two members. 3. To develop student's abilities to transmit technical information and test the same by working on Mini Project. 4. To learn and observe the actual industrial practices and after visit students have to prepare the industrial visit report.							
Course Outcomes	Upon completion of this course, Students will be able to 1. Understand, plan and execute a Mini Project with the team. 2. Implement various manufacturing techniques, CAD learnt so far for designing and developing a prototype of a model. 3. Prepare a technical report based on the Mini project. 4. Students will able to prepare the industrial visit report. 5. Deliver presentation on Mini Project work carried out.							

Unit No.	Course Content	Hours
I	**Mini Project Completion and Assessment :** 1. The purpose of mini project is to promote self-study, innovative, creative thinking and independent research ability. Students have to initiate their own small conceptual or practical based projects individually as a team of no more than 2 members. While making this exercise it is expected that the knowledge acquired by them through application of subjects leant so far is applied by them carrying out mini project work will certainly help the students for satisfactory and successful completion of their major project in the final year. 2. A mini project report is to be written upon completion of the activity. For team projects, each member has to write his own report. The report should include academic content such as the background, objectives, product/system description, the work done, the achievements and difficulties encountered. Students will deliver report presentation and demonstration of their work. The assessment will be done by mini project guide.	12
II	**Industrial Visit** 1) Industrial visit of the required subjects should be done. The purpose of Industrial visit is to	--

	learn and observe the actual industrial practices and after visit students have to prepare the industrial visit report individually. The ultimate aim of industrial visit is to give more emphasis on: 1. Introduction of the Industry: Provide an overview of the industry being visited, including its history, significance. 2. Manufacturing Processes: Explore the various stages of production or manufacturing processes involved in the industry, including raw material sourcing, processing, assembly, quality control, and distribution. 3. Technology and Machinery: Examine the technology and machinery utilized in the industry, including any innovative equipment or automation techniques employed to enhance efficiency and productivity. 4. Plant Layout: Draw the detailed Plant layout of the industry representing various departments, production line, labs, etc. 5. Health and Safety Practices: Discuss the health and safety regulations and practices implemented within the industry to ensure the well-being of workers and compliance with relevant standards. 6. Environmental Impact: Investigate the environmental impact of the industry's operations, including waste management practices, energy consumption, and efforts towards sustainability and eco-friendliness. 7. Supply Chain Management: Analyze the supply chain management practices within the industry, including procurement, logistics, inventory management, and transportation strategies. 8. Industry Challenges and Future Outlook. 2). An Industrial Report is to be written upon completion of the activity. Each member has to write his own report. The report should include all above mentioned points. The assessment will be done by mini project guide	

Year, Program, Semester	S.Y. Part I (Mechanical Engg. Program) Semester III				
Course Code	HSMEC 211				
Course Category	Humanities, Social Sciences, Management, Environment				
Course title	Environmental Studies				
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**
	02	--	--	02	00
Evaluation Scheme	SEE: 70 Marks + IOE: 30 Marks, evaluation only at Even Semester End				
Pre-requisites(if any)	Basic Physics, Basic Chemistry, Basic Mechanical Engineering				
Course Objectives	The course teacher will 1. Introduce students to the fundamental concepts and principles of environmental science. 2. Describe the components of various ecosystems and their interrelationships. 3. Classify different types of natural resources and assess their availability and distribution. 4. Define biodiversity and its significance to ecosystem functioning and human well-being.				
Course Outcomes	Upon completion of this course, student should be able to – 1. Define key terms and concepts related to environmental science. 2. Analyse ecosystem services and their importance to human well-being. 3. Identify various types of natural resources and their significance. 4. Describe the levels and patterns of biodiversity and their importance.				

Unit No.	Course Content	Hours
1	**Nature of Environmental Science:** Definition, scope and importance. Multidisciplinary nature of environmental studiesNeed for public awareness. Introduction to sustainable development: Sustainable Development Goals (SDGs) - targets and indicators, challenges and strategies for SDGs.	4
2	**Ecosystem:** 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, characteristics features, structure and function of the Following ecosystem: -Forest ecosystem, b) Grassland ecosystem, c) Desert ecosystem, d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) Degradation of ecosystems and its impacts.	8
3	**Natural Resources and Associated Problems:** Overview of natural resources: Definition of resource; Classification of natural resources-biotic and abiotic, renewable and non-renewable. Forest resources: Use and over-exploitation, deforestation, dams and their effectson forests and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Water scarcity and stress; Conflicts over water. Soil and Mineral resources: Soil as resource and its degradation, Usage and exploitation, Environmental effects of extracting and using mineral resources, Wasteland reclamation, Energy resources: Growing energy needs, renewable and non- renewable energy	8

	resources, use of alternate energy sources. Solar energy, Biomass energy, Nuclear energy, Role of Indian traditions and culture in conservation of the environment	
4	**Biodiversity and its conservation:** Introduction- Definition: genetic, species and ecosystem diversity, Bio-geographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, India as a mega- diversity nation. Western Ghats as a biodiversity region. Hot-spots 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 Ramsar sites; Biosphere reserves; Protected Areas; Ecologically Sensitive Areas; Coastal Regulation Zone	7

Assignmnts

Nature Visits / Field Work /Field Tour/ Industrial visits / Activities related to Campus environmental management (05 Hrs.)

Text Books

1.	Agarwal, K. C., 2001, Environmental Biology, Nidi Publ. Ltd., Bikaner.
2.	Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad, 380013, India.
3.	Brunner R. C., 1989, Hazardous Waste Incineration, McGraw Hill Inc,

Reference Books

1.	Cunningham, W. P. Cooper, T. H. Gorhani, E. & Hepworth, M. T. ,2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai,
2.	Gleick, H., 1993, Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute. Oxford Univ. Press.
3.	Hawkins R. e., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R).
4.	Heywood, V. H. & Watson, R. T., 1995, Global Biodiversity Assessment, Cambridge Univ. Press.
5.	Jadhav, H. & Bhosale, V. M., 1995, Environmental Protection and Laws, Himalaya Pub. House, Delhi.
6.	Mckinney, M. L. & Schocl. R. M. ,1996, Environmental Science Systems & Solutions, Web enhanced edition.
7.	Odum, E. P., 1971, Fundamentals of Ecology, W. B. Saunders Co. USA.
8.	Rao M. N. & Datta, A. K. ,1987, Waste Water Treatment, Oxford & IBH Publ. Co. Pvt. Ltd.
9.	Sharma B. K., 2001, Environmental Chemistry, Goel Publ. House, Meerut.
10.	Trivedi R. K. and P. K. Goel, Introduction to air pollution Techno-Science Publications (TB).
11.	Trivedi R. K., Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro Media (R).
12.	Wagner K. D., 1998, Environmental Management, W. B. Saunders Co. Philadelphia, USA.

Useful web links

1.	https://onlinecourses.swayam2.ac.in/cec19_bt03/preview
2.	http://nitttrc.edu.in/nptel/courses/video/109105203/L41.html

Shivaji University, Kolhapur

Department of Technology

Second Year B. Tech (Mechanical Engineering), Semester-IV

Year, Program, Semester	Second Year B. Tech, (Mechanical Engineering) ,Semester IV							
Course Code	PCC 221							
Course Category	Professional Core Course							
Course title	**Fluid and Turbo Machinery**							
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Total Credits		
	03	-	--	03		03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total	
	30	70	---	---	--	--	100	
Pre-requisites(if any)	In order to complete the course studies successfully, it is important to have a good command of English, Engineering Physics, Chemistry-I, Fluid Mechanics, Thermodynamics-I and Fluid Flow Operations.							
Course Objectives	The course is aimed at – 1.To understand impulse momentum principle and its applications 2. To learn the working principles of impulse and reaction water turbines. 3. To illustrate the concept of different types of pumps and compressor. 4.Train the students to acquire the knowledge and skill of analyzing different turbo machines							
Course Outcomes	Upon completion of this course, student should be able to – 1. To design and calculate different parameters for turbo machines. 2. To understand thermodynamics and kinematics behind turbo machines. 3. To formulate design criteria. 4. To understand the concept of centrifugal and axial compressors.							

Unit No.	Course Content	Hours
I	**Impulse Water Turbines** Introduction to turbo machinery, Classifications, Machines classification of water turbines, Pelton wheel, its construction and working, velocity triangles. Pelton wheel design bucket dimensions, number of buckets, jet diameter, wheel diameter, jet ratio, speed ratio, number of jets, calculation of efficiency, power, discharge etc. Governing of Pelton wheel. **(Note: The chapter includes numerical treatment on the appropriate topics.)**	6
II	**Reaction Water Turbines** Principle of operation, construction and working of Francis and Kaplan Turbine, effect of modification of velocity triangles on runner shape, draft tube, calculation of various efficiencies, power, discharge, blade angles, runner dimensions etc. Governing of Francis and Kaplan turbine. Draft tube-types and analysis. Compare the impulse and reaction turbines with each other. **(Note: The chapter includes numerical treatment on the appropriate topics.)**	6

III	**Centrifugal Pumps** Working principles, Construction, various heads, multistage pumps, velocity triangles, minimum starting speed, cavitation, MPSH and NPSH. Methods of priming calculations of efficiencies, discharge, blade angles, head, power required, impeller dimensions etc. **(Note: The chapter includes numerical treatment on the appropriate topics.)**	6
IV	**Similarity Principles** Model testing, unit quantities, Specific speed of turbine (Pelton wheel, Francis turbine, Kaplan turbine), specific speed of pumps. Prediction of performance at other operating conditions. Performance characteristics of Turbines and pumps. **(Note: The chapter includes numerical treatment on the appropriate topics.)**	6
V	**Air compressors** Application of compressed air , classification of compressor, reciprocating compressors, construction , work input, necessity of cooling , isothermal efficiency, heat rejected, effect of clearance volume, volumetric efficiency, necessity of multi staging, construction, optimum intermediate pressure for minimum work required, after cooler, Roots blower and vane blower (descriptive treatment) **(Note: The chapter includes numerical treatment on the appropriate topics.)**	6
VI	**Rotodyanamic Air Compressors** Centrifugal compressor- velocity diagram, pre whirl, slip factor, performance calculations. Axial flow compressors- velocity diagram, degree of reaction, polytropic efficiency, surging, chocking, stalling, performance, comparison with centrifugal. Screw compressors. **(Note: The chapter includes numerical treatment on the appropriate topics.)** **Suggested list of Tutorials and Assignments:** Each Student has to write at least 6 assignments on entire syllabus.	6

Text Books

1.	“Fluid Mechanics & Hydraulic Machines”, Dr. R.K. Bansal, Laxmi Publications LTD, revised 9th Edition
2.	“Steam and gas Turbines”, R. Yadav, Central Publishing House, Allahabad, 6th Edition , 1997 .
3.	“Gas Turbines”, V. Ganeshan, Published by TMH Education Pvt. Ltd. , 3rd Edition.
4.	“Thermal Engg.”, Kumar vasant dani, Khanna publisher
5.	“Thermal Engg.”,P.L. Balleny, Khanna publisher. , 20th Edition

Reference Books

1.	“Hydraulic Machines” V.P. Vasantdani
2.	“Fluid flow machines” N.S. Govindrao
3.	“Turbo machines” S.M. Yahya
4.	“Fluid power Engineering” D.S. Kumar
5.	“Steam and gas Turbines” R. Yadav
6.	"Fluid Mechanics",White McGraw Hill Publication
7.	"Advanced Fluid Engineering", Murlidhar, Narosa Publication.
8.	"Fundamentals of fluid mechanics", G.S.Sawhney I.K. International Publishing House Pvt. Limited, New-Delhi, 2008 New York
9.	"Mechanics of Fluid",Irving Shames McGraw Hill Publication

Useful web links

1. **https://archive.nptel.ac.in/courses/112/106/112106200/**

Year, Program, Semester	Second Year B. Tech, (Mechanical Engineering) ,Semester IV							
Course Code	PCC 221							
Course Category	Professional Core Course							
Course title	**Fluid and Turbo Machinery (Practical)**							
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Credits		
	--	-	02	02		**01**		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total	
	-	-	-	50	50	-	50	
Pre-requisites(if any)	In order to complete the course studies successfully, it is important to have a good command of English, Engineering Physics, Chemistry-I, Fluid Mechanics, Thermodynamics-I and Fluid Flow Operations.							
Course Objectives	The course is aimed at - 1. To describe the main / operating characteristics of turbines and pumps. 2. To explain the working of reciprocating compressor. 3. To distinguish between different hydraulic devices. 4. To distinguish between different types of pumps.							
Course Outcomes	Upon completion of this course, student should be able to – 1. Conduct trial and Calculate performance parameters of different turbomachinery. 2. Draw and compare performance characteristics curves with their theoretical nature of different turbomachinery. 3. Explain construction and working of different types of pumps. 4. Explain construction and working of various hydraulic devices.							

Experiment No.	Experiment Title/Objective (Any Seven)	Hours
1.	Study and trial on Pelton wheel.	02
2.	Study and trial on Francis/ Kaplan turbine	02
3.	Trial on Centrifugal pump	02
4.	Study and demonstration of reciprocating pump	02
5.	Study and trial on single stage reciprocating compressor	02
6.	Study and trial on two stage reciprocating compressor	02
7.	Study of hydraulic devices- Intensifier, Accumulator, Hydraulic jacks, press, Crane.	02
8.	Study of other types of pumps- Gear pump, Jet pump, submersible pump, air lift pump	02
9.	Industrial visit or hydro power plant visit	02
10.	Study of minor losses in the flow system.	02

General Instructions: Institute's Laboratory Course Manual and equipment wise Standard Operating Procedure to follow.

Suggested Reference Books:

1. Institute's Laboratory Course Manual and equipment wise Standard Operating Procedure to follow.

Year, Program, Semester	Second Year B. Tech, (Mechanical Engineering) ,Semester IV						
Course Code	PCC 222						
Course Category	Professional Core Course						
Course title	**Strength of Materials**						
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**		
	03	-	-	03	03		
Evaluation Scheme	**ISE**	**ESE**	**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	30	70	---	----	--	--	100
Pre-requisites(if any)	Applied Mechanics						
Course Objectives	The course is aimed at - 1. Develop the theoretical basis about the stress, strain and elastic modulus concepts in various components. To learn about applications of first law to various conversion devices. 2. To familiarize about finding shear force, bending moment, deflection and slopes in various types of beams with different load conditions.. 3. To enable students to solve practical problems related to shafts & springs. 4. To enable students to solve practical problems related to Pressure Vessel.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Explain basic laws, relationship between elastic constants, principal stress and principal planes. 2. Solve the problems related to shear force, bending moment, deflection and slope in various types of beams. 3. Solve the practical problems related to shafts and springs. 4. Solve practical problems and design thin cylinders, Spherical Shell.						

Unit No.	Course Content	Hours
1	**Simple stresses and strains** Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses- elastic constants and their relations- volumetric, linear and shear strains Principal stresses and principal planes – Mohr's Circle , (Numerical)	6
2	**Shear Force & bending Moment Diagrams** Shear force and bending moment diagrams Concept and definition of shear force and Bending Moment in beams due to Point load, UDL, UVL. Construction of SF, and BM diagrams for cantilevers, simply support beam. (Numerical)	6
3	**Bending and Shear Stresses in beams** Theory of simple bending, concept and assumptions, Derivation of Flexure formula. Bending stress distribution diagram. Moment of resistance and section modules calculations. Shear stresses concept, shear stress distribution diagram for common symmetrical sections such as : circular, I, and T (Numerical)	6
4	**Torsion of Circular Shaft & Impact load** Torsion of circular shaft – Torsion, stresses and deformation in circular and hollow shafts, Basic assumptions, Derivation of torsion formulae, (Numerical). **Strain energy and impact load-** Concept of strain energy, derivation and use of expressions for deformation of axially loaded members under gradual sudden and impact loads, (Numerical)	6

5	**Deflection of beams , Axially loaded column** Concept and definition, relation between B.M., slope and deflection, Calculations of slope and deflection. **Axially Loaded Column –** Theory of Columns, Concept of critical load and buckling, Euler's formulae for different end connections, Rankin's formulae, safe load on column, Limitations of Euler's formulae. (Numerical)	6
6	**Pressure Vessels** Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thin cylinders, deformation in spherical shells subjected to internal pressure (Numerical)	6
	Assignment Students should write at least 5/6 questions on each unit.	

	Text Books
1.	"Strength of Materials", Dr. R.K. Bansal, Laxmi Publications
2.	"Strength of Materials", R.K. Rajput, Laxmi Publications Pvt. Ltd. New Delhi
3.	"Mechanics of Materials", R.C. Hibbeler , PEARSON Publication
4.	"Strength of Materials", Timoshenko and Young , CSB Publishe
5.	"Strength of Materials", G.H. Rider, Mac Millan India Ltd
	Reference Books
1.	"Mechanics of Material", Gere &Timoshenko, CSB Publisher 1984
2.	"Introduction to Mechanics of solids", E.P. Pov, Prentice Hall Publication.
3.	"Strength of Materials", Singer and Pytel , Harper and Row Publications.
4.	"Mechanics of Materials", R.C. Hibbeler , PEARSON Publication
	Useful web links
1.	**https://archive.nptel.ac.in/courses/122/107/122107035/**

Year, Program, Semester	Second Year B. Tech, (Mechanical Engineering) ,Semester IV							
Course Code	PCC 223							
Course Category	Professional Core Course							
Course title	**Manufacturing Processes**							
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Total Credits		
	03	-	--	03		03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total	**Duration of SEE**
	30	70	---	--	--	--	100	**4 hours**
Pre-requisites(if any)	To complete the course studies successfully, it is important to have a good command of English. Other Pre-requisites include the study of Metal Cutting and Machine Tools							
Course Objectives	1. To understand the manufacturing processes and primary shaping processes. 2. To explain the fundamentals in metal forming processes such as casting, forging, rolling, extrusion, wire drawing, sheet metal working, etc. 3. To explain the importance of welding processes in manufacturing based on the type of industrial application. 4. To introduce the design practices of jigs, fixtures, and die design for Press work.							
Course Outcomes	Students will be able to 1. To summarize and classify different manufacturing processes 2. To analyze and assess the importance of welding processes in manufacturing and for application. 3. Design of jigs and fixtures for simple components. 4. Design of press tool die for simple components.							

Unit No.	Course Content	Hours
I	**Foundry: Pattern making, moulding and casting** Importance of casting as manufacturing process, advantages and disadvantages of casting processes, foundry layouts and mechanization 2. Introduction to patterns, core boxes and gating systems: types of patterns, pattern materials, pattern making allowances, core boxes, core making, core prints, components of gating system, functions and importance of runners and risers, solidification control devices: chills, ceramics bricks, progressive and directional solidification, sand properties **(Note: Numerical treatment of gating and riser system design)** 3. Hand and machine moulding 4. Melting and pouring - melting furnaces- fuel fired, electric arc and induction furnaces. Cleaning, finishing of casting, casting defects anremedies 5. Advanced casting methods: Lost wax processes, shell moulding and investment casting. Permanent mould dies casting- Die-casting, centrifugal casting, and continuous	06

	casting. 6. safety and environmental aspects of manufacturing processes.	
II	**Metal Forming Processes** Hot, cold and worm working. Recovery and Recrystallization. Formability and parameters affecting the yield strength of materials. Classification of various metal Forming processes, their special features with respect to other manufacturing processes. Friction and lubrication in Metal Forming processes. Stresses in Metal Forming process. **Forging:** Basic operations, types of forging, forging hammers/ presses, forging stages and force calculations, die design considerations, forging applications, Defects and remedies in forging process.	06
III	**Rolling** Classification of rolling processes, rolling mill types, condition for natural entry in rolling operation, number of passes in rolling, roll bite, elongation, reduction, rolling of sheets, plates, bars, sections and tubes. Applications, defects and remedies in rolling process. **Extrusion:** Equipment and principles, types of extrusion, direct, indirect, impact, continuous, hydrostatic, tube extrusion, metal flow in extrusion, Die design considerations, factors affecting extrusion load, defects and remedies in extrusion. **Drawing:** Types of Drawing, Rod and wire drawing, Die Design considerations, equipment and principles of process, Tube drawing, defects and remedies in drawing.	06
IV	**Joining Processes** 1. Introduction, classification of joining processes 2. Arc welding- Theory, SMAW, GTAW, GMAW, FCAW, Submerged arc welding, Stud welding, Resistance welding- Theory, spot and seam projection welding processes , Gas welding Friction welding, Ultrasonic welding, Thermit welding, EBW and LASER welding 3. Welding defects and quality control in welding	06
V	**Design of Jigs and Fixtures** Definition, Applications, basic elements, principles and types of locating, clamping and indexing elements, auxiliary elements like tenon, setting block etc. Type of Drilling jigs and Milling fixtures-Design consideration of Jigs and fixtures with respect to different operations.	06
VI	**Press Tools** Elements of Dies and Punch set. Types of dies – simple, compound, combination and progressive dies and punches of various press working operations such as punching, blanking, drawing, bending, forming, coining etc. Design of Blanking die, Progressive die, Calculations of clearances, center of pressure, different forces, press tonnage, strip layout, sheet utilization ratio, methods of reducing forces.	06
	Note: 1. The unit no.V, includes drawing a jigs/ fixtures for simple objects whereas unit no. VI, includes drawing sheet on press tools. **2. The course includes numerical treatment on the appropriate modules of various units.)** **Suggested list of Assignments:** Each Student has to write at least 6 assignments on entire syllabus.	

Text Books	
1.	Chapman, “Workshop technology” vol. I,II and III, Edward Arnold Publication Ltd. London
2.	S.K Hajra Chaudhary, “Workshop Technology”, Vol. I and II, Media Promoters and Publication, Mumbai.
3.	R. K. Jain, “Production technology”, Khanna Publications.
4.	P.C. Sharma, “A Textbook of Production Technology (Manufacturing Processes)”, S. Chand & Co., 8th Edition, 1999, ISBN: 978-8121901116
5.	P. L. Jain, “Principles of Foundry Technology”, Tata McGraw-Hill, New Delhi, 5th Edition,2009, ISBN: 0070151296, 9780070151291
6.	R. K. Rajput, “ A Textbook of Manufacturing Technology”, Laxmi Publications, 2016, ISBN:9788131802441
Reference Books	
1.	HMT Hand book- “Production Technology”.
2.	E. Paul DeGarmo, J.T. Black, Ronald A. Kosher, “Materials and Processes in Manufacturing”, John Wiley and Sons Ltd, 9th revised edition, 2004.ISBN:,9780471656777
3.	S. E. Rusinoff: “Manufacturing Processes”, Times India Press. Doyle, Manufacturing Processes and Materials for engineers, Prentice Hall of India Press
4.	S. K. Basu, “Fundamentals of Tool Design”, Oxford IBH
5.	Donaldson, “Tool Design”, THM Publication, 3rd Edition.
6.	Kempster “Jigs and Fixtures”, ELBS.
Useful web links	
1.	https://onlinecourses.nptel.ac.in/noc21_me30/preview

Year, Program, Semester	Second Year B. Tech, (Mechanical Engineering) ,Semester IV						
Course Code	PCC 223						
Course Category	Professional Core Course						
Course title	**Manufacturing Processes- Lab**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Credits		
	--	-	02	02	01		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	---	--	---	50	--	--	50
Pre-requisites(if any)	Pre-requisites include the study and knowledge of Metal Cutting and Machine Tools, and its safe practices.						
Course Objectives	1. To explain patterns and its types, material used, allowances. 2. To classify and study different metal forming processes and process parameters. 3. To explain the importance of welding processes in manufacturing. 4. To explain the design practices of jigs, fixtures, and die design.						
Course Outcomes	1. To explain the types, allowances and construction of pattern. 2. To Compare different types of metal forming Process 3. To acquire machining skills to fabricate a job on various machining tools. 4. To design and drawing a jig, fixtures and press tool.						

Experiment No.	Experiment Title/Objective	Hours
1.	Study the different types of patterns the materials used, and allowances.	02
2.	Study of metal forming processes such as casting, forging, rolling, extrusion, etc.	02
3.	Study of metal forming processes such as wire drawing, sheet metal working, etc.	02
4.	Study of various elements of jigs and fixtures.	02
5.	Design and drawing of any one drilling jig.	02
6.	Design and drawing of any one milling fixture.	02
7.	Design and drawing of any one die set.	
8.	Study of CNC machines	
9.	Fabrication of a job involving turning, drilling, milling, and welding (One or two jobs)	02
10.	Visit a factory to study the various foundry and foundry-related operations	02
	General Instructions: • Institutes Laboratory Course Manual and equipment-wise Standard Operating Procedure to follow. • Conduct any eight experiments from the above. • Batch-wise practicals are to be conducted. The number of students per batch should be as per the practical batches. • Each Student has to write a practical journal.	
Reference Books and web links		
1.	Chapman, “Workshop technology” vol. I,II and III, Edward Arnold Publication Ltd. London	

2.	S.K.Hajara Chaudhary, “Workshop Technology”, Vol. I and II, Media Prom and Publication, Mumbai.
3.	Hoffman: “Introduction to Jigs and Fixtures”, Galgotia Publishers
4.	P.C. Sharma, “Text Book of Production Engineering”, S. Chand Publication, 11th Edition.
5.	P.H.Joshi, “Jigs and Fixture”, Mc Graw Hill, new Delhi.
6.	R. K. Rajput, “ A Textbook of Manufacturing Technology”, Laxmi Publications, 2016, ISBN:9788131802441
7.	P. L. Jain, “Principles of Foundry Technology”, Tata McGraw-Hill, New Delhi, 5th Edition,2009, ISBN: 0070151296, 9780070151291
8.	https://www.vlab.co.in/ba-nptel-labs-mechanical-engineering

Year, Program, Semester	Second Year B. Tech, (Mechanical Engineering) ,Semester IV						
Course Code	PCC 223						
Course Category	Professional Core Course						
Course title	**Kinematics of Machines**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-	--	03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	---	---	--	--	100
Pre-requisites(if any)	--						
Course Objectives	The course is aimed at - 1. Make the student familiar with commonly used mechanism for industrial application. 2. Develop competency in drawing velocity and acceleration diagram for simple and complex mechanism 3. Develop an ability to design gear drive and cam profile for given application 4. Impart the knowledge of working of belt drives.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Identify mechanism that should be used according to application and find the degree of freedom of different mechanism. 2. Demonstrate the kinematics of cams and followers and their characteristics and also design cams and followers for specified motion profiles. 3. Differentiate between types of gears and to analyse the characteristics of meshing gears. 4. Select different power transmitting elements according to application.						

Unit No.	Course Content	Hours
I	**Machines and Mechanism** Structure, Machine, Link and its types Kinematics pair: Lower pair and higher pair, Form closed pair and force closed pairs, Based on relative motion permitted such as revolute, prismatic, cam, helical, globular. Kinematics chain and Mechanisms: Grublers criterion for movability of chains and mechanisms, Limitations of Grublers Criteria. Inversion of chain: Study of various mechanisms derived from inversions of following Four bar chain (Grashoffian, and non-Grashoffian), Single slider crank chain, and Double slider crank chain Offset slider crank mechanisms Pantograph, Hook joint single and Steering gear mechanisms – Ackerman, Davis	7
II	**Kinematics** Velocity and Acceleration Diagrams: Velocity and acceleration- Motion of link in machine- Determination of velocity and acceleration, Graphical method, application of relative velocity method, slider crank mechanism, four bar mechanism, acceleration diagrams for simple mechanism, Coriolis	7

	acceleration, determination of Coriolis component of acceleration, Kliens construction, analysis of slider crank mechanism for displacement, velocity and acceleration of slider using analytical method. Instantaneous Centre Method: Instantaneous centre of rotation, centrode and axode- relatice motion between two bodies- three centres in-line theorem, locating instantaneous centres for simple mechanism and determination of angular velocities of point and joints.	
III	**Gear** Gears-Introduction, types, Law of gearing, Construction of Involute and Cycloid gear tooth profile, Details of gear terminology, involutes and cycloidal tooth profile, Interference in involutes gears, Critical numbers of teeth for interference free motion Methods to control interference in involutes gears. Helical Gears- Nomenclatures, center distance, Spiral Gears- Center distance, efficiency.	6
IV	**Gear Train** Gear Trains: Kinematics and dynamic analysis of simple and compound gear trains, reverted gear trains, epi-cycle gear trains with spur gear combination	6
V	**Mechanical Power Transmitting** Belt Drive- Calculation of power transmitted, Belt tension ratio, Actual tension in a running belt, Centrifugal and initial tension in belt, Slip and creep of belt, V Belts, Selection of Belts. [Numerical Treatment on flat belt only]	6
VI	**Cams and Followers** Classification of cams, Classification of followers, Terminologies of cam and follower, Motions of Follower a) Uniform velocity b) Simple harmonic motion c) Uniform acceleration and retardation d) Cycloidal motions, Displacement diagram of follower, Velocity and acceleration diagram of Follower, Construction of cam profile	6

	Text Books
1.	“Theory of Machines” Ratan S.S Tata McGraw Hill New Delhi.
2.	“Theory of Machines” P.L.Ballany Khanna Publication, New Delhi
3.	“Theory of Machines “V.P. Singh Dhanpat Rai and
4.	“Theory of machines” Dr. R. K. Bansal Laxmi Publication
	Reference Books
1.	“Theory of Machines” Thomas Bevan CBS Publishers, New Delhi.
2.	“Theory of Machines and Mechanism” Shigley Oxford International
3.	“Theory of mechanism and machines” Sadhu Singh Pearson
4.	“Theory of machines and Mechanism” Jagdish Lal Metropolitin Book Company
5.	“Mechanism and Machines” Gosh And Mallik East West Press
6.	“Theory of Machine” Sarkar Tata Mc Graw Hill

Year, Program, Semester	Second Year B. Tech, (Mechanical Engineering) ,Semester IV						
Course Code	PCC 223						
Course Category	Engineering Science Course						
Course title	**Kinematics of Machines (Practical)**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Credits		
	--	-	**02**	02	**01**		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	--	--	---	--	50	--	50
Pre-requisites(if any)	--						
Course Objectives	The course is aimed at - 1. Determine slip and angular velocities. 2. Distinguish between different types of mechanism and machine. 3. Understand the Inversion of kinematic chain, limiting position and dead position. 4. Demonstrate of x-t, v-t, a-t, curves of follower motions.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Calibrate slip and angular velocities. 2. Illustrate different types of mechanism and machine. 3. Apply the inversion of kinematic chain, limiting position and dead position 4. Calibrate of x-t, v-t, a-t, curves of follower motions						

Experiment No.	**Experiment Title/Objective (Any Eight)**	**Hours**
1..	Inversion of kinematic chain, limiting position and dead position	02
2.	Location of instant center, Velocity analysis by ICR	02
3.	Velocity and acceleration analysis by relative method.	02
4.	Construction of cam profile.	02
5.	Construction of x-t, v-t, a-t, curves of follower motions	02
6.	To generate gear tooth profile and to study the effect of under cutting and rack shift using model.	02
7.	Numerical Problems on gear and gear train	02
8.	Verification of ratio of angular velocities of shafts connected by Hooks joint.	02
9.	To determine the belt slip	02
10.	To study frictional properties of clutch/brake lining and to determine experimentally torque carrying capacity and slip of the clutch or brake.	02
11.	To determine the coefficient of friction and wear of a given material.	02
12.	Simulation of motions of mechanism using CAD package	02

Text Books	
1.	“Theory of Machines” Ratan S.S Tata McGraw Hill New Delhi.
2.	“Theory of Machines” P.L.Ballany Khanna Publication, New Delhi
3.	“Theory of Machines “V.P. Singh Dhanpat Rai and
4.	“Theory of machines” Dr. R. K. Bansal Laxmi Publication
Reference Books	
1.	“Theory of Machines” Thomas Bevan CBS Publishers, New Delhi.
2.	“Theory of Machines and Mechanism” Shigley Oxford International
3.	“Theory of mechanism and machines” Sadhu Singh Pearson
4.	“Theory of machines and Mechanism” Jagdish Lal Metropolitin Book Company
5.	“Mechanism and Machines” Gosh And Mallik East West Press
6.	“Theory of Machine” Sarkar Tata Mc Graw Hill

Year, Program, Semester	Second Year B. Tech, (Mechanical Engineering) ,Semester IV					
Course Code	PCC 224					
Course Category	Professional Core Course					
Course title	**Machine Design I**					
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Total Credits
	03	-	--	03		03
Evaluation Scheme	ISE	ESE		IE	EE	Total
	30	70		----	--	100
Pre-requisites(if any)	Engineering Mechanics, Material Science and Machine Drawing					
Course Objectives	The course is aimed at - 1. To understand fundamental aspects of design. 2. To study design procedures of different mechanical components. 3. To understand stresses and strain induced in the component. 4. Study of component behavior and failure criteria's of different mechanical components subjected to loads..					
Course Outcomes	Upon completion of this course, student should be able to – 1. Formulate the problem by identifying customer need and convert into design specification. 2. Design of components like shaft, key, coupling, spring, power screw, Knuckle joint, Cotter joint and turn buckle etc. 3. Analyze the stresses and strain induced in the component. 4. Understand component behavior subjected to loads and identify failure criteria.					

Unit No.	Course Content	Hours
I	Unit I: Fundamental Aspects of Design The meaning of design, Engineering design, Phases of design, factor of safety and its selection, standardization, preferred series, material selection- weighted point method. Concurrent Engineering. (Note: The unit includes numerical treatment on the appropriate topics.)	5
II	Unit II: Design Against Static Load Commonly used engineering materials and their important mechanical properties – Cast Iron, Mild Steel, Non-ferrous materials like Copper and Brass, Stress-strain relationship, stresses due to bending and torsional load, design of Cotter joint, Knuckle joint, and Turn-buckle. (Note: The unit includes numerical treatment on the appropriate topics.)	6
III	Unit III: Design of Shafts, Keys and Coupling Shaft design on strength basis, Shaft design on Torsional rigidity basis, A.S.M.E. code for shaft Design, Types of keys, Design of Flat key and Square key, Design of Muff coupling, Clamp coupling. (Note: The unit includes numerical treatment on the appropriate topics.)	7
IV	Unit IV: Design of Power Screws Forms of Threads, Terminology of Power screw, Torque requirement for lifting and lowering load, efficiency of square threaded screw and self-locking screw, design of power screws.	6

	(Note: The unit includes numerical treatment on the appropriate topics.)	
V	Unit V: Design of Mechanical Springs Springs, Types of Spring, Terminology of Helical Spring, Styles of End, Spring Material,	6
	Design of Helical springs, Concept Helical Torsion Spring, Multi Leaf Spring and Equalized Stress in Spring Leaves (Nipping) (Note: The unit includes numerical treatment on the appropriate topics.)	
VI	Unit VI: Design of Welded Joints Types of welded joints, eccentrically loaded joints, and welded joints subjected to bending moment, Strength of welded joints. (Note: The unit includes numerical treatment on the appropriate topics.)	6
Text Books		
1.	Bhandari V.B. "Design of Machine Elements" , Tata McGraw Hill Publ. Co. Ltd.	
2.	Khurmi R.S. and Gupta J.K, "A Text Book of Machine Design", S.Chand Publ. Co. Ltd.	
Reference Books		
1.	Spotts M.F. and Shoup T.E. "Design of Machine Elements", Prentice Hall International.	
2.	Shigley J.E. and Mischke C.R., "Mechanical Engineering Design", McGraw Hill Publ. Co. Ltd.	
3.	Black P.H. and O. Eugene Adams , "Machine Design" , McGraw Hill Book Co. Ltd.	
4.	William C. Orthwein, "Machine Component Design", West- publishing Co. and Jaico Publ. House.	
5.	"Design Data", P.S.G. College of Technology, Coimbatore.	
6.	Juvinal R.C. , "Fundamentals of Machine Components Design", John Wiley and Sons.	
7.	Hall A.S.; Holowenko A.R. and Laughlin H.G. , "Theory and Problems of Machine Design" , Schaum's outline series.	

Year, Program, Semester	Second Year B. Tech, (Mechanical Engineering) ,Semester IV					
Course Code	PCC 224					
Course Category	Professional Core Course					
Course title	**Machine Design I (Practical)**					
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Total Credits
	--	-	02	02		01
Evaluation Scheme	ISE		ESE	IE	EOE	Total
	--		--	----	50	50
Pre-requisites(if any)	Engineering Mechanics, Material Science and Machine Drawing					
Course Objectives	1. Study basic principles of machine design. 2. Understand the methods involved in evaluating the dimensions of a component to satisfy Functional and strength requirements. 3. Learn use of catalogues and design data book to extract required design information					
Course Outcomes	Upon completion of this course, student should be able to – 1. Identify and apply basic principles of machine design. 2. Design machine elements on the basis of strength concept. 3. Formulate and solve the problems of various machine elements used in industries. 4. Prepare assembly and detail drawings for different machine elements.					

Sr. No.	Design Project/ Assignments/ Case study	Hours
1.	Assignment based on problems of Preferred series and weighted point method for material selection.	02
2.	Design procedure, calculations and drawing of Cotter joint or Knuckle joint.	04
3.	Assignment based on problems of Shaft design and key design.	04
4.	Design Calculations and Drawing of Muff coupling or Clamp Coupling.	04
5.	Assignment based on problems of power screw design.	02
6.	Case Study on design of mechanical spring with its drawing and practical application.	04

Text Books

1.	Bhandari V.B. “Design of Machine Elements” , Tata McGraw Hill Publ. Co. Ltd.
2.	Khurmi R.S. and Gupta J.K, “A Text Book of Machine Design”, S.Chand Publ. Co. Ltd.

Reference Books

1.	Spotts M.F. and Shoup T.E. “Design of Machine Elements”, Prentice Hall International.
2.	Shigley J.E. and Mischke C.R., “Mechanical Engineering Design”, McGraw Hill Publ. Co. Ltd.

3.	Black P.H. and O. Eugene Adams , "Machine Design" , McGraw Hill Book Co. Ltd.
4.	William C. Orthwein, "Machine Component Design", West- publishing Co. and Jaico Publ. House.
5.	"Design Data" – P.S.G. College of Technology, Coimbatore.
6.	Juvinal R.C. , "Fundamentals of Machine Components Design", John Wiley and Sons.
7.	Hall A.S.; Holowenko A.R. and Laughlin H.G. , "Theory and Problems of Machine Design" , Schaum's outline series.

<table>
<tr><td>Year, Program, Semester</td><td colspan="7">Second Year B. Tech, (Mechanical Engineering) ,Semester IV</td></tr>
<tr><td>Course Code</td><td colspan="7">IKS221</td></tr>
<tr><td>Course Category</td><td colspan="7">Indian Knowledge system</td></tr>
<tr><td>Course title</td><td colspan="7">Introduction to Performing Arts</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Total Contact Hours</td><td colspan="3">Total Credits</td></tr>
<tr><td>01</td><td>-</td><td>--</td><td>01</td><td colspan="3">01</td></tr>
<tr><td rowspan="2">Evaluation Scheme</td><td>ISE</td><td>ESE</td><td>IOE</td><td>IPE</td><td>EOE</td><td>EPE</td><td>Total</td></tr>
<tr><td>---</td><td>---</td><td>50</td><td>----</td><td>----</td><td>----</td><td>50</td></tr>
<tr><td>Pre-requisites(if any)</td><td colspan="7"></td></tr>
<tr><td>Course Objectives</td><td colspan="7">Course Objective Statements: The course teacher will ensure
1. Introduce fundamental concepts, history, and theoretical frameworks of various performing arts forms.
2. Cultivate appreciation for cultural, social, and aesthetic dimensions of performing arts.
3. Develop critical thinking and analytical skills through performance analysis.
4. Enhance communication and presentation skills through practical exercises.
5. Foster creativity and imagination through exploration of diverse performing arts mediums.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">Course Outcomes Statements: By the end of the course, students will be able to
1. Identify and analyze key elements and techniques across theater, dance, music, and visual arts.
2. Demonstrate understanding of historical, cultural, and social contexts in performing arts.
3. Critically evaluate performances using appropriate terminology.
4. Apply performance principles to effectively communicate ideas and emotions.
5. Engage in creative expression through original performances.</td></tr>
</table>

Unit No.	Course Content	Hours
1	Unit 1: Foundations of Performing Arts (2 hours) • Introduction to Performing Arts: Definition, scope, and significance. • Historical overview: Evolution of performing arts across cultures and civilizations.	2
2	Unit 2: Theatrical Arts • Introduction to theater: Origins, elements, and dramatic conventions. • Major theatrical movements and styles: Realism, surrealism, absurdism, etc. • Analysis of selected plays and playwrights.	3
3	Unit 3: Dance Forms • Introduction to dance: Styles, techniques, and cultural contexts. • Exploration of classical, folk, and contemporary dance forms. • Practical exercises and choreography workshops.	3
4	Unit 4: Musical Expressions • Introduction to music: Basic principles, genres, and traditions. • Appreciation of classical, folk, and popular music styles. • Analysis of musical compositions and performances.	2
5	Unit 5: Visual Performing Arts • Introduction to visual arts in performance: Set design, costume, and makeup. • Role of visual elements in enhancing the theatrical experience. • Case studies and practical demonstrations.	2
6	Unit 6: Performance and Presentation • Practical application of performing arts principles: Group performances and presentations. • Rehearsal techniques, stage presence, and audience engagement. • Reflection and feedback on individual and group performances.	2

Course Assessment Method

For the internal assessment of the course, with a total evaluation is of 50 marks. Combination of different evaluation methods can be utilized to ensure comprehensive assessment of the students' performance. Following Evaluation Components are suggested:

- Written Assignments: 20 Marks
- Practical Assessments: 20 Marks

- Class Participation and Engagement: 10 Marks

Reference Books	
1.	Bharata Muni, *Natyashastra*, An ancient Indian treatise on performing arts covering various aspects of classical dance, music, and drama, composed between 200 BCE and 200 CE, influencing the theory and practice of Indian performing arts for centuries.
2.	Girish Karnad. (2005). Collected Plays: Volume 1. Oxford University Press.
3.	Mohan Khokar. (2000). Traditions of Indian Classical Dance. Clarion Books.
4.	Sunil Kothari. (2001). Kathak, Indian Classical Dance Art. Abhinav Publications.
5.	Sangeet Natak Akademi. (2005). Indian Music: Tradition and Trends. Sangeet Natak Akademi.
6.	P. Sambamurthy. (2010). South Indian Music, Vol. 1. The Indian Music Publishing House.
7.	Kapila Vatsyayan. (2007). Indian Classical Dance: Tradition in Transition. Publications Division, Ministry of Information and Broadcasting, Government of India.
8.	Vijay Tendulkar. (2010). Collected Plays in Translation. Oxford University Press.
Useful web links	
1.	https://www.youtube.com/watch?v=W7bEzgZrN7s
2.	https://www.youtube.com/watch?v=DQbNpx_CfJY
3.	https://www.youtube.com/watch?v=eGiz50aVYWQ

Year, Program, Semester	Second Year B. Tech, (Mechanical Engineering) ,Semester IV						
Course Code	MAC 222						
Course Category	Mandatory Audit Course						
Course title	**Aptitude Enhancement Course I**						
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**		
	--	01	--	01	--		
Evaluation Scheme	**ISE**	**ESE**	**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	--	--	----	----	----	----	---
Pre-requisites(if any)	Basic Physics, Basic Chemistry, Basic Mechanical Engineering						
Course Objectives	**Course Objective Statements:** The course teacher will ensure to- 1. equip students with critical thinking skills through analytical exercises and problem-solving tasks. 2. foster creativity and innovation by engaging students in structured workshops and practical projects. 3. develop students' emotional intelligence through self-awareness activities and stress management techniques. 4. enhance collaborative skills and effective communication through group discussions and team-based projects.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Demonstrate proficiency in critical thinking by analysing complex problems and proposing effective solutions. 2. Exhibit creativity through the development of innovative projects and solutions. 3. Display heightened emotional intelligence by managing stress, communicating empathetically, and resolving conflicts constructively. 4. Showcase collaborative skills by actively participating in group activities, contributing to team goals, and communicating ideas effectively.						

Unit No.	Course Content	Hours
1	**Course Content** Inter-Personal & Inter-Organizational Communication	2
2	Creative & Critical Thinking	2
3	Group Dynamics & Decision-Making Techniques .	2
4	Emotional Intelligence & Stress Management Strategies (3 hours)	3
5	Assessment	5

Course Assessment Method

For the internal assessment of the course, with a total evaluation is of 50 marks. Combination of different evaluation methods can be utilized to ensure comprehensive assessment of the students' performance. The assessment will focus real-world scenarios that require the application of critical thinking, problem-solving, creativity, emotional intelligence, and teamwork. Following Evaluation Components are suggested:

1. Activity 1- Group Presentation (20 marks)
2. Activity 2- Group Discussion (20 marks)
3. Classroom Participation and Engagement (10 marks)
   Active participation in class discussions, group activities and question-answer sessions.

Studnts should write 6/8 questions on each Unit.

Reference Books

1.	Chakravarthi T. Kalyana and Chakravarthi T. Latha, *Soft Skills for Managers* (Biztantra Publications, 2014 (ISBN: 978-81-7722-568-6))
2.	Kumar Sanjay and Pushp Lata (2015), *Communication Skills*, 2nd Edition, Oxford University Press, (ISBN: 9780199457069)
3.	P. D. Chaturvedi and Mukesh Chaturvedi (2017), *The Art and Science of Business Communication- Skills, Concepts, Cases and Applications*, 4th Edition, Pearson India Education Services Pvt. Ltd., (ISBN 978-93-325-8728-1)
4.	Wright, L. (2001). Critical Thinking: An Introduction to Analytical Reading and Reasoning. Oxford University Press.
5.	Kallet, M. (2014). Think Smarter: Critical Thinking to Improve Problem-Solving and Decision-Making Skills. Wiley.
6.	Bradberry, T., & Greaves, J. (2009). Emotional Intelligence 2.0. TalentSmart.
7.	Dweck, C. S. (2007). Mindset: The New Psychology of Success. Ballantine Books.

Year, Program, Semester	Second Year B. Tech, (Mechanical Engineering) ,Semester IV							
Course Code	PBL221							
Course Category	Project Based Learning							
Course title	**Mini Project II & Industrial Visit**							
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Total Credits		
	-	01	**-**	01		**-**		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total	
	--	--	---	**--**	--	--	--	
Pre-requisites(if any)	Machine Tools and Processes, Tool Engineering, Machine drawing, Machine Design							
Course Objectives	The course is aimed at - 1. To understand the Product Development Process including budgeting through Mini Project. 2. To plan for various activities of the project and distribute the work amongst team of two members. 3. To develop student's abilities to transmit technical information and test the same by working on Mini Project. 4. To learn and observe the actual industrial practices and after visit students have to prepare the industrial visit report.							
Course Outcomes	Upon completion of this course, Students will be able to 1. Understand, plan and execute a Mini Project with the team. 2. Implement various manufacturing techniques, CAD learnt so far for designing and developing a prototype of a model. 3. Prepare a technical report based on the Mini project. 4. Students will able to prepare the industrial visit report. 5. Deliver presentation on Mini Project work carried out.							

Unit No.	Course Content	Hours
I	**Mini Project Completion and Assessment :** 1. The purpose of mini project is to promote self-study, innovative, creative thinking and independent research ability. Students have to initiate their own small conceptual or practical based projects individually as a team of no more than 2 members. While making this exercise it is expected that the knowledge acquired by them through application of subjects leant so far is applied by them carrying out mini project work will certainly help the students for satisfactory and successful completion of their major project in the final year. 2. A mini project report is to be written upon completion of the activity. For team projects, each member has to write his own report. The report should include academic content such as the background, objectives, product/system description, the work done, the achievements and difficulties encountered. Students will deliver report presentation and demonstration of their work. The assessment will be done by mini project guide	12(T)

II	**Industrial Visit** 1). Industrial visit of the required subjects should be done. The purpose of Industrial visit is to learn and observe the actual industrial practices and after visit students have to prepare the industrial visit report individually. The ultimate aim of industrial visit is to give more emphasis on: 1. Introduction of the Industry: Provide an overview of the industry being visited, including its history, significance. 2. Manufacturing Processes: Explore the various stages of production or manufacturing processes involved in the industry, including raw material sourcing, processing, assembly, quality control, and distribution. 3. Technology and Machinery: Examine the technology and machinery utilized in the industry, including any innovative equipment or automation techniques employed to enhance efficiency and productivity. 4. Plant Layout: Draw the detailed Plant layout of the industry representing various departments, production line, labs,etc. 5. Health and Safety Practices: Discuss the health and safety regulations and practices implemented within the industry to ensure the well-being of workers and compliance with relevant standards. 6. Environmental Impact: Investigate the environmental impact of the industry's operations, including waste management practices, energy consumption, and efforts towards sustainability and eco-friendliness. 7. Supply Chain Management: Analyze the supply chain management practices within the industry, including procurement, logistics, inventory management, and transportation strategies. 8. Industry Challenges and Future Outlook. 2). An Industrial Report is to be written upon completion of the activity. Each member has to write his own report. The report should include all above mentioned points. The assessment will be done by mini project guide	--

Year, Program, Semester	Second Year B. Tech, (Mechanical Engineering) ,Semester IV				
Course Code	HSMEC 221				
Course Category	Humanities, Social Sciences, Management, Environment				
Course title	Environmental Studies				
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**
	02	--	--	02	00
Evaluation Scheme	Semester End Exam: 70 marks , Project/Visit based IOE: 30 Marks				
Pre-requisites(if any)	Basic Physics, Basic Chemistry, Basic Mechanical Engineering				
Course Objectives	The course teacher will - 1. Describe the various types and sources of environmental pollution. 2. Explore other global environmental issues, such as biodiversity loss, deforestation, and ocean acidification. 3. Explain key environmental laws and regulations at the national and international levels. 4. Explain the relationship between human society and the environment.				
Course Outcomes	Upon completion of this course, student should be able to – 1. Classify different types of environmental pollutants and their sources. 2. Analyze the interconnections between climate change and other global environmental issues. 3. Understand the legal frameworks and regulations governing environmental protection and management. 4. Describe the socio-economic drivers of environmental degradation and inequality				

Unit No.	Course Content	Hours
1	**Environmental Pollution:** Definition: Causes, effects and control measures of: Air pollution, Water pollution: Causes, effects and control measures, Marine pollution, Soil pollution: Causes, effects and control measures, Noise pollution: Causes, effects and control measures, Thermal pollution: Causes, effects and control measures, Nuclear hazards and their effects. Solid waste Management: Causes, effects and control, measures of urban and Industrial wastes, Role of an individual in prevention of pollution.	7
2	**Understanding climate change and other global environmental issues:-** Structure of atmosphere; greenhouse gas emissions; Projections of global climate change, Importance of 1.5 °C and 2.0 °C limits to global warming; Carbon foot print, -Impacts of climate change: on ocean and land systems; Sea level rise, changes in marine and coastal ecosystems; Impacts on forests and natural ecosystems; Impacts on animal species, agriculture, health, urban infrastructure;-Mitigation of climate change: Green House Gas (GHG) reduction, sink enhancement; Concept of carbon intensity, energy intensity and carbon neutrality; National and international policies for mitigation, net zero targets for the future; Energy efficiency measures; Renewable energy sources for carbon reduction; Carbon capture and storage, Acid Rain: Causes, effects and mitigation, Ozone Layer Depletion: Causes, effects and mitigation	8

3	**Environmental legislation:** Introduction to environmental laws and regulation: Constitutional provisions- Article 48A, Article 51A (g), Environmental Protection Act., Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act.	6
4	**Social Environment:** Environmental ethics, Environmental movements- Chipko Movement, Appiko Movement, Silent Valley Movement. Water conservation: rain water harvesting, watershed management, Disaster management: floods, earthquake, cyclone, tsunami and landslides.	4

Assignmnts

Nature Visits / Field Work /Field Tour/ Industrial visits / Activities related to Campus environmental management (05 Hrs.)

Text Books

4.	Agarwal, K. C., 2001, Environmental Biology, Nidi Publ. Ltd., Bikaner.
5.	Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad, 380013, India.
6.	Brunner R. C., 1989, Hazardous Waste Incineration, McGraw Hill Inc,

Reference Books

13.	Cunningham, W. P. Cooper, T. H. Gorhani, E. & Hepworth, M. T. ,2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai,
14.	Gleick, H., 1993, Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute. Oxford Univ. Press.
15.	Hawkins R. e., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R).
16.	Heywood, V. H. & Watson, R. T., 1995, Global Biodiversity Assessment, Cambridge Univ. Press.
17.	Jadhav, H. & Bhosale, V. M., 1995, Environmental Protection and Laws, Himalaya Pub. House, Delhi.
18.	Mckinney, M. L. & Schocl. R. M. ,1996, Environmental Science Systems & Solutions, Web enhanced edition.
19.	Miller T. G. Jr., Environmental Science, Wadsworth Publishing Co. (TB).
20.	Odum, E. P., 1971, Fundamentals of Ecology, W. B. Saunders Co. USA.
21.	Rao M. N. & Datta, A. K. ,1987, Waste Water Treatment, Oxford & IBH Publ. Co. Pvt. Ltd.
22.	Sharma B. K., 2001, Environmental Chemistry, Goel Publ. House, Meerut.
23.	Trivedi R. K. and P. K. Goel, Introduction to air pollution Techno-Science Publications (TB).
24.	Trivedi R. K., Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro Media (R).
25.	Wagner K. D., 1998, Environmental Management, W. B. Saunders Co. Philadelphia, USA.

Useful web links

1.	https://onlinecourses.swayam2.ac.in/cec19_bt03/preview
2.	http://nitttrc.edu.in/nptel/courses/video/109105203/L41.html

Multidisciplinary Minor
In
Energy Engineering
For
B. Tech (Mechanical Engineering)

Shivaji University, Kolhapur

Department of Technology

Multidisciplinary Minor in Energy Engineering

Teaching & Evaluation Scheme

S.N.	Category	Code	Course Title	Hours per week			Contact Hours	Credits	Evaluation scheme	
									Theory	Practical
				L	T	P			ISE:ESE	IE:EE
1.	Preferably on SWAYAM (NPTEL) or any other MOOCs (Minor Program Core) Or In a Face-to-Face mode	EE-1	Hydrogen and Fuel cell	03	-	-	03	03	30:70	00:00
2.		EE-2	Energy Management	03	-	-	03	03	30:70	00:00
3.		EE-3	Solar Thermal Power Engineering	03	-	-	03	03	30:70	00:00
4.	Minor Program Based Internship	PBI	Industrial Internship (Minor Program Specific Industry)	One Month				03	00:00	50:50
5.	Project Based Learning	PBL	Mini Project	-	-	-	-	02	00:00	50:50
							-	**14**	**300**	**200**
			Total Hours	09	00	00	**09**	-	-	-

Note: MDM Program's Internship and Mini Project need to be planned during winter or summer vacation days after 4th semester while respective evaluations will be the part of 7th and 8th Semesters of the B. Tech Major structure.

Year, Program, Semester	Multidisciplinary Minor I , 4th Semester Onwards						
Course Code	EE01						
Course Category	Minor Program Core						
Course title	Hydrogen and Fuel cell						
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Total Credits	
	03	-	-	03		03	
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	-	-	-	-	100
Pre-requisites(if any)							
Course Objectives	The course is aimed at - 1. To understand the importance of Hydrogen and fuel cell. 2. To get the knowledge of various elements of hydrogen production and storage process. 3. To understand the hydrogen utilization and the role of fuel cell.						
Course Outcomes	Upon completion of this course, student should be able to – 1. To understand the importance of hydrogen and fuel cell 2. To get the knowledge of various elements of hydrogen and fuel cell 3. To understand the emerging trends in fuel and hydrogen cell.						

Unit No.	Course Content	Hours
I	**Introduction of hydrogen energy systems:** Properties of hydrogen as fuel, Hydrogen pathways introduction-current uses, general introduction to infrastructure requirement for hydrogen production, storage, dispensing and utilization, and hydrogen production plants.	6
II	**Hydrogen production processes:** Thermal-Steam reformation, thermo chemical water splitting, gasification-pyrolysis, nuclear thermal catalytic and partial oxidation methods. Electrochemical-Electrolysis, photo electro chemical, Biological-Anaerobic digestion, fermentation micro-organism, PM based electrolyser.	6
III	**Hydrogen storage:** Physical and chemical properties, general storage methods, compressed storage-composite cylinders, glass micro sphere storage, zeolites, metal hydride storage, chemical hydride storage and cryogenic storage, carbon based materials for hydrogen storage. **Hydrogen utilization:** Overview of hydrogen utilization, IC Engines, gas turbines, hydrogen burners, power plant, domestic cooking gas, marine applications, hydrogen dual fuel engines.	6
IV	**Fuel cells:** History – principle - working - thermodynamics and kinetics of fuel cell process – performance evaluation of fuel cell – comparison on battery Vs fuel cell, Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC, microbial fuel cells, relative merits and demerits.	6

V	**Applications of fuel cells:** Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space, economic and environmental analysis on usage of hydrogen and fuel cell. Future trends in fuel cells, portable fuel cells, laptops, mobiles, submarines.	6
VI	**Hydrogen safety:** Hydrogen safety aspects, backfire, pre-ignition, hydrogen emission NOx control techniques and strategies, Hydrogen powered vehicles.	6
Text Books		
1.	Sorenson B, Hydrogen and Fuel Cells: Emerging Technologies and Applications, Bent Sorenson, Academic Press (2005).	
2.	Hordeski MF, Hydrogen and Fuel Cells: Advances in Transportation and Power, The Fairmont Press, Inc. (2009)	
3.	Busby RL, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Books (2005).	

Year, Program, Semester	Multidisciplinary Minor I , 4th Semester Onwards						
Course Code	EE02						
Course Category	Minor Program Core						
Course title	**Energy Management**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-	-	03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	-	-	-	-	100
Pre-requisites(if any)	--						
Course Objectives	The course is aimed at - 1. Model and analyze energy management systems for an engineering application 2. Identify different energy scenario based on economics for a process or product. 3. Develop energy management programs for an engineering application. 4. Evaluate the performance of energy management systems.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Ability to recognize and analyze energy management system in daily lives. 2. Understand the role of energy ecomonics in energy management systems. 3. Understand the basic theory of energy management. 4. Understand various computational techniques in energy management system.						

Unit No.	Course Content	Hours
I	Importance of energy management. Energy auditing :(methodology, analysis of past trends plant data),laws of thermodynamics, measurements, portable and on line measurements.	6
II	Energy economics – Discount rate, pay back period, internal rate of return, life cycle costing.Steam systems:Boiler – efficiency testing, steam distribution and use steam traps, condensate recovery, flash steam utilisation.Thermal insulation.	6
III	Electrical systems: Demand control, power factor correction, Motor drives- motor efficiency testing, energy efficient motors, motor speed control.Varaible speed drives. Lighting-lighting levels, fixtures, daylighting, timers, energy efficient windows.	6
IV	Energy conservation in pumps, Fans (flow control), compressed air systems, Refrigeration and air conditioning systems.Waste heat recovery: recuprators, heat wheels, heat pipes, heta pumps.	6
V	Cogeneration – concept, options (steam/ gas turbines/diesel engine based), selection criteria, control strategy	6
VI	Computational Tools: Demonstration and projects using simulation software (e.g., Matlab, Scilab, ROBODK) for energy management.	6
Text Books		
1.	Hand book on Energy Audit and Management, Amit kumar Tyagi, TERI Press.	

2.	L.C.Witte, P.S.Schimdt, D.R.Brown, Industrial Energy Management and Utilisation, Hemisphere Publ,Washington, 1988.
3.	Practical hand book on Energy Conservation in Buildings, Indian Building Congress, Nabhi Publication.
4.	The Efficient use of Energy, Ed: I.G.C.Dryden, Butterworths, London, 1982.
5.	Energy Management Handbook, Ed: WQ.C.Turner, Wiley, New York, 1982.

Year, Program, Semester	Multidisciplinary Minor I , 4th Semester Onwards							
Course Code	EE03							
Course Category	Minor Program Core							
Course title	**Solar Thermal Power Engineering**							
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Total Credits		
	03	-	-	03		03		
Evaluation Scheme	ISE		ESE	IOE	IPE	EOE	EPE	Total
	30		70	---	---	---	--	100
Pre-requisites(if any)	--							
Course Objectives	The course is aimed at - 1. Model and analyze solar thermal power energy systems for an engineering application 2. Identify different energy resource and solar spectrum. 3. Evaluate the performance of solar thermal energy systems.							
Course Outcomes	Upon completion of this course, student should be able to – 1. Understand the principles of solar thermal power plant . 2. Design an application of solar thermal power plant. 3. Understand the working of solar thermal power plant. 4. Understand conversion system of solar thermal power plant.							

Unit No.	Course Content	Hours
I	**Energy Resources And Solar Spectrum** World energy resources - Indian energy scenario - Environmental aspects of energy utilization. Renewable energy resources and their importance - Global solar resources. Solar spectrum – Electromagnetic spectrum, basic laws of radiation. Physics of the Sun - Energy balance of the earth, energy flux, solar constant for earth, green house effect.	6
II	**Solar Radiation And Measurement** Solar radiation on the earth surface - Extraterrestrial radiation characteristics, Terrestrial radiation, solar insolation, spectral energy distribution of solar radiation. Depletion of solar radiation - Absorption, scattering. Beam radiation, diffuse and Global radiation. Measurement of solar radiation – Pyranometer, Pyrheliometer, Sunshine recorder. Solar time - Local apparent time (LAT), equation of time (E).	6
III	**Solar Radiation Geometry And Calculations** Solar radiation geometry - Earth-Sun angles – Solar angles. Calculation of angle of incidence – Surface facing due south, horizontal, inclined surface and vertical surface. Solar day length – Sun path diagram – Shadow determination. Estimation of Sunshine hours at different places in India. Calculation of total solar radiation on horizontal and tilted surfaces. Prediction of solar radiation availability.	6
IV	**Solar Thermal Energy Conversion** Thermodynamic cycles – Carnot – Organic, reheat, regeneration and supercritical Rankine cycles – Brayton cycle – Stirling cycle – Binary cycles – Combined cycles. Solar thermal power plants - Parabolic trough	6

	system, distributed collector, hybrid solar-gas power plants, solar pond based electric-power plant, central tower receiver power plant.	
V	**Solar Electrical Energy Conversion** Solar photovoltaic energy conversion - Principles - Physics and operation of solar cells. Classification of solar PV systems, Solar cell energy conversion efficiency, I-V characteristics, effect of variation of solar insolation and temperature, losses. Solar PV power plants.	6
VI	**Examples and Case Studies:**	6
Text Books		
1.	Foster .R, Ghassemi M., Cota A., "Solar Energy", CRC Press, 2010.	
2.	Duffie .J.A, Beckman W.A. "Solar Engineering of Thermal Processes", 3rd ed., Wiley, 2006.	
3.	De Vos .A, "Thermodynamics of Solar Energy Conversion", Wiley-VCH, 2008.	
4.	Garg .H.P, Prakash .J, "Solar Energy Fundamentals and Applications", Tata	

<table>
<tr><td>Year, Program, Semester</td><td colspan="7">Multidisciplinary Minor, 4th Semester Onwards</td></tr>
<tr><td>Course Code</td><td colspan="7">PBI</td></tr>
<tr><td>Course Category</td><td colspan="7">Program Based Internship</td></tr>
<tr><td>Course title</td><td colspan="7">Internship</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td colspan="2">Total Contact Hours</td><td colspan="2">Total Credits</td></tr>
<tr><td colspan="4">One Month</td><td colspan="2">03</td></tr>
<tr><td rowspan="2">Evaluation Scheme</td><td colspan="2">ISE</td><td>ESE</td><td>IOE</td><td>IPE</td><td>EOE</td><td>EPE</td><td>Total</td></tr>
<tr><td colspan="2">-</td><td>-</td><td>50</td><td>-</td><td>50</td><td>-</td><td>100</td></tr>
<tr><td>Pre-requisites(if any)</td><td colspan="7"></td></tr>
<tr><td>Course Objectives</td><td colspan="7">The course is aimed at -
1. To Identify and compare technical and practical issues in industrial as well as in social area.
2. To write, speak and demonstrate well in different contexts.
3. To Prepare a well-organized report of technical writing and innovative thinking.
4. To Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presentation.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">Upon completion of this course, student should be able to –
1. Establish motivation for any topic of interest and develop a thought process for technical presentation.
2. Organize a detailed literature survey and build a document with respect to technical publications.
3. Analysis and comprehension of concept and related data.
4. Effective presentation and improve soft skills.</td></tr>
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Course Content

The course consists of a one-month internship in Minor Specific Industry. Students will be placed in companies or organizations that align with the particular sector. During the internship, students will engage in various activities, including but not limited to:

1. Shadowing industry professionals to observe and learn about different processes and operations.
2. Assisting with ongoing projects or research initiatives within the organization.
3. Participating in hands-on tasks related to their minor sub-specialization, under the guidance of experienced mentors.
4. Attending training sessions, workshops, and seminars conducted by the industry to enhance their knowledge and skills.
5. Engaging in discussions and meetings with supervisors and colleagues to gain insights into industry practices, challenges, and innovations.
6. Documenting their internship experience through reports, presentations, or reflective journals.

The period of one month for this internship will be during the winter or summer vacations, any such slots 4^{th} Semester onwards.

Course Assessment Process

This particular evaluation will be the part of the structure of 7th Semester.

The evaluation for the Industrial Internship course will be conducted as follows:

Internal Evaluation (50 marks):

- Assessment by course teachers based on students' performance during the internship, including attendance, participation, attitude, and contribution to assigned tasks.
- Evaluation by industrial supervisors on students' professional conduct, technical skills, problem-solving abilities, and overall performance in the workplace.

External Evaluation (50 marks):

- Evaluation by an external examiner appointed by the institute, who will assess students' internship reports, presentations, or any other documentation submitted at the end of the internship period.
- The external examiner will review the quality of students' reflections on their internship experience, their ability to apply theoretical knowledge to practical situations, and the depth of their understanding of industry practices and challenges.

The final grades for the Industrial Internship course will be determined based on the combined assessment from both internal and external evaluations.

Year, Program, Semester	Multidisciplinary Minor, 4th Semester Onwards							
Course Code	PBL							
Course Category	Project Based Learning							
Course title	**Mini Project**							
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Total Credits		
						02		
Evaluation Scheme	ISE		ESE	IOE	IPE	EOE	EPE	Total
	-		-	50	-	50	-	100
Pre-requisites(if any)								
Course Objectives	The course teacher will 1. Facilitate application of theoretical knowledge. 2. Guide the students about enhancement of practical skills. 3. Explain about development of industry-relevant competencies.							
Course Outcomes	Upon completion of this course, student should be able to 1. Demonstrate application of theoretical concepts with instructor guidance. 2. Collaborate effectively in instructor-led team-based projects. 3. Communicate findings and insights professionally under instructor supervision.							

Course Content

Minor Program Based Mini Project is a dynamic course designed to bridge the gap between classroom learning and real-world application. All the students will engage themselves in a series of tasks and challenge that will enable them to apply theoretical concepts learned in previous courses to solve practical problems. The project work need to be carried out independently covering a range of topics relevant to their field of study, allowing them to explore different facets of the particular discipline and develop versatile skill sets.

This activity may be planned after 4th Semester and can be completed prior to 8th Semester of their Major studies.

Course Assessment Process

This particular evaluation will be the part of 8th Semester of the major structure.

The course evaluation for the internals will be at the course teacher end while there will also be the external evaluation of the Project work.

The teachers will follow the instructions as below:

Evaluation Format: The evaluation may be conducted using a combination of assessment methods, including:

- Rubric-based assessment for the project work and its report.
- Peer evaluation for project.
- Instructor-led discussions or presentations to evaluate communication skills and critical thinking.
- Overall course grading based on a weighted average of individual assessments and participation.

The evaluation format should be transparent, fair, and aligned with the course objectives and outcomes. Regular feedback and communication with students will ensure that the evaluation process remains supportive of their learning journey.

Multidisciplinary Minor
In
Manufacturing Engineering
For
B.Tech (Mechanical Engineering)

Shivaji University, Kolhapur

Department of Technology

Multidisciplinary Minor in Manufacturing Engineering

Teaching & Evaluation Scheme

S.N.	Category	Code	Course Title	Hours per week			Contact Hours	Credits	Evaluation scheme	
									Theory	Practical
				L	T	P			ISE:ESE	IE:EE
1.	Preferably on SWAYAM (NPTEL) or any other MOOCs (Minor Program Core) Or In a Face-to-Face mode	ME-1	Design for Manufacturing and Assembly	03	-	-	03	03	30:70	00:00
2.		ME-2	Non Destructive Testing	03	-	-	03	03	30:70	00:00
3.		ME-3	Maintenance Engineering	03	-	-	03	03	30:70	00:00
4.	Minor Program Based Internship	PBI	Industrial Internship (Minor Program Specific Industry)	One Month				03	00:00	50:50
5.	Project Based Learning	PBL	Mini Project	-	-	-	-	02	00:00	50:50
							-	**14**	**300**	**200**
			Total Hours	09	00	00	**09**	-	-	-

Note: MDM Program's Internship and Mini Project need to be planned during winter or summer vacation days after 4th semester while respective evaluations will be the part of 7th and 8th Semesters of the B. Tech Major structure.

Year, Program, Semester	Multidisciplinary Minor II , 4th Semester Onwards						
Course Code	ME01						
Course Category	Minor Program Core						
Course title	**Design for Manufacturing and Assembly**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-	-	03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	-	-	-	-	100
Pre-requisites(if any)							
Course Objectives	The course is aimed at - 1. To understand the importance of design for manufacturing and assembly based manufacturing. 2. To get the knowledge of various techniques in DFMA. 3. To understand the basics of product design, component design and its design consideration.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Understand the principles of DFMA. 2. Understand the design methods of DFMA. 3. Understand design consideration for gauges, components and various other components. 4. Learn the advanced methods of DFMA.						

Unit No.	Course Content	Hours
I	Effect of Materials & Manufacturing Processes on Design - Major Phases in Design & Manufacture, Effect of Material Properties on Design, Effect of Manufacturing Process on Design, Material Selection Process, Cost Per Unit Property & Weighed Properties Methods.	6
II	Tolerancing - Tolerance Specification & Representation of Various Tolerances, their Significance in Assembly, Material Tolerances for Assembly Line -True Position Tolerancing, Cumulative Effect of Tolerances in Assembly, Interchangeability and	6

	Selective Assembly in Manufacturing, Process Capability & Its Significance with Ref. to Tolerancing, Achieving Larger Machining Tolerances. Datum Features - Functional Datum, Datum for Manufacturing, Changing the Datum, etc.	
III	Design Considerations - Design of Components with Casting Considerations, Pattern, Mould, and Parting Line, Cored Holes and Machine Holes, Identifying the Possible and Probable Parting Line, Castings Requiring Special Sand Cores, Designing of Obviate Sand Cores.	6
IV	Design of Gauges - Design of Gauges for Checking Components In Assembly with emphasis on Various Types of Limit Gauges For Both Hole and Shaft.	6
V	Component Design - Component Designwith Machining Considerations(Design for Turning ComponentsMilling, Drilling and other Related Processes Including Finish-Machining Operations).	6
VI	Case Studies - Related to Above Topics and (I) Redesign to Suit Manufacture of Typical Assemblies (II) Tolerance Design of a Typical Assembly (III) Design to Minimize Cost of A Product (IV) Computer Aided DFMA	6
Text Books		
1.	Harry Peck, Design for Manufacture, Pitman Publications.	
2.	Boothroyd, G., Dewhurst, P. and Knight, W. - Product Design for Manufacture and Assembly, Mercel Dekker, New York.	
3.	Dieter -Machine Design, McGraw Hill, New York.	
4.	Groover. M. P. - Automation, Production Systems and computer Integrated Manufacturing, Pearson Education Asia, New Delhi	
5.	Zeid, I. - CAD/CAM - Theory and Practice, Tata McGraw Hill, New Delhi.	

Year, Program, Semester	Multidisciplinary Minor II , 4th Semester Onwards						
Course Code	ME02						
Course Category	Minor Program Core						
Course title	**Non Destructive Testing**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-	-	03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	-	-	-	-	100
Pre-requisites(if any)	--						
Course Objectives	The course is aimed at - 1. Model and analyze non destructive testing systems for an engineering application 2. Identify sensors, transducers and actuators to monitor and control a process or product in non destructive testing 3. Develop programs of non destructive testing for an engineering application. 4. Evaluate the performance of non destructive testing.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Ability to recognize and analyze non destructive testing in daily lives. 2. Understand the role of sensors, actuators, and controls in non destructive testing. 3. Understand the basic theory of non destructive testing. 4. Familiarity with various non destructive testing. 5. Understand the measurement of various quantities using instruments, their accuracy & range, and the techniques for controlling devices automatically.						

Unit No.	Course Content	Hours
I	**Visual Testing** Fundamentals of Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods – mirrors, magnifiers, boroscopes and fibroscopes– light sources and special lighting – computer enhanced system – Employer defined applications, metallic materials including raw materials and welds – Inspection objectives, inspection checkpoints, sampling plan,	6

	inspection pattern etc – classification of indications for acceptance criteria - Codes, Standards and Specifications (ASME,ASTM,AWS etc.)	
II	**Liquid Penetrant Testing** Principles – types and properties of liquid penetrants – developers – advantages and limitations of various methods - Preparation of test materials – Application of penetrants to parts, removal of excess penetrants, post cleaning – Control and measurement of penetrant process variables – selection of penetrant method – solvent removable, water washable, post emulsifiable – Units and lighting for penetrant testing – Interpretation and evaluation of test results - dye penetrant process, applicable codes and standards.	6
III	**Magnetic Particle Testing** Theory of magnetism – ferromagnetic, paramagnetic materials – characteristics of magnetic fields – magnetic hysteresis – magnetization by means of direct and alternating current – surface strength characteristics – Depth of penetration factors – Circular and longitudinal magnetization techniques, current calculation — field produced by a current in a coil, shape and size of coils, field strength, Magnetic Bharkhausen Noise Analysis (MBN) – advantages and limitations	6
IV	**Magnetic Particle Testing Equipments** Selecting the method of magnetization, inspection materials, wet and dry particles – portable, mobile and stationary equipment – capabilities of equipments – magnetic particle inspection of castings and welding – Dry continuous method, wet residual method – Interpretation and evaluation of test indications – Principles and methods of demagnetization – Residual magnetism – applicable codes and standards.	6
V	**Eddy Current Testing** Generation of eddy currents – effect of change of impedance on instrumentation – properties of eddy currents – eddy current sensing elements, probes, type of coil arrangement – absolute, differential, lift off, operation, applications, advantages, limitations – Through encircling coils, type of arrangements –absolute, differential fill factor, operation, application, advantages, limitations – Factors affecting sensing elements and coil impedance - test part and test system - Signal to noise ratio – equipment's, reference samples, calibration, inspection of tubes, cylinders, steel bars, welded tubing, plates and pipes, Remote Field Sensing Interpretation/Evaluation – Applicable codes and standards.	6
VI	Examples and Case Studies on Non Destructive Methods	6

Text Books	
1.	Non-Destructive Examination and Quality Control, ASM International, Vol.17, 9th edition (1989)
2.	J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition (2011).
3.	B. Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3rd edition (2002).
4.	T. Rangachari, J. Prasad and B.N.S. Murthy, Treatise on non-destructive testing and evaluation, Navbharath Enterprises, Vol.3, (1983).
5.	C. Hellier, Handbook of Non-Destructive Evaluation, McGraw-Hill Professional, 1st edition (2001).
6.	J. Thomas Schmidt, K. Skeie and P. Maclntire, ASNT Non Destructive Testing Handbook:
7.	Magnetic Particle Testing, American Society for Nondestructive Testing, American Society for Metals, 2nd edition (1989).
8.	V. S. Cecco, G. V. Drunen and F. L. Sharp, Eddy current Manual: Test method, Vol.1, Chalk River Nuclear Laboratories (1983).
9.	B.P.C. Rao, Practical Eddy Current Testing, Alpha Science International Limited (2006).
10.	N. A. Tracy, P. O. Moore, Non-Destructive Testing Handbook: Liquid Penetrant Testing, Vol. 2, American Society for Nondestructive Testing, 3rd edition (1999).

Year, Program, Semester	Multidisciplinary Minor II , 4th Semester Onwards						
Course Code	ME03						
Course Category	Minor Program Core						
Course title	**Maintenance Engineering**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-		03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	---	---	---	--	100
Pre-requisites(if any)	--						
Course Objectives	The course is aimed at - 1. Model and analyze Machine Health Monitoring systems for an engineering application 2. Identify sensors, transducers and actuators to monitor and control a process or product in health monitoring system. 3. Develop programs of maintence for an engineering application. 4. Evaluate the performance of maintenance plan.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Understand the principles of maintenance engineering. 2. Design an maintenance engineering plan using health monitoring system. 3. Understand the working of health monitoring system. 4. Understand RAM of maintenance management. 5. Learn the basics of maintenance engineering system.						

Unit No.	Course Content	Hours
I	**Introduction** Fundamentals of Maintenance Engineering, Maintenance Engineering, Its Importance in Material & Energy Conservation, Inventory Control, Productivity, Safety, Pollution Control, etc. Safety Regulations, Pollution Problems, Human Reliability, Total Quality Management (TQM), Total Productivity Maintenance (TPM), Environmental Issues in Maintenance, ISO 9000.	6

II	**Maintenance Management** Types of Maintenance Strategies, Planned and Unplanned Maintenance, Breakdown, Preventive & Predictive Maintenance, Comparison, Advantages & Disadvantages, Computer Aided Maintenance, Maintenance Scheduling, Spare Part Management, Inventory Control, Organization of Maintenance Department	6
III	**Tribology In Maintenance** Friction Wear and Lubrication, Friction & Wear Mechanisms, Prevention of Wear, Types of Lubrication Mechanisms, Lubrication Processes. Lubricants- Types, General and Special Purpose, Additives, Testing of Lubricants, Degradation of Lubricants, Seal & Packing.	6
IV	**Machine Health Monitoring** Condition Based Maintenance, Signature Analysis, Oil Analysis, Vibration, Noise and Thermal Signatures, OnLine & Off Line Techniques, Instrumentation & Equipment Used in Machine Health Monitoring,Instrumentation In Maintenance, Signal Processing, Data Acquisition and Analysis, Application of Intelligent Systems, Data Base Design.	6
V	**Reliability, Availability & Maintainability (RAM) Analysis** Introduction to RAM Failure Mechanism, Failure Data Analysis, Failure Distribution, Reliability of Repairable and Non-Repairable Systems, Improvement in Reliability, Reliability Testing, Reliability Prediction, Utilization Factor, System Reliability by Monte Carlo Simulation Technique.	6
VI	**Examples and Case Studies Based On Maintenance Engineering**	6
Text Books		
1.	Gopal Krishnan and Banerji, Maintenance & Spare parts Management	
2.	Mishra and Pathak, Maintenance Engineering and Management, PHI	
3.	Higgins, Maintenance Engineering Hand Book.	
4.	S.K. Shrivastava, Industrial Maintenance Management.	
5.	CNR Rao, Handbook of Condition Monitoring,.	

<table>
<tr><td>Year, Program, Semester</td><td colspan="7">Multidisciplinary Minor, 4th Semester Onwards</td></tr>
<tr><td>Course Code</td><td colspan="7">PBI</td></tr>
<tr><td>Course Category</td><td colspan="7">Program Based Internship</td></tr>
<tr><td>Course title</td><td colspan="7">Internship</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td colspan="2">Total Contact Hours</td><td colspan="2">Total Credits</td></tr>
<tr><td colspan="4">One Month</td><td colspan="2">03</td></tr>
<tr><td rowspan="2">Evaluation Scheme</td><td colspan="2">ISE</td><td>ESE</td><td>IOE</td><td>IPE</td><td>EOE</td><td>EPE</td><td>Total</td></tr>
<tr><td colspan="2">-</td><td>-</td><td>50</td><td>-</td><td>50</td><td>-</td><td>100</td></tr>
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1. To Identify and compare technical and practical issues in industrial as well as in social area.
2. To write, speak and demonstrate well in different contexts.
3. To Prepare a well-organized report of technical writing and innovative thinking.
4. To Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presentation.</td></tr>
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1. Establish motivation for any topic of interest and develop a thought process for technical presentation.
2. Organize a detailed literature survey and build a document with respect to technical publications.
3. Analysis and comprehension of concept and related data.
4. Effective presentation and improve soft skills.</td></tr>
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Course Content

The course consists of a one-month internship in Minor Specific Industry. Students will be placed in companies or organizations that align with the particular sector. During the internship, students will engage in various activities, including but not limited to:

1. Shadowing industry professionals to observe and learn about different processes and operations.
2. Assisting with ongoing projects or research initiatives within the organization.
3. Participating in hands-on tasks related to their minor sub-specialization, under the guidance of experienced mentors.
4. Attending training sessions, workshops, and seminars conducted by the industry to enhance their knowledge and skills.
5. Engaging in discussions and meetings with supervisors and colleagues to gain insights into industry practices, challenges, and innovations.
6. Documenting their internship experience through reports, presentations, or reflective journals.

The period of one month for this internship will be during the winter or summer vacations, any such slots 4^{th} Semester onwards.

Course Assessment Process

This particular evaluation will be the part of the structure of 7th Semester.

The evaluation for the Industrial Internship course will be conducted as follows:

Internal Evaluation (50 marks):

- Assessment by course teachers based on students' performance during the internship, including attendance, participation, attitude, and contribution to assigned tasks.
- Evaluation by industrial supervisors on students' professional conduct, technical skills, problem-solving abilities, and overall performance in the workplace.

External Evaluation (50 marks):

- Evaluation by an external examiner appointed by the institute, who will assess students' internship reports, presentations, or any other documentation submitted at the end of the internship period.
- The external examiner will review the quality of students' reflections on their internship experience, their ability to apply theoretical knowledge to practical situations, and the depth of their understanding of industry practices and challenges.

The final grades for the Industrial Internship course will be determined based on the combined assessment from both internal and external evaluations.

Year, Program, Semester	Multidisciplinary Minor, 4th Semester Onwards							
Course Code	PBL							
Course Category	Project Based Learning							
Course title	**Mini Project**							
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Total Credits		
						02		
Evaluation Scheme	ISE		ESE	IOE	IPE	EOE	EPE	Total
	-		-	50	-	50	-	100
Pre-requisites(if any)								
Course Objectives	The course teacher will 1. Facilitate application of theoretical knowledge. 2. Guide the students about enhancement of practical skills. 3. Explain about development of industry-relevant competencies.							
Course Outcomes	Upon completion of this course, student should be able to 1. Demonstrate application of theoretical concepts with instructor guidance. 2. Collaborate effectively in instructor-led team-based projects. 3. Communicate findings and insights professionally under instructor supervision.							

Course Content

Minor Program Based Mini Project is a dynamic course designed to bridge the gap between classroom learning and real-world application. All the students will engage themselves in a series of tasks and challenge that will enable them to apply theoretical concepts learned in previous courses to solve practical problems. The project work need to be carried out independently covering a range of topics relevant to their field of study, allowing them to explore different facets of the particular discipline and develop versatile skill sets.

This activity may be planned after 4th Semester and can be completed prior to 8th Semester of their Major studies.

Course Assessment Process

This particular evaluation will be the part of 8th Semester of the major structure.

The course evaluation for the internals will be at the course teacher end while there will also be the external evaluation of the Project work.

The teachers will follow the instructions as below:

Evaluation Format: The evaluation may be conducted using a combination of assessment methods, including:

- Rubric-based assessment for the project work and its report.
- Peer evaluation for project.
- Instructor-led discussions or presentations to evaluate communication skills and critical thinking.
- Overall course grading based on a weighted average of individual assessments and participation.

The evaluation format should be transparent, fair, and aligned with the course objectives and outcomes. Regular feedback and communication with students will ensure that the evaluation process remains supportive of their learning journey.

Multidisciplinary Minor
In
Mechatronics and Automation
For
B.Tech (Mechanical Engineering)

Shivaji University, Kolhapur

Department of Technology

Multidisciplinary Minor in Mechatronics and Automation

Teaching & Evaluation Scheme

S.N.	Category	Code	Course Title	Hours per week			Contact Hours	Credits	Evaluation scheme	
									Theory	Practical
				L	T	P			ISE:ESE	IE:EE
1.	Preferably on SWAYAM (NPTEL) or any other MOOCs (Minor Program Core) Or In a Face-to-Face mode	MA-1	Manufacturing Automation	03	-	-	03	03	30:70	00:00
2.		MA-2	Mechatronics, Robotics and Control	03	-	-	03	03	30:70	00:00
3.		MA-3	Basic Electronic Engineering	03	-	-	03	03	30:70	00:00
4.	Minor Program Based Internship	PBI	Industrial Internship (Minor Program Specific Industry)	One Month				03	00:00	50:50
5.	Project Based Learning	PBL	Mini Project	-	-	-	-	02	00:00	50:50
							-	**14**	**300**	**200**
			Total Hours	09	00	00	**09**	-	-	-

Note: MDM Program's Internship and Mini Project need to be planned during winter or summer vacation days after 4th semester while respective evaluations will be the part of 7th and 8th Semesters of the B. Tech Major structure.

Year, Program, Semester	Multidisciplinary Minor III , 4th Semester Onwards						
Course Code	MA01						
Course Category	Minor Program Core						
Course title	**Manufacturing Automation**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-	-	03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	-	-	-	-	100
Pre-requisites(if any)							
Course Objectives	The course is aimed at - 1. To understand the importance of automation in the of field machine tool based manufacturing. 2. To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC. 3. To understand the basics of product design and the role of manufacturing automation						
Course Outcomes	Upon completion of this course, student should be able to – 1. To understand the importance of automation in manufacturing value chain 2. To get the knowledge of various elements of automation tools and techniques 3. To understand the emerging digital manufacturing trends						

Unit No.	Course Content	Hours
I	**Introduction:** Definition; Reasons for automating; Strategies; Types of automation; Numerical control (NC, CNC, DNC); Introduction to CNC programming and computer-aided process planning.	6
II	**Machine and Process Automation:** CNC machines, Automated flow lines (types, selection); Work part transport and transfer mechanisms; Feedback systems and control; Modular and reconfigurable machines, adaptive machine controls.	6
III	**Automated Assembly Systems:** Historical developments; Choice of assembly methods; Design for automated assembly; Transfer systems; Vibratory and non-vibratory feeders; Feed tracks, part orienting and placing mechanisms. **Factory Automation:** Lean manufacturing, Automation scalability (fixed, programmable, flexible and reconfigurable); Design and analysis of automated flow lines; Average production time, production rate, line efficiency; Analysis of transfer lines without storage; Partial and full automation.	6
IV	**Automation Tools and Techniques:** Mechanical, electro-mechanical, pneumatic and hydraulic systems; Sensors integration; Process monitoring, data analysis and control using actuators; Robots (pick, place, assembly, welding, painting, etc.); Automatic Guided Vehicles; Automated inspection and measurement (CMM and 3D Scanning);	6

	Machine vision, AI and machine learning; Human-machine interfaces; Examples and case studies.	
V	**Advanced Automation Trends:** Digital, inclusive, smart and distributed manufacturing; Industry 4.0; Digital transformations in shop-floors (CIM to Smart factory; Intelligent machines to Smart Machines; Factory automation to Distributed automation; Human sense to system sensed).	6
VI	**Examples and Case Studies:** Pick and place robots, testing and sorting based systems, etc; Orientation of parts: in-bowl and out-of-bowl toolings; Manufacturing equipment embedded with digital data and driven by adoptive controls; Manufacturing automation with autonomous decisions taken by computers based on the realistic process/machines (production conditions) data acquired from the resources.	6
Text Books		
1.	M. P. Groover, Automation, Production Systems and Computer-integrated Manufacturing, Prentice Hall, 2018.	
2.	S. Kalpakjian and S. R. Schmid, Manufacturing – Engineering and Technology, Pearson.	
3.	Yoram Koren, Computer Control of Manufacturing Systems, McGraw Hill, 2005	
4.	CAD/CAM Principles and Applications, P.N. Rao, Tata McGraw Hill, 2010.	
Online Resources		
1.	https://nptel.ac.in/courses/112/104/112104289/	
2.	https://nptel.ac.in/courses/112/103/112103293/	
3.	https://nptel.ac.in/courses/112/103/112103174/	

Year, Program, Semester	Multidisciplinary Minor III , 4th Semester Onwards						
Course Code	MA02						
Course Category	Minor Program Core						
Course title	**Mechatronics, Robotics and Control**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-	-	03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	-	-	-	-	100
Pre-requisites(if any)	--						
Course Objectives	The course is aimed at - 1. Model and analyze mechatronic systems for an engineering application 2. Identify sensors, transducers and actuators to monitor and control a process or product. 3. Develop PLC programs for an engineering application. 4. Evaluate the performance of mechatronic systems.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Ability to recognize and analyze electro-mechanical systems in daily lives. 2. Understand the role of sensors, actuators, and controls in mechatronic systems. 3. Understand the basic theory of robot kinematics. 4. Familiarity with control theory and controller design. 5. Understand the measurement of various quantities using instruments, their accuracy & range, and the techniques for controlling devices automatically.						

Unit No.	Course Content	Hours
I	**Introduction:** Electro-mechanical systems; Typical applications; Examples – automobiles, home appliances, medical instruments, etc.	6
II	**Sensors:** Transduction principles; Sensitivity, accuracy, range, resolution, noise sources; Sensors for common engineering measurements – proximity, force, velocity, temperature, etc.; Signal processing and conditioning; Selection of sensors. **Actuators:** Pneumatic and hydraulic actuators; Electric motors including DC, AC, BLDC, servo and stepper motors; Solenoids and relays; Active materials – piezoelectric and shape memory alloys.	6
III	**Machine Controls:** Microprocessors and their architecture; Memory and peripheral interfacing; Programming; Microcontrollers; Programmable Logic Controllers; PLC principle and operation; Analog and digital input/output modules; Memory module; Timers, internal relays, counters and data handling; Industrial automation systems; Basic PLC programming; Industry kits (Arduino, Raspberry Pi, etc.).	6
IV	**Robotics:** Robot configurations: serial and parallel; Denavit–Hartenberg parameters; Manipulators kinematics; Rotation matrix, Homogenous transformation matrix; Direct and inverse Kinematics for robot position and orientation; Workspace estimation and	6

	path planning; Robot vision; Motion tracking; Robot programming and control; Industrial robots - Pick and place robots, sorting, assembly, welding, inspection, etc.	
V	**Control Theory and Systems:** Basic control concepts; Feedback; Open and closed loop control; Concept of block diagrams; P, PI and PID controllers; Tuning the gain of controllers; System models, transfer functions, system response, frequency response; Root Locus method and Bode plots.	6
VI	**Computational Tools:** Demonstration and projects using simulation software (e.g., Matlab, Scilab, ROBODK) for control systems and robotics.	6
Text Books		
1.	W. Bolton, "Mechatronics," Addison Wesley Longman, 2010.	
2.	J. J. Craig, Introduction to Robotics Mechanics and Control, Addison Wesley, 1999.	
3.	G.K. McMillan, "Process/Industrial Instruments and Controls Handbook," McGraw-Hill, 1999.	
4.	S. Mukherjee, "Essentials of Robotics Process Automation", Khanna Book Publishing, 2021.	
Online Resources		
1.	https://nptel.ac.in/courses/107/106/107106090/	
2.	https://nptel.ac.in/courses/112/101/112101098/	
3.	https://nptel.ac.in/courses/112/107/112107289/	

Year, Program, Semester	Multidisciplinary Minor III , 4th Semester Onwards						
Course Code	MA03						
Course Category	Minor Program Core						
Course title	**Basic Electronic Engineering**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-		03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	---	---	---	--	100
Pre-requisites(if any)	--						
Course Objectives	The course is aimed at - 1. To provide an overview of electronic device components to Mechanical engineering students						
Course Outcomes	Upon completion of this course, student should be able to – 1. Understand the principles of semiconductor devices and their applications. 2. Design an application using Operational amplifier. 3. Understand the working of timing circuits and oscillators. 4. Understand logic gates, flip flop as a building block of digital systems. 5. Learn the basics of Electronic communication system.						

Unit No.	Course Content	Hours
I	**Semiconductor Devices and Applications** Introduction to P-N Junction Diode and V-I characteristics, Half wave and Full-wave rectifiers, capacitor filter. Zener diode and its characteristics, Zener diode as voltage regulator. Regulated power supply IC based on 78XX and 79XX series, Introduction to BJT, its input-output and transfer characteristics, BJT as a single stage CE amplifier, frequency response and bandwidth	6
II	**Operational amplifier and its applications** Introduction to operational amplifiers, Op-amp input modes and parameters, Op-amp in open loop configuration, op-amp with negative feedback, study of practical op-amp IC 741, inverting and non-inverting amplifier applications: summing and difference amplifier, unity gain buffer, comparator, integrator and differentiator.	6
III	**Timing Circuits and Oscillators** RC-timing circuits, IC 555 and its applications as astable and mono-stable multi-vibrators, positive feedback, Barkhausen's criteria for oscillation, R-C phase shift and Wein bridge oscillator.	6
IV	**Digital Electronics Fundamentals** Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K- map, Logic ICs, half and full adder/subtractor, multiplexers, de-multiplexers, flip-flops, shift	6

	registers, counters, Block diagram of microprocessor/microcontroller and their applications	
V	**Electronic Communication Systems** The elements of communication system, IEEE frequency spectrum, Transmission media: wired and wireless, need of modulation, AM and FM modulation schemes, Mobile communication systems: cellular concept and block diagram of GSM system.	6
VI	**Examples and Case Studies:** Elecronics used in Pick and place robots, testing and sorting based systems, etc; Orientation of parts: in-bowl and out-of-bowl toolings; Manufacturing equipment embedded with digital data and driven by adoptive controls; Manufacturing automation with autonomous decisions taken by computers based on the realistic process/machines (production conditions) data acquired from the resources	6
Text Books		
1.	Floyd, Electronic Devices‖ Pearson Education 9th edition, 2012.	
2.	R.P. Jain, ―Modern Digital Electronics‖, Tata Mc Graw Hill, 3rd Edition, 2007.	
3.	A.K. Maini & Nakul Maini - All-in-One Electronics Simplified, Khanna Book Publishing, 2021.	
4.	Frenzel, ―Communication Electronics: Principles and Applications‖, Tata Mc Graw Hill, 3rd Edition, 2001	
5.	Mittel, Basic Electrical Engineering, Tata McGraw Hill	

<table>
<tr><td>Year, Program, Semester</td><td colspan="7">Multidisciplinary Minor, 4th Semester Onwards</td></tr>
<tr><td>Course Code</td><td colspan="7">PBI</td></tr>
<tr><td>Course Category</td><td colspan="7">Program Based Internship</td></tr>
<tr><td>Course title</td><td colspan="7">Internship</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td colspan="2">Total Contact Hours</td><td colspan="2">Total Credits</td></tr>
<tr><td colspan="4">One Month</td><td colspan="2">03</td></tr>
<tr><td rowspan="2">Evaluation Scheme</td><td colspan="2">ISE</td><td>ESE</td><td>IOE</td><td>IPE</td><td>EOE</td><td>EPE</td><td>Total</td></tr>
<tr><td colspan="2">-</td><td>-</td><td>50</td><td>-</td><td>50</td><td>-</td><td>100</td></tr>
<tr><td>Pre-requisites(if any)</td><td colspan="7"></td></tr>
<tr><td>Course Objectives</td><td colspan="7">The course is aimed at -
1. To Identify and compare technical and practical issues in industrial as well as in social area.
2. To write, speak and demonstrate well in different contexts.
3. To Prepare a well-organized report of technical writing and innovative thinking.
4. To Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presentation.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">Upon completion of this course, student should be able to –
1. Establish motivation for any topic of interest and develop a thought process for technical presentation.
2. Organize a detailed literature survey and build a document with respect to technical publications.
3. Analysis and comprehension of concept and related data.
4. Effective presentation and improve soft skills.</td></tr>
</table>

Course Content

The course consists of a one-month internship in Minor Specific Industry. Students will be placed in companies or organizations that align with the particular sector. During the internship, students will engage in various activities, including but not limited to:

1. Shadowing industry professionals to observe and learn about different processes and operations.
2. Assisting with ongoing projects or research initiatives within the organization.
3. Participating in hands-on tasks related to their minor sub-specialization, under the guidance of experienced mentors.
4. Attending training sessions, workshops, and seminars conducted by the industry to enhance their knowledge and skills.
5. Engaging in discussions and meetings with supervisors and colleagues to gain insights into industry practices, challenges, and innovations.
6. Documenting their internship experience through reports, presentations, or reflective journals.

The period of one month for this internship will be during the winter or summer vacations, any such slots 4^{th} Semester onwards.

Course Assessment Process

This particular evaluation will be the part of the structure of 7th Semester.

The evaluation for the Industrial Internship course will be conducted as follows:

Internal Evaluation (50 marks):

- Assessment by course teachers based on students' performance during the internship, including attendance, participation, attitude, and contribution to assigned tasks.
- Evaluation by industrial supervisors on students' professional conduct, technical skills, problem-solving abilities, and overall performance in the workplace.

External Evaluation (50 marks):

- Evaluation by an external examiner appointed by the institute, who will assess students' internship reports, presentations, or any other documentation submitted at the end of the internship period.
- The external examiner will review the quality of students' reflections on their internship experience, their ability to apply theoretical knowledge to practical situations, and the depth of their understanding of industry practices and challenges.

The final grades for the Industrial Internship course will be determined based on the combined assessment from both internal and external evaluations.

Year, Program, Semester	Multidisciplinary Minor, 4th Semester Onwards							
Course Code	PBL							
Course Category	Project Based Learning							
Course title	**Mini Project**							
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Total Credits		
						02		
Evaluation Scheme	ISE		ESE	IOE	IPE	EOE	EPE	Total
	-		-	50	-	50	-	100
Pre-requisites(if any)								
Course Objectives	The course teacher will 1. Facilitate application of theoretical knowledge. 2. Guide the students about enhancement of practical skills. 3. Explain about development of industry-relevant competencies.							
Course Outcomes	Upon completion of this course, student should be able to 1. Demonstrate application of theoretical concepts with instructor guidance. 2. Collaborate effectively in instructor-led team-based projects. 3. Communicate findings and insights professionally under instructor supervision.							

Course Content

Minor Program Based Mini Project is a dynamic course designed to bridge the gap between classroom learning and real-world application. All the students will engage themselves in a series of tasks and challenge that will enable them to apply theoretical concepts learned in previous courses to solve practical problems. The project work need to be carried out independently covering a range of topics relevant to their field of study, allowing them to explore different facets of the particular discipline and develop versatile skill sets.

This activity may be planned after 4th Semester and can be completed prior to 8th Semester of their Major studies.

Course Assessment Process

This particular evaluation will be the part of 8th Semester of the major structure.

The course evaluation for the internals will be at the course teacher end while there will also be the external evaluation of the Project work.

The teachers will follow the instructions as below:

Evaluation Format: The evaluation may be conducted using a combination of assessment methods, including:

- Rubric-based assessment for the project work and its report.
- Peer evaluation for project.
- Instructor-led discussions or presentations to evaluate communication skills and critical thinking.
- Overall course grading based on a weighted average of individual assessments and participation.

The evaluation format should be transparent, fair, and aligned with the course objectives and outcomes. Regular feedback and communication with students will ensure that the evaluation process remains supportive of their learning journey.

Shivaji University, Kolhapur

Department of Technology

B.Tech (Mechanical Engineering), Exit After Second Year (Diploma in Mechanical Engineering)

Teaching & Evaluation Scheme

S.N.	Category	Code	Course Title	Hours per week			Contact Hours	Credits	Evaluation scheme	
									Theory	Practical
				L	T	P			ISE:ESE	IE:EE
1.	SWAYAM (NPTEL) or any other MOOCs Or any other course from in face to face mode (Program Core Courses)	DC-01	Measurements and Metrology	02	-	-	02	02	30:70	00:00
2.		DC-02	Computer Aided Design and Analysis	02	-	-	02	02	30:70	00:00
3.		DC-03	Design for Manufacturing and Assembly	02	-	-	02	02	30:70	00:00
4.	Program Based Internship	DC-PBI	One-Month Industrial Internship	-	-	-	-	04	00:00	50:50
				-	**-**	**-**	**-**	**10***	**300**	**100**
			Total Hours	**06**	**-**	**-**	**06**	**-**	**-**	**-**

Note: The Workload against the Diploma Course will be finalised at the Program Level considering the strength of the students seeking for the Diploma.

***Obtaining these credits will be in addition to 85 regular credits up to SY B. Tech**

**** There is an option for End Semester Examination either on respective MOOC platform or at the course teacher's end through the University System.

Note 1: The students aspiring to exit after the second year will finalise the title of the course/MOOC from the list provided by the Program.

Note 2: Program Specific Industry Internship to be completed by such students before commencement of TY B. Tech.

Year, Program, Semester	Exit after Second Year of B. Tech (Mechanical Engineering), Diploma Claim						
Course Code	DC-01						
Course Category	Engineering Course						
Course title	**Measurements and Metrology**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	02	-	-	02	02		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	-	-	-	-	100
Pre-requisites(if any)	--						
Course Objectives	The course is aimed at - 1. To understand the proper use and maintenance of important instruments, such as Vernier callipers, autocollimators, slip gauges, and pyrometers 2. To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Basic knowledge about measurement systems and their components 2. Various instruments used for measurement of mechanical and electrical parameters 3. Integrate measurement systems for process monitoring and control 4. Design of limits, fits and tolerances for given applications						

Unit No.	Course Content	Hours
I	**Measurement Purpose and Parameters:** Parameters – geometry (straightness, flatness, roundness, etc.), displacement, force, speed, torque, flow, level, pressure, temperature, acceleration, etc.; Definitions: Accuracy, precision, range, resolution, uncertainly and error sources; Regression analysis.	6
II	**Measurement Principles:** Structure and examples of measurement systems; Calibration principles; Linear and angular measurements; Comparators; Gauge design; Interferometry.	6
III	**Limits, Fit and Tolerances:** Definitions; Tolerance zone and grades, Hole and shaft system, Geometric tolerances, Tylor's principle of gauging, Design of tolerances for	6

	various applications; Tolerance analysis in manufacturing and assembly; Role of metrology in Design of Manufacturing.	
IV	**Mechanical Measurements and Equipment:** *Dimensional metrology* – Vernier, micrometers, LVDT; *Form metrology* – form tester, surface profiler, CMM, 3D scanning; *Surface metrology* – optical microscopes, Laser scanning microscopes, electron microscopy (SEM/TEM), x-ray microscopy, Raman spectroscopy; Tool wear, workpiece quality and process metrology.	6
V	**Thermal and Flow Measurement**: Measurement of temperature, thermal conductivity and diffusivity; Flow obstruction methods; Magnetic flow meters. **Electrical Measurements and Instruments:** Signal generators and analysis; Wave analyzer; Spectrum analyzer; *Frequency counters* – measurement errors, extending the frequency range; *Transducers* – types, strain gages, displacement transducers; *Digital data acquisition system* - interfacing transducers to electronics control and measuring system; Instrumentation amplifier; Isolation amplifier; Computer-controlled test systems.	6
VI	**Design of Experiments and Statistical Analysis:** DOE techniques; Taguchi orthogonal arrays; Data acquisition, signal processing and conditioning; Error of a system of ideal elements; Error probability density function of a system of non-ideal elements; Error reduction techniques; Quality control and assurance in industry.	6
Text Books		
1.	E.O Doebelin and Dhanesh Manik, "Measurement Systems", McGraw Hill, 2017	
2.	Bewoor & Kulkarni, "Metrology & Measurement" Tata McGraw Hill, 2009.	
3.	D. James, and S, Meadow, "Geometric Dimensioning and Tolerancing", Marcel Dekker, 1995	
4.	Madhav S. Phadke, Quality Engineering using Robust Design, Prentice Hall, 1989	
Online Resource		
1.	https://nptel.ac.in/courses/112/103/112103261/	
2.	https://nptel.ac.in/courses/112/106/112106138/	

Year, Program, Semester	Exit after Second Year of B. Tech (Mechanical Engineering), Diploma Claim						
Course Code	DC-02						
Course Category	Course for Diploma in Mechanical Engineering						
Course title	**Computer Aided Design and Analysis**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	02	-	-	02	02		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	-	-	-	-	100
Pre-requisites(if any)							
Course Objectives	The course is aimed at - 1. To provide an overview of how computers can be utilized in mechanical component design						
Course Outcomes	Upon completion of this course, student should be able to – 1. Upon completion of this course, the students can use computer and CAD software for modelling and analyzing simple mechanical components						

Unit No.	Course Content	Hours
I	**Introduction:** Role of computers in design process; Computer aided design, analysis and manufacturing; Computer integrated manufacturing; Popular CAD software used in industry; Input and output devices	6
II	**Transformations:** Matrix representation of points, lines and planes; 2D transformation for translation, scaling, rotation and reflection; Homogeneous representation and concatenation; 3D transformations.	6
III	**Curves and Surfaces:** Representation of curves; Hermite curves, Bezier curves, B-spline curves, Rational curves; Surface modelling – parametric representation, planar surface, surface of revolution, Coons and bicubic patches, Bezier and B-spline surfaces.	6
IV	**Solid Modelling:** Solid modelling techniques – sweep (linear and curved), Boolean (constructive solid geometry) and other techniques; Solid model representation (Boundary and Constructive Solid Geometry); Medical modelling (pixels, scans and voxels); Exchange standards (IGES, DXF, STEP, STL etc.).	6

V	**Engineering Analysis:** Introduction to finite element method; Principle of potential energy; FE analysis of 1D element problems (spring, bar, truss elements); Development of element stiffness equation and their assembly; Plain strain and plain stress problems; Domain discretization, pre-processing and post-processing; Verification and validation; Popular CAE software used in industry	6
VI	**Design Optimization:** Purpose and application of optimum design, Primary and subsidiary design equations, Limit Equations, Normal, redundant and incompatible specifications problems; Computer-aided design optimization.	6
Text Books		
1.	Ibrahim Zeid, "Mastering CAD CAM," Tata McGraw Hill Publishing Co. 2007.	
2.	C. McMohan and J. Browne, "CAD/CAM Principles," Pearson Education, 2nd Edition, 1999.	
3.	Geometric Modeling, Michael E. Mortenson, Tata McGraw Hill, 2013.	
4.	W. M. Neumann and R.F. Sproul, "Principles of Computer Graphics," McGraw Hill, 1989.	
5.	D. Hearn and M.P. Baker, "Computer Graphics," Prentice Hall Inc., 1992.	
Online Resources		
1.	https://ocw.mit.edu/courses/mechanical-engineering/2-158j-computational-geometry-spring-2003/	
2.	https://nptel.ac.in/courses/112/104/112104031/	
3.	https://nptel.ac.in/courses/112/102/112102101/,	

Year, Program, Semester	Exit after Second Year of B. Tech (Mechanical Engineering), Diploma Claim						
Course Code	DC-03						
Course Category	Course for Diploma in Mechanical Engineering						
Course title	**Design for Manufacturing and Assembly**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	02	-	-	02	02		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	-	-	-	-	100
Pre-requisites(if any)							
Course Objectives	The course is aimed at - 1. To understand the importance of design for manufacturing and assembly based manufacturing. 2. To get the knowledge of various techniques in DFMA. 3. To understand the basics of product design, component design and its design consideration.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Understand the principles of DFMA. 2. Understand the design methods of DFMA. 3. Understand design consideration for gauges, components and various other components. 4. Learn the advanced methods of DFMA.						

Unit No.	Course Content	Hours
I	Effect of Materials & Manufacturing Processes on Design - Major Phases in Design & Manufacture, Effect of Material Properties on Design, Effect of Manufacturing Process on Design, Material Selection Process, Cost Per Unit Property & Weighed Properties Methods.	6
II	Tolerancing - Tolerance Specification & Representation of Various Tolerances, their Significance in Assembly, Material Tolerances for Assembly Line -True Position Tolerancing, Cumulative Effect of Tolerances in Assembly, Interchangeability and	6

	Selective Assembly in Manufacturing, Process Capability & Its Significance with Ref. to Tolerancing, Achieving Larger Machining Tolerances. Datum Features - Functional Datum, Datum for Manufacturing, Changing the Datum, etc.	
III	Design Considerations - Design of Components with Casting Considerations, Pattern, Mould, and Parting Line, Cored Holes and Machine Holes, Identifying the Possible and Probable Parting Line, Castings Requiring Special Sand Cores, Designing of Obviate Sand Cores.	6
IV	Design of Gauges - Design of Gauges for Checking Components In Assembly with emphasis on Various Types of Limit Gauges For Both Hole and Shaft.	6
V	Component Design - Component Designwith Machining Considerations(Design for Turning ComponentsMilling, Drilling and other Related Processes Including Finish-Machining Operations).	6
VI	Case Studies - Related to Above Topics and (I) Redesign to Suit Manufacture of Typical Assemblies (II) Tolerance Design of a Typical Assembly (III) Design to Minimize Cost of A Product (IV) Computer Aided DFMA	6
Text Books		
1.	Harry Peck, Design for Manufacture, Pitman Publications.	
2.	Boothroyd, G., Dewhurst, P. and Knight, W. - Product Design for Manufacture and Assembly, Mercel Dekker, New York.	
3.	Dieter -Machine Design, McGraw Hill, New York.	
4.	Groover. M. P. - Automation, Production Systems and computer Integrated Manufacturing, Pearson Education Asia, New Delhi	
5.	Zeid, I. - CAD/CAM - Theory and Practice, Tata McGraw Hill, New Delhi.	

<table>
<tr><td>Year, Program, Semester</td><td colspan="8">Exit after Second Year of B. Tech (Mechanical Engineering), Diploma Claim</td></tr>
<tr><td>Course Code</td><td colspan="8">DC - PBI</td></tr>
<tr><td>Course Category</td><td colspan="8">Course for Diploma in Mechanical Engineering</td></tr>
<tr><td>Course title</td><td colspan="8">In plant Training</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td colspan="3">Total Contact Hours</td><td colspan="2">Total Credits</td></tr>
<tr><td colspan="5">One Month</td><td colspan="2">04</td></tr>
<tr><td rowspan="2">Evaluation Scheme</td><td colspan="2">ISE</td><td>ESE</td><td>IOE</td><td>IPE</td><td>EOE</td><td>EPE</td><td>Total</td></tr>
<tr><td colspan="2">-</td><td>-</td><td>50</td><td>-</td><td>50</td><td>-</td><td>100</td></tr>
<tr><td>Pre-requisites(if any)</td><td colspan="8"></td></tr>
<tr><td>Course Objectives</td><td colspan="8">The course is aimed at -
1. To Identify and compare technical and practical issues in industrial as well as in social area.
2. To write, speak and demonstrate well in different contexts.
3. To Prepare a well-organized report of technical writing and innovative thinking.
4. To Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presentation.</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">Upon completion of this course, student should be able to –
1. Establish motivation for any topic of interest and develop a thought process for technical presentation.
2. Organize a detailed literature survey and build a document with respect to technical publications.
3. Analysis and comprehension of concept and related data.
4. Effective presentation and improve soft skills.</td></tr>
</table>

Course Content

The In-Plant Training course encompasses a comprehensive blend of theoretical learning and handson experience in an industrial setting. The course content includes:

1. Introduction to Mechanical Engineering Industry: Overview of different sectors, processes, and applications within the Mechanical engineering domain.
2. Safety Procedures and Protocols: Training on safety regulations, hazard identification, emergency procedures, and personal protective equipment (PPE) usage.
3. Equipment Familiarization: Hands-on experience with common equipment and instrumentation used in Mechanical engineering processes, including pumps, reactors, distillation columns, and control systems.
4. Process Simulation and Optimization: Practical exercises on process simulation software and optimization techniques to enhance efficiency and productivity.
5. Troubleshooting and Maintenance: Practical sessions on diagnosing and resolving equipment malfunctions, conducting routine maintenance, and ensuring operational integrity.
6. Industrial Visits and Guest Lectures: Field trips to industrial facilities and guest lectures by industry experts to provide first hand insights into real-world applications and challenges.
7. Project Work: Collaborative projects or case studies addressing specific engineering problems or process improvements relevant to the host industry.
8. Evaluation and Assessment: Continuous evaluation based on performance during training, report submissions with the components of the report has been separately mentioned under Evaluation Method.

Course Assessment Process

1. **Attendance and Participation:** Regular attendance and active participation in training sessions, workshops, and industrial visits will be monitored.
2. **Skills Assessment:** Evaluation of practical skills demonstrated during hands-on training activities, including equipment operation, experimentation, troubleshooting, and safety compliance.
3. **Performance Review:** Ongoing assessment of individual and group performance based on assigned tasks, projects, and team collaborations.
4. **Supervisor Feedback:** Feedback from industry supervisors regarding student performance, professionalism, attitude, and adaptability in the workplace.
5. **Training Report:** Submission of a comprehensive training report summarizing the learning outcomes, experiences, observations, and insights gained during the In Plant Training period.

Training Report Format: The training report should follow a structured format to ensure clarity, coherence, and completeness. Here's a suggested outline:

1. **Title Page:**
   - Title of the report: "In Plant Training Report"
   - Student's name
   - Enrolment number
   - Department/Program
   - Name of the institution
   - Duration of the training period
   - Name and address of the host industry
2. **Acknowledgments (Optional):**
   - Acknowledge any individuals, organizations, or institutions that contributed to the training experience.
3. **Table of Contents:**
   - List of sections and subsections with corresponding page numbers.
4. **Introduction:**
   - Brief overview of the training objectives, scope, and significance.
   - Description of the host industry and the specific department or division where the training was conducted.
5. **Training Objectives:**
   - Recapitulation of the objectives outlined at the beginning of the training period.
6. **Training Activities:**
   - Detailed account of the activities undertaken during the training, including:
   - Description of the tasks assigned and responsibilities undertaken.
   - Summary of workshops, seminars, industrial visits, and hands-on training sessions participated in.
   - Highlights of any notable experiences, challenges faced, and lessons learned.
7. **Skills Acquired:**
   - Discussion of the practical skills and knowledge gained throughout the training period.
   - Reflection on the application of theoretical concepts in real-world industrial scenarios.
8. **Observations and Insights:**
   - Analysis of observations made during the training, including:
   - Observations regarding industry practices, processes, and technologies.
   - Insights into workplace dynamics, organizational culture, and professional etiquettes.

- Suggestions for improvement or areas of further learning identified during the training.

9. **Conclusion:**

- Summary of key takeaways and learning outcomes from the training experience.

10. **References:**

- List of sources referenced or consulted during the preparation of the report (if applicable).

11. **Appendices (Optional):**

- Additional materials such as photographs, diagrams, charts, or supplementary documents supporting the content of the report.

12. **Declaration:**

- Statement affirming the authenticity and originality of the report, along with the student's signature and date.

The training report should be well-organized, concise, and professionally presented, demonstrating the student's ability to articulate their learning experiences and insights gained during the In-Plant Training period.

SHIVAJI UNIVERSITY, KOLHAPUR

Established: 1962
A++ Accredited by NAAC (2021) with CGPA 3.52

New Syllabus for

Multidisciplinary Minor in B. Tech (Mechanical Engineering) with Honors and Honors with Research

UNDER

Faculty of Science and Technology

B. Tech (Mechanical Engineering) – Semester IV, V and VI

STRUCTURE AND SYLLABUS ACCORDING WITH
NATIONAL EDUCATION POLICY – 2020
WITH MULTIPLE ENTRY AND MULTIPLE EXIT OPTIONS

(TO BE IMPLIMATED FORM ACADEMIC YEAR 2024-25 ONWORDS)

Multidisciplinary Minor
In
B. Tech (Mechanical Engineering) with Honors

Shivaji University, Kolhapur

Department of Technology

Multidisciplinary Minor in B. Tech (Mechanical Engineering) with Honors

Teaching & Evaluation Scheme

S.N.	Category	Code	Course Title	Hours per week			Contact Hours	Credits	Evaluation scheme	
									Theory	Practical
				L	T	P			ISE:ESE	IE:EE
1.	Preferably on SWAYAM (NPTEL) or any other MOOCs (Minor Program Core) Or In a Face-to-Face mode	HN-1	Research Methodology	03	-	-	03	03	30:70	00:00
2.		HN-2	Design of Composite Material	03	-	-	03	03	30:70	00:00
3.		HN-3	Design for Manufacturing and Assembly	03	-	-	03	03	30:70	00:00
4.		HN-4	Computational Fluid Flow and Heat Transfer	03	-	-	03	03	30:70	00:00
5.		HN-5	Industrial Internet of Things	03	-	-	03	03	30:70	00:00
6.	Ability Enhancement Course	HN-AEC1	Advance Mechanical Laboratory	-	-	04	04	02	00:00	50:50
							-	**17**	**500**	**100**
			Total Hours	15	00	04	**19**	-	-	-

<table>
<tr><td>Year, Program, Semester</td><td colspan="8">B. Tech Mechanical Engineering (Honors/Honors with Research)</td></tr>
<tr><td>Course Code</td><td colspan="8">HN-01</td></tr>
<tr><td>Course Category</td><td colspan="8">Engineering Course in Honour</td></tr>
<tr><td>Course title</td><td colspan="8">Research Methodology</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td colspan="3">Total Contact Hours</td><td colspan="2">Total Credits</td></tr>
<tr><td>03</td><td>-</td><td>-</td><td colspan="3">03</td><td colspan="2">03</td></tr>
<tr><td rowspan="2">Evaluation Scheme</td><td colspan="2">ISE</td><td>ESE</td><td>IOE</td><td>IPE</td><td>EOE</td><td>EPE</td><td>Total</td></tr>
<tr><td colspan="2">30</td><td>70</td><td>-</td><td>-</td><td>-</td><td>-</td><td>100</td></tr>
<tr><td>Pre-requisites(if any)</td><td colspan="8"></td></tr>
<tr><td>Course Objectives</td><td colspan="8">The course is aimed at -
1. Familiarize students with various research methodologies and approaches used in scientific inquiry.
2. Develop student’s critical thinking and analytical skills necessary for conducting research.
3. Provide students with practical guidance on designing research studies, including formulating research questions and hypotheses.
4. Equip students with the necessary skills to conduct literature reviews, analyze data, and interpret research findings.
5. Cultivate ethical research practices and promote integrity in the research process.
6. Prepare students for effectively communicating research findings through presentations, reports, and scholarly publications.</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">Upon completion of this course, student should be able to –
1. Demonstrate an understanding of different research methodologies, including quantitative, qualitative, and mixed methods approaches.
2. Evaluate existing research literature, identify gaps, and formulate relevant research questions and hypotheses.
3. Develop proficiency in research design, including selecting appropriate methodologies, sampling techniques, and data collection methods.
4. Gain practical experience in data analysis techniques, such as statistical analysis, qualitative coding, and thematic analysis.
5. Adhere to ethical guidelines and principles in research conduct, including obtaining informed consent, ensuring confidentiality, and avoiding plagiarism.
6. Communicate research findings through written reports, oral presentations, and academic publications.</td></tr>
</table>

Unit No.	Course Content	Hours
I	**Introduction to Research Methodology** Understanding the Research Process, Importance of Research in Engineering, Types of Research: Basic vs. Applied, Quantitative vs. Qualitative, Research Paradigms: Positivism, Interpretivism, Pragmatism, Formulating Research Questions and Objectives, Literature Review: Search Strategies, Critical Analysis, Research Ethics and Integrity, Research Design: Experimental, Descriptive, Exploratory, Case Study.	6
II	**Research Design and Sampling Techniques** Research Variables and Hypothesis Formulation, Experimental Design: Control Groups, Randomization, Replication, Survey Design: Questionnaire Construction, Scaling Techniques, Sampling Methods: Probability Sampling, Non-probability Sampling, Sample Size Determination and Power Analysis, Case Study Research Design, Qualitative Research Design: Interviews, Focus Groups, Observations, Mixed-Methods Research Design.	6
III	**Unit III: Data Collection and Analysis** Surveys, Interviews, Observations, Experiments, Instrumentation and Measurement Tools, Data Quality and Validation, Data Analysis Methods: Descriptive Statistics, Inferential Statistics, Statistical Software Tools: SPSS, R, MATLAB, Qualitative Data Analysis: Coding, Theme Analysis, Narrative Analysis.	6
IV	**Research Proposal Development** Components of a Research Proposal: Title, Abstract, Introduction, Literature Review, Methodology, Timeline, Budget, Writing and Organizing a Research Proposal, Proposal Review Process and Feedback Incorporation, Presentation Skills for Research Proposals, Grant Writing Techniques and Funding Opportunities, Ethical Considerations in Research Proposal Development.	6
V	**Advanced Research Methods** Longitudinal and Cross-Sectional Studies, Meta-Analysis and Systematic Reviews, Action Research and Participatory Research, Simulation and Modeling Techniques, Big Data Analytics in Engineering Research, Emerging Trends in Research Methodology.	6
VI	**Research Proposal Development**	6

	Project Planning and Time Management, Collaboration and Teamwork in Research Projects, Data Management and Documentation, Intellectual Property Rights and Patents, Writing and Publishing Research Papers, Peer Review Process and Journal Selection.	
Text Books		
1.	Creswell, J. W., & Creswell, J. D., 2017, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. SAGE Publications, 978-1506386763.	
2.	Bryman, A., & Bell, E., 2015, Business Research Methods, Oxford University Press, 978-0199668649.	
3.	Kumar, R., 2019, Research Methodology: A Step-by-Step Guide for Beginners, SAGE Publications, 78-9389093014.	

Year, Program, Semester	B. Tech Mechanical Engineering (Honors/Honors with Research)						
Course Code	HN-02						
Course Category	Core						
Course title	**Design of Composite Materials**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-		03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	---	---	---	--	100
Pre-requisites(if any)	--						
Course Objectives	The course is aimed at - 1. Model and analyze composite material for an engineering application 2. Identify stress and strain of composite material. 3. Understand method for finding mechanical characteristics of composite material an engineering application.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Understand the principles of governing composite material. 2. Design an composite material for engineering application. 3. Understand the working of stress and strain in composite material. 4. Understand Equilibrium Equations of Motion in composite material.						

Unit No.	**Course Content**	**Hours**
I	Introduction to Composite Materials Constituents, Material forms Processing, Applications Definition – Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic and Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices –Characteristics of fibers and matrices.	6
II	Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina – Transformation Matrix, Transformed Stiffness.	6

III	Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations– Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina, Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.	6
IV	Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure.	6
V	Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies.	6
VI	Modification of Hooke's Law due to thermal properties-Modification of Laminate Constitutive Equations. Orthotropic Lamina - special Laminate Configurations – Unidirectional, Off-axis, Symmetric Balanced Laminates - Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates	6
Text Books		
1.	Jones, R.M., "Mechanics of Composite Materials", McGraw-Hill, Kogakusha Ltd., Tokyo, 1985.	
2.	Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites", John Wiley and sons. Inc., New York, 1995.	
3.	Hyer, M.W., "Stress Analysis of Fiber-Reinforced Composite Materials", McGraw-Hill, 1998.	
4.	Mechanics of Composite Materials, Autar K. Kaw, 2nd ed., CRC Press, 2006	

Year, Program, Semester	B. Tech Mechanical Engineering (Honors/Honors with Research)						
Course Code	HN-03						
Course Category	Core						
Course title	**Design for Manufacturing and Assembly**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-	-	03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	-	-	-	-	100
Pre-requisites(if any)							
Course Objectives	The course is aimed at - nderstand the importance of design for manufacturing and assembly based ıfacturing. et the knowledge of various techniques in DFMA. nderstand the basics of product design, component design and its design deration.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Understand the principles of DFMA. 2. Understand the design methods of DFMA. 3. Understand design consideration for gauges, components and various other components. 4. Learn the advanced methods of DFMA.						

Unit No.	Course Content	Hours
I	Effect of Materials & Manufacturing Processes on Design - Major Phases in Design & Manufacture, Effect of Material Properties on Design, Effect of Manufacturing Process on Design, Material Selection Process, Cost Per Unit Property & Weighed Properties Methods.	6
II	Tolerancing - Tolerance Specification & Representation of Various Tolerances, their Significance in Assembly, Material Tolerances for Assembly Line -True Position Tolerancing, Cumulative Effect of Tolerances in Assembly, Interchangeability and	6

	Selective Assembly in Manufacturing, Process Capability & Its Significance with Ref. to Tolerancing, Achieving Larger Machining Tolerances. Datum Features - Functional Datum, Datum for Manufacturing, Changing the Datum, etc.	
III	Design Considerations - Design of Components with Casting Considerations, Pattern, Mould, and Parting Line, Cored Holes and Machine Holes, Identifying the Possible and Probable Parting Line, Castings Requiring Special Sand Cores, Designing of Obviate Sand Cores.	6
IV	Design of Gauges - Design of Gauges for Checking Components In Assembly with emphasis on Various Types of Limit Gauges For Both Hole and Shaft.	6
V	Component Design - Component Designwith Machining Considerations(Design for Turning ComponentsMilling, Drilling and other Related Processes Including Finish-Machining Operations).	6
VI	Case Studies - Related to Above Topics and (I) Redesign to Suit Manufacture of Typical Assemblies (II) Tolerance Design of a Typical Assembly (III) Design to Minimize Cost of A Product (IV) Computer Aided DFMA	6
Text Books		
1.	Harry Peck, Design for Manufacture, Pitman Publications.	
2.	Boothroyd, G., Dewhurst, P. and Knight, W. - Product Design for Manufacture and Assembly, Mercel Dekker, New York.	
3.	Dieter -Machine Design, McGraw Hill, New York.	
4.	Groover. M. P. - Automation, Production Systems and computer Integrated Manufacturing, Pearson Education Asia, New Delhi	
5.	Zeid, I. - CAD/CAM - Theory and Practice, Tata McGraw Hill, New Delhi.	

Year, Program, Semester	B. Tech Mechanical Engineering (Honors/Honors with Research)						
Course Code	HN-05						
Course Category	Core						
Course title	**Additive Manufacturing**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-	-	03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	-	-	-	-	100
Pre-requisites(if any)							
Course Objectives	The course is aimed at - 1. To understand the importance of additive manufacturing process. 2. To get the knowledge of various solution methods in additive manufacturing. 3. To understand the basics of additive manufacturing.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Understand the overall principle and various processes for additive manufacturing. 2. Select a particular additive manufacturing process based on the end application. 3. Plan the steps in fabricating a given part using additive manufacturing.						

Unit No.	Course Content	Hours
I	**Introduction to Additive Manufacturing (AM)**: Evolution of AM/3D printing; Comparison with subtractive and forming processes; Advantages of AM; Classification of AM processes; Key steps in AM.	6
II	**Liquid State-based AM Processes**: Stereo lithography – Process and working principle; Photopolymers; Photo polymerization, layering technology, Laser and Laser scanning; Micro-stereolithography; Equipment and specifications; Applications, advantages, disadvantages, examples; Solid ground curing: Process, Working principle; Equipment and specifications; Applications, advantages, disadvantages, examples.	6

III	**Solid State-based AM Processes**: Fused Deposition Modeling – Process, working principle and materials; Equipment and specifications; Laminated object manufacturing – Process and working principle; Equipment and specifications; Applications, advantages, disadvantages, examples; Other solid-state processes – Ultrasonic consolidation, Gluing, Thermal bonding; Demonstration of equipment.	6
IV	**Powder Based AM Processes I**: Powder Bed Fusion Processes – Working principle and materials; Powder fusion mechanism and powder handling; Various LBF processes (principle, materials, applications and examples) – Selective laser Sintering, Electron Beam Melting.	6
V	**Powder Based AM Processes II**:Laser Engineered Net Shaping, Binder Jetting and Direct Metal Deposition; Comparison between LBF processes; Materials-process-structure-property relationships; relative advantages and limitations.	6
VI	**Applications of AM**: Product development lifecycle applications – Rapid prototyping, concept models, visualization aids, replacement parts, tooling, jigs and fixtures, moulds and casting; Application sectors – aerospace, automobile, medical, jewelry, sports, electronics, food, architecture, construction and others.	6
Text Books		
1.	Sabrie Soloman, 3D Printing & Design, Khanna Book Publishing Company, New Delhi, 2020.	
2.	Ian Gibson, David W Rosen, Brent Stucker, "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping and Direct Digital Manufacturing", Springer, 2015	
3.	Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles & Applications," World Scientific, 2015.	
4.	C.P Paul, A.N Junoop, "Additive Manufacturing: Principles, Technologies and Applications," McGrawHill, 2021.	

Year, Program, Semester	B. Tech Mechanical Engineering (Honors/Honors with Research)						
Course Code	HN-AEC1						
Course Category	Core						
Course title	**Advanced Mechanical Laboratory**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Credits	
	-	-	**04**	04		**02**	
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	--	--	---	**50**	--	--	50
Pre-requisites(if any)	--						
Course Objectives	The course is aimed at - 1. Determine various mechanical, hydraulic, thermal and vibration parameters. 2. Distinguish between Signal & system analysis of various machines and mechanism. 3. Understand the basic of finite element analysis using engineering applications. 4. Demonstrate of stress, strain and displacement occurring in engineering application using FEA.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Calibrate various parameters using sensor and transducer. 2. Illustrate different system to monitor vibration of machine.. 3. Apply the FEA in engineering applications. 4. Calibrate stress and strain curve of various engineering components						

Experiment No.	Experiment Title/Objective
1.	The following experiments are to be performed in the laboratory 1. Measurements of mechanical parameters: a) Displacement b) Force c) Torque 2. Measurement of hydraulic parameters: a) Pressure b) vacuum c) Flow 3. Measurement of thermal parameters: Temperature : Industrial thermo couples, Resistance thermometer, Radiation temperature measurement. 4. Measurement of vibration parameter: a) Displacement -Vibrometer b) Velocity - Velocity pickup.

	c) Acceleration- Accelerometer d) Frequency –Vibration Analyzer 5. Measurement of Sound parameters (Noise Meter): a) Sound intensity level b)Sound Power level c) Sound Pressure level 6. Signal & system analysis. 7. Condition monitoring & signature analysis applications. Vibration signature analysis of different existing machines such as Lathe, Grinder, Blower etc. 8. Data acquisition & conversion. 9. Microprocessor & computer application in measurements.
2.	Various manufacturing processes will be modeled and simulated and the effects of process variables on the quality of product will be analyzed. 1. Study of Finite Element Analysis and its different approaches. 2. Basic procedure of Finite Element Method and Mathematical formulation of problems. 3. Analysis of 1D structural members and verification of the same through manual calculation. 4. Beam analysis problems and their verification 5. Formulation of Dynamic problem and its solution for finding Eigen values and Eigen vectors 6. Problem formulation of 1D & 2D heat transfer problem and verifying solution using software 7. Finite Element Analysis of 2D , 3D problems(**any one**) using FEA • Gear tooth analysis • Crane Hook analysis • Pressure Vessel stress Analysis • Connecting Rod, Crank Shaft, Cam Shaft Stress Analysis. 8. Flow Simulation: Flow through pipes, flow over bodies. 9. At least one project and a case study should be carried out based on recent Publications / research papers / technical development.

Text Books

1.	B. C. Nakra & K. K. Choudhary, " Instrumentation, Measurement & Analysis" Tata McGraw Hill Publications Pvt. Ltd., New Delhi.
2.	Rangan & Sharma, "Instrument Devices & Systems" " Tata McGraw Hill Publications Pvt. Ltd., New Delhi.
3.	Earnest O Doeblin, "Measurement Systems : Applications & Design", McGraw Hill International.

4.	Rao S. S. "Finite Elements Method in Engineering"- 4th Edition, Elsevier, 2006
5.	Frank L. Stasa," Applied finite Element Analysis for Engineers", CBS International Edition, 1985.
6.	Bathe K. J. Finite Elements Procedures, PHI. Cook R. D., et al. "Concepts and Application of Finite Elements Analysis"- 4th Edition, Wiley & Sons, 2003.
7.	Zeinkovich, "The Finite Element Method for Solid and Structural Mechanics, 6th Ed., Elsevier 2007.
8.	Desai C.S and Abel, J.F., Introduction to the finite element Method, Affiliated East west Press Pvt. Ltd. New Delhi 2000.

Multidisciplinary Minor
In
B. Tech (Mechanical Engineering) Honors with Research

Shivaji University, Kolhapur

Department of Technology

Multidisciplinary Minor in B. Tech (Mechanical Engineering) Honors with Research

Teaching & Evaluation Scheme

S.N.	Category	Code	Course Title	Hours per week			Contact Hours	Credits	Evaluation scheme	
									Theory	Practical
				L	T	P			ISE:ESE	IE:EE
1.	Preferably on SWAYAM (NPTEL) or any other MOOCs (Minor Program Core) Or In a Face-to-Face mode	HNR-1	Research Methodology	03	-	-	03	03	30:70	00:00
2.		HNR-2	Design of Composite Material	03	-	-	03	03	30:70	00:00
3.		HNR-3	Design for Manufacturing and Assembly	03	-	-	03	03	30:70	00:00
4.		HNR-4	Computational Fluid Flow and Heat Transfer	03	-	-	03	03	30:70	00:00
5.		HNR-5	Additive Manufacturing	03	-	-	03	03	30:70	00:00
6.	Ability Enhancement Course	HNR-AEC1	Advance Mechanical Laboratory	-	-	04	04	02	00:00	50:50
7.	Project Based Learning	HNR – PBL	*Additional Research Project	-	-	06	06	03	00:00	50:50
							-	**17**	**500**	**200**
			Total Hours	15	00	10	**25**	-	-	-

Note: For Honors with Research, the courses and the credits as that for Honors will be the same. In addition, there will be 3 credits against an additional research project completion with success in publishing at least one research paper in a peer reviewed journal.

<table>
<tr><td>Year, Program, Semester</td><td colspan="8">B. Tech Mechanical Engineering (Honors with Research)</td></tr>
<tr><td>Course Code</td><td colspan="8">HNR-PBL</td></tr>
<tr><td>Course Category</td><td colspan="8">Core</td></tr>
<tr><td>Course title</td><td colspan="8">Additional Research Project</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td colspan="3">Total Contact Hours</td><td colspan="2">Total Credits</td></tr>
<tr><td>-</td><td>-</td><td>06</td><td colspan="3">06</td><td colspan="2">03</td></tr>
<tr><td rowspan="2">Evaluation Scheme</td><td colspan="2">ISE</td><td>ESE</td><td>IOE</td><td>IPE</td><td>EOE</td><td>EPE</td><td>Total</td></tr>
<tr><td colspan="2">-</td><td>-</td><td>50</td><td>-</td><td>50</td><td>-</td><td>100</td></tr>
<tr><td>Pre-requisites(if any)</td><td colspan="8"></td></tr>
<tr><td>Course Objectives</td><td colspan="8">The course is aimed at -
1. To facilitate exploration of focused research areas in Mechanical engineering..</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">Upon completion of this course, student should be able to –
1. Formulate research questions and design methodologies.
2. Analyze and interpret data effectively.
3. Synthesize literature to contextualize research.
4. Present findings effectively through oral and written communication.
5. Demonstrate critical thinking and problem-solving in research.</td></tr>
</table>

Course Content
I Topic Selection and Proposal Development: • Identifying research gaps and formulating research questions. • Writing a research proposal outlining objectives, methodology, and expected outcomes. • Conducting rigorous ‘ research topic relevant literature survey’ **II Research Methodologies:** • Introduction to research design and planning. • Data collection techniques and tools. • Statistical analysis methods. **III Conducting Research:** • Implementing the proposed methodology. • Data collection, analysis, and interpretation. • Troubleshooting research challenges. **IV Presentation and Communication:** • Preparing and delivering oral presentations. • Writing research reports following standard scientific formats. • Communicating research findings effectively to diverse audiences.
Course Assessment Process
Assessment in this course will be based on the following criteria: 1. Research Proposal (20%): Evaluation of the clarity, feasibility, and originality of the research proposal. 2. Research Progress (30%): Assessment of the student's progress in conducting the research project, including data collection, analysis, and interpretation. 3. Final Research Report (30%): Evaluation of the quality of the written research report, including organization, clarity, depth of analysis, and adherence to scientific standards. 4. Oral Presentation (20%): Assessment of the student's ability to effectively communicate research findings through a formal presentation. Additionally, continuous engagement, participation in research discussions, and adherence to deadlines will be considered in the overall assessment of the course.

SHIVAJI UNIVERSITY, KOLHAPUR

Established: 1962
A++ Accredited by NAAC (2021) with CGPA 3.52

New Syllabus for

Specialization Minor in B. Tech (Mechanical Engineering) with Honors

UNDER

Faculty of Science and Technology

B. Tech (Mechanical Engineering) – Semester IV, V and VI

STRUCTURE AND SYLLABUS ACCORDING WITH
NATIONAL EDUCATION POLICY – 2020
WITH MULTIPLE ENTRY AND MULTIPLE EXIT OPTIONS

(TO BE IMPLIMATED FORM ACADEMIC YEAR 2024-25 ONWORDS)

Specialization Minor
In
Design Engineering
For
B. Tech (Mechanical Engineering)

Shivaji University, Kolhapur

Department of Technology

Specialization Minor in Design Engineering

Teaching & Evaluation Scheme

S.N.	Category	Code	Course Title	Hours per week			Contact Hours	Credits	Evaluation scheme	
									Theory	Practical
				L	T	P			ISE:ESE	IE:EE
1.	Preferably on SWAYAM (NPTEL) or any other MOOCs (Minor Program Core) Or In a Face-to-Face mode	SMP-1.1	Computer Aided Design and Analysis	03	-	-	03	03	30:70	00:00
2.		SMP-1.2	Product Design and Development	03	-	-	03	03	30:70	00:00
3.		SMP-1.3	Design of Composite Materials	03	-	-	03	03	30:70	00:00
4.	Minor Program Based Internship	PBI	Industrial Internship (Minor Program Specific Industry)	One Month				03	00:00	50:50
5.	Project Based Learning	PBL	Mini Project	-	-	-	-	02	00:00	50:50
							-	**14**	**300**	**200**
			Total Hours	09	00	00	**09**	-	-	-

Note: MDM Program's Internship and Mini Project need to be planned during winter or summer vacation days after 4th semester while respective evaluations will be the part of 7th and 8th Semesters of the B. Tech Major structure.

Year, Program, Semester	Specialization Minor I, 4th Semester onwards						
Course Code	SMP1.1						
Course Category	Specialization Minor Program Core						
Course title	**Computer Aided Design and Analysis**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-	-	03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	-	-	-	-	100
Pre-requisites(if any)							
Course Objectives	The course is aimed at - 1. To provide an overview of how computers can be utilized in mechanical component design						
Course Outcomes	Upon completion of this course, student should be able to – 1. Upon completion of this course, the students can use computer and CAD software for modelling and analyzing simple mechanical components						

Unit No.	Course Content	Hours
I	**Introduction:** Role of computers in design process; Computer aided design, analysis and manufacturing; Computer integrated manufacturing; Popular CAD software used in industry; Input and output devices	6
II	**Transformations:** Matrix representation of points, lines and planes; 2D transformation for translation, scaling, rotation and reflection; Homogeneous representation and concatenation; 3D transformations.	6
III	**Curves and Surfaces:** Representation of curves; Hermite curves, Bezier curves, B-spline curves, Rational curves; Surface modelling – parametric representation, planar surface, surface of revolution, Coons and bicubic patches, Bezier and B-spline surfaces.	6
IV	**Solid Modelling:** Solid modelling techniques – sweep (linear and curved), Boolean (constructive solid geometry) and other techniques; Solid model representation (Boundary and Constructive Solid Geometry); Medical modelling (pixels, scans and voxels); Exchange standards (IGES, DXF, STEP, STL etc.).	6

V	**Engineering Analysis:** Introduction to finite element method; Principle of potential energy; FE analysis of 1D element problems (spring, bar, truss elements); Development of element stiffness equation and their assembly; Plain strain and plain stress problems; Domain discretization, pre-processing and post-processing; Verification and validation; Popular CAE software used in industry	6
VI	**Design Optimization:** Purpose and application of optimum design, Primary and subsidiary design equations, Limit Equations, Normal, redundant and incompatible specifications problems; Computer-aided design optimization.	6
Text Books		
1.	Ibrahim Zeid, "Mastering CAD CAM," Tata McGraw Hill Publishing Co. 2007.	
2.	C. McMohan and J. Browne, "CAD/CAM Principles," Pearson Education, 2nd Edition, 1999.	
3.	Geometric Modeling, Michael E. Mortenson, Tata McGraw Hill, 2013.	
4.	W. M. Neumann and R.F. Sproul, "Principles of Computer Graphics," McGraw Hill, 1989.	
5.	D. Hearn and M.P. Baker, "Computer Graphics," Prentice Hall Inc., 1992.	
Online Resources		
1.	https://ocw.mit.edu/courses/mechanical-engineering/2-158j-computational-geometry-spring-2003/	
2.	https://nptel.ac.in/courses/112/104/112104031/	
3.	https://nptel.ac.in/courses/112/102/112102101/,	

Year, Program, Semester	Specialization Minor I, 4th Semester onwards						
Course Code	SMP1.2						
Course Category	Specialization Minor Program Core						
Course title	**Product Design and Development**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-	-	03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	-	-	-	-	100
Pre-requisites(if any)	--						
Course Objectives	The course is aimed at - 1. Model and analyze product design for an engineering application 2. Identify customer requirements for a process or product. 3. Develop protoyping method for an engineering application. 4. Evaluate the ergonomics of engineering application.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Describe the characteristics used for product design and development. 2. Assess the customer requirements in product design. 3. Apply structural approach to concept generation, selection and testing. 4. Identify various aspects of design such as industrial design, design for manufacture, assembly, service and quality and product architecture. 5. Explain various principles and technologies used for the preparation of prototype.						

Unit No.	Course Content	Hours
I	Product Design – Traditional and Modern Design Processes, Innovation, Creation and Diffusion Techniques, and Functional, Technological, Ecological, Ligiale Evaluation of New Product Ideas.	6
II	Product Modeling and Reverse Engineering-Wireframe, Surface, and Solid Modeling Techniques, Reverse Engineering	6
III	Product Data Exchange-Neutral File Format such as DXF, IGES, STEP, Concurrent EngineeringConcept Design For X, DFM, DFA, DFR, DFQ	6

IV	Rapid Protyping Methods-Liquid Based RP Methods Such As SLA, SGC, and SCS, Solid Based RP Methods such as FDM, And LOM, Powder Based RP Methods such as SLS, 3DP, And BPM	6
V	Prototyping: Prototyping basics, principles of prototyping, technologies, planning for prototypes Product development economics: Elements of economic analysis, base case financial mode, sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.	6
VI	Ergonomics / Aesthetics: Gross human autonomy. Anthropometry. Man-Machine interaction. Concepts of size and texture, colour .Comfort criteria. Psychological and Physiological considerations. Creativity Techniques: Creative thinking, conceptualization, brain storming, primary design, drawing, simulation, detail design.	6
Text Books		
1.	Product Design and Manufacturing - A.K.Chitab andR.C.Gupta, PHI (EEE).	
2.	The Technology of Creation Thinking - R.P.Crewford – Prentice Hall	
3.	The Art of Thought – Grohem Walls – Bruce andCo., New York	
4.	Product Design and Decision Theory - M.K. Starr - Prentice Hall	

Year, Program, Semester	Specialization Minor I, 4th Semester onwards						
Course Code	SMP1.3						
Course Category	Specialization Minor Program Core						
Course title	**Design of Composite Materials**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-		03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	---	---	---	--	100
Pre-requisites(if any)	--						
Course Objectives	The course is aimed at - 1. Model and analyze composite material for an engineering application 2. Identify stress and strain of composite material. 3. Understand method for finding mechanical characteristics of composite material an engineering application.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Understand the principles of governing composite material. 2. Design an composite material for engineering application. 3. Understand the working of stress and strain in composite material. 4. Understand Equilibrium Equations of Motion in composite material.						

Unit No.	Course Content	Hours
I	Introduction to Composite Materials Constituents, Material forms Processing, Applications Definition – Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic and Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices –Characteristics of fibers and matrices.	6
II	Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina – Transformation Matrix, Transformed Stiffness.	6

III	Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations– Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina, Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.	6
IV	Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure.	6
V	Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies.	6
VI	Modification of Hooke's Law due to thermal properties-Modification of Laminate Constitutive Equations. Orthotropic Lamina - special Laminate Configurations – Unidirectional, Off-axis, Symmetric Balanced Laminates - Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates	6
Text Books		
1.	Jones, R.M., "Mechanics of Composite Materials", McGraw-Hill, Kogakusha Ltd., Tokyo, 1985.	
2.	Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites", John Wiley and sons. Inc., New York, 1995.	
3.	Hyer, M.W., "Stress Analysis of Fiber-Reinforced Composite Materials", McGraw-Hill, 1998.	
4.	Mechanics of Composite Materials, Autar K. Kaw, 2nd ed., CRC Press, 2006	

<table>
<tr><td>Year, Program, Semester</td><td colspan="7">Specialization Minor I, 4th Semester onwards</td></tr>
<tr><td>Course Code</td><td colspan="7">PBI</td></tr>
<tr><td>Course Category</td><td colspan="7">Program Based Internship</td></tr>
<tr><td>Course title</td><td colspan="7">Internship</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td colspan="2">Total Contact Hours</td><td colspan="2">Total Credits</td></tr>
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<tr><td>Course Objectives</td><td colspan="7">The course is aimed at -
1. To Identify and compare technical and practical issues in industrial as well as in social area.
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3. To Prepare a well-organized report of technical writing and innovative thinking.
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<tr><td>Course Outcomes</td><td colspan="7">Upon completion of this course, student should be able to –
1. Establish motivation for any topic of interest and develop a thought process for technical presentation.
2. Organize a detailed literature survey and build a document with respect to technical publications.
3. Analysis and comprehension of concept and related data.
4. Effective presentation and improve soft skills.</td></tr>
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Course Content

The course consists of a one-month internship in Minor Specific Industry. Students will be placed in companies or organizations that align with the particular sector. During the internship, students will engage in various activities, including but not limited to:

1. Shadowing industry professionals to observe and learn about different processes and operations.
2. Assisting with ongoing projects or research initiatives within the organization.
3. Participating in hands-on tasks related to their minor sub-specialization, under the guidance of experienced mentors.
4. Attending training sessions, workshops, and seminars conducted by the industry to enhance their knowledge and skills.
5. Engaging in discussions and meetings with supervisors and colleagues to gain insights into industry practices, challenges, and innovations.
6. Documenting their internship experience through reports, presentations, or reflective journals.

The period of one month for this internship will be during the winter or summer vacations, any such slots 4^{th} Semester onwards.

Course Assessment Process

This particular evaluation will be the part of the structure of 7th Semester.

The evaluation for the Industrial Internship course will be conducted as follows:

Internal Evaluation (50 marks):

- Assessment by course teachers based on students' performance during the internship, including attendance, participation, attitude, and contribution to assigned tasks.
- Evaluation by industrial supervisors on students' professional conduct, technical skills, problem-solving abilities, and overall performance in the workplace.

External Evaluation (50 marks):

- Evaluation by an external examiner appointed by the institute, who will assess students' internship reports, presentations, or any other documentation submitted at the end of the internship period.
- The external examiner will review the quality of students' reflections on their internship experience, their ability to apply theoretical knowledge to practical situations, and the depth of their understanding of industry practices and challenges.

The final grades for the Industrial Internship course will be determined based on the combined assessment from both internal and external evaluations.

Year, Program, Semester	Specialization Minor I, 4th Semester onwards							
Course Code	PBL							
Course Category	Project Based Learning							
Course title	**Mini Project**							
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Total Credits		
						02		
Evaluation Scheme	ISE		ESE	IOE	IPE	EOE	EPE	Total
	-		-	50	-	50	-	100
Pre-requisites(if any)								
Course Objectives	The course teacher will 1. Facilitate application of theoretical knowledge. 2. Guide the students about enhancement of practical skills. 3. Explain about development of industry-relevant competencies.							
Course Outcomes	Upon completion of this course, student should be able to 1. Demonstrate application of theoretical concepts with instructor guidance. 2. Collaborate effectively in instructor-led team-based projects. 3. Communicate findings and insights professionally under instructor supervision.							

Course Content
Minor Program Based Mini Project is a dynamic course designed to bridge the gap between classroom learning and real-world application. All the students will engage themselves in a series of tasks and challenge that will enable them to apply theoretical concepts learned in previous courses to solve practical problems. The project work need to be carried out independently covering a range of topics relevant to their field of study, allowing them to explore different facets of the particular discipline and develop versatile skill sets. This activity may be planned after 4th Semester and can be completed prior to 8th Semester of their Major studies.
Course Assessment Process

This particular evaluation will be the part of 8th Semester of the major structure.

The course evaluation for the internals will be at the course teacher end while there will also be the external evaluation of the Project work.

The teachers will follow the instructions as below:

Evaluation Format: The evaluation may be conducted using a combination of assessment methods, including:

- Rubric-based assessment for the project work and its report.
- Peer evaluation for project.
- Instructor-led discussions or presentations to evaluate communication skills and critical thinking.
- Overall course grading based on a weighted average of individual assessments and participation.

The evaluation format should be transparent, fair, and aligned with the course objectives and outcomes. Regular feedback and communication with students will ensure that the evaluation process remains supportive of their learning journey.

Specialization Minor
In
Thermal Engineering
For
B. Tech (Mechanical Engineering)

Shivaji University, Kolhapur

Department of Technology

Specialization Minor in Thermal Engineering

Teaching & Evaluation Scheme

S.N.	Category	Code	Course Title	Hours per week			Contact Hours	Credits	Evaluation scheme	
									Theory	Practical
				L	T	P			ISE:ESE	IE:EE
1.	Preferably on SWAYAM (NPTEL) or any other MOOCs (Minor Program Core) Or In a Face-to-Face mode	SMP2.1	Computational Fluid Flow and Heat Transfer	03	-	-	03	03	30:70	00:00
2.		SMP2.2	Fuel and Combustion	03	-	-	03	03	30:70	00:00
3.		SMP2.3	Advanced Refrigeration And Air Conditioning	03	-	-	03	03	30:70	00:00
4.	Minor Program Based Internship	PBI	Industrial Internship (Minor Program Specific Industry)	One Month				03	00:00	50:50
5.	Project Based Learning	PBL	Mini Project	-	-	-	-	02	00:00	50:50
							-	**14**	**300**	**200**
			Total Hours	09	00	00	**09**	-	-	-

Note: MDM Program's Internship and Mini Project need to be planned during winter or summer vacation days after 4th semester while respective evaluations will be the part of 7th and 8th Semesters of the B. Tech Major structure.

Year, Program, Semester	Specialization Minor II, 4th Semester onwards						
Course Code	SMP2.1						
Course Category	Specialization Minor Program Core						
Course title	**Computational Fluid Flow and Heat Transfer**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-	-	03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	-	-	-	-	100
Pre-requisites(if any)							
Course Objectives	The course is aimed at - 1. To understand the importance of fluid flow and heat transfer. 2. To get the knowledge of various solution methods in computational fluid flow and heat transfer. 3. To understand the basics of computational fluid flow and heat transfer.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Understand the principles of computational fluid flow and heat transfer. 2. Understand the solution methods of computational fluid flow and heat transfer. 3. Understand treatment methods for compressible flow. 4. Learn the basics of finite volume method.						

Unit No.	Course Content	Hours
I	Introduction - Mathematical Description of Fluid Flow and Heat Transfer; Conservation Equations for Mass, Momentum, Energy and Chemical Species, Finite Difference Method, Finite Volume Method, Finite Element Method, Governing Equations and Boundary Conditions, Derivation of Finite Difference Equations.	6
II	Solution Methods of Elliptical Equations – Finite Difference Formulations, Interactive Solution Methods, Direct Method With Gaussian Elimination.Parabolic Equations-Explicit Schemes and Von Neumann Stability Analysis, Implicit Schemes, Alternating Direction Implicit Schemes, Approximate Factorization, Fractional Step Methods, Direct Method with Tridiagonal Matrix Algorithm.	6

III	Hyperbolic Equations - Explicit Schemes and Von Neumann Stability Analysis, Implicit Schemes, Multi Step Methods, Nonlinear Problems, Second Order One-Dimensional Wave Equations.Burgers Equations -Explicit and Implicit Schemes, Runge-Kutta Method. Formulations of Incompressible Viscous Flows - Formulations of Incompressible Viscous Flows by Finite Difference Methods, Pressure Correction Methods, Vortex Methods.	6
IV	Treatment of Compressible Flows - Potential Equation, Euler Equations, Navier-Stokes System of Equations, Flow Field-Dependent Variation Methods, Boundary Conditions, Example Problems.	6
V	Finite Volume Method - Finite Volume Method Via Finite Difference Method, Formulations For Two and ThreeDimensional Problems.	6
VI	Standard Variational Methods - Linear Fluid Flow Problems, Steady State Problems, Transient Problems.	6
Text Books		
1.	Chung, T. J. - Computational Fluid Dynamics, Cambridge University Press.	
2.	Frank Chorlton - Text Book of Fluid Dynamics, CBS Publishers, New Delhi.	
3.	Patankar, S. V. - Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation.	
4.	Anderson, D. A., Tannehill J. C. and Pletcher, R. H. - Computational Fluid Mechanics and Heat Transfer, Hemisphere Publishing Corporation.	
5.	H. K. Versteeg and W. Malalasekara, An Introduction to Computational Fluid Dynamics, Longman	

Year, Program, Semester	Specialization Minor II, 4th Semester onwards							
Course Code	SMP2.2							
Course Category	Specialization Minor Program Core							
Course title	**Fuel and Combustion**							
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Total Credits		
	03	-	-	03		03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total	
	30	70	-	-	-	-	100	
Pre-requisites(if any)	--							
Course Objectives	The course is aimed at - 1. Identify type of working of two stroke and four stroke engine. 2. Identify lubrication system for two stroke and four stroke engine . 3. Evaluate the performance of S. I. And C. I. Engine. 4. Identify Pollutant formation and control in S. I. And C. I. Engine							
Course Outcomes	Upon completion of this course, student should be able to – 1. Ability to recognize and analyze working of two stroke and four stroke engine. 2. Understand the role of lubrication system for two stroke and four stroke engine. 3. Understand the basic theory of S. I. And C. I. Engine. 4. Understand the measurement of various quantities using instruments, their accuracy & range, and the techniques for Pollutant formation and control in S. I. And C. I. Engine.							

Unit No.	Course Content	Hours
I	Working of two stroke & four stroke - Petrol and Diesel Engines (Review Only) - valve timing diagrams - Fuels - Chemical structure- qualities, ratings of fuels - Alternative fuels, Alcohol, vegetable oils, biogas. Types of Engines - Wankel E/n, Stirling E/n, Stratified charge e/n, VCR E/n, free piston E/n. Fuel air cycle (actual) for petrol and diesel engines - variation of specific heats - heat losses - Dissociation	6

II	Carburation - Air fuel mixture requirements - stoichiometry and excess air calculations - types of carburetors - Fuel injection systems- classifications - fuel injection pump - nozzle - direct and indirect injection - Injection in S. I. Engine - M. P. F. I. System - Ignition system - Battery & Magneto type – firing order - Ignition timing and spark advance -	6
III	Lubrication systems - types - properties of lubricants – additives for lubricants - Heat rejection and cooling - Theory of engine heat transfer - types of cooling system – Air and liquid system - Super charging & turbo charging.	6
IV	Combustion in S. I. E/n - Ignition limits - stages of combustion - combustion quality - Ignition lag – Flame propagation - Abnormal combustion - detonation - effects - Theory, chemistry and control - flash point, fire point & viscosity index - combustion chamber design considerations.	6
V	Combustion in C. I. Engines - Air Fuel ratio in C. I. Engines - Ignition Lag - diesel knock – Controlling Methods - Various stages of combustion - vaporization of fuel droplets and spray formation - Air motion - Swirl - combustion chamber - design considerations.	6
VI	Pollutant formation and control in S. I. And C. I. Engine, Nox, CO, Unburned hydro Carbon and particulate - Exhaust gas treatment - catalytic converter - Thermal reaction - Particulate Trap. Engine operating characteristics - Testing of I. C. Engines - Indicated power - Brake power - Volumetric Efficiency – Heat balance Test - Morse Test - Measurement of exhaust smoke and exhaust emission.	6
Text Books		
1.	Internal Combustion Engine Fundamentals - John B. Heywood	
2.	Internal Combustion Engine and Air Pollution -Obert E. F.	
3.	Internal Combustion Engine - Lichty L. C.	
4.	Internal Combustion Engine - V. Genesan	

Year, Program, Semester	Specialization Minor II, 4th Semester onwards						
Course Code	SMP2.3						
Course Category	Specialization Minor Program Core						
Course title	**Advanced Refrigeration And Air Conditioning**						
Teaching Scheme and Credits	L	T	P	Total Contact Hours	Total Credits		
	03	-		03	03		
Evaluation Scheme	ISE	ESE	IOE	IPE	EOE	EPE	Total
	30	70	---	---	---	--	100
Pre-requisites(if any)	--						
Course Objectives	The course is aimed at - 1. To apply the principles of thermodynamics to analyze different types of refrigeration and air conditioning systems and to understand the functionality of the major components.						
Course Outcomes	Upon completion of this course, student should be able to – 1. Differentiate between different types of refrigeration systems with respect to application as well as conventional & unconventional refrigeration systems. 2. Thermodynamically analyze refrigeration and air conditioning systems and evaluate performance parameters. 3. Apply the principles of psychometrics to design the air conditioning loads for industrial applications.						

Unit No.	Course Content	Hours
I	Vapour Compression Refrigeration: Performance of Complete vapor compression system. Actual Vs Ideal cycle - Effect of operating parameters on COP, Components of Vapor Compression System: The condensing unit – Evaporators – Expansion valve – Refrigerants – Properties – ODP & GWP - Load balancing of vapor compression Unit. Compound Compression: Flash inter-cooling – flash chamber – Multi-evaporator & Multistage systems	6
II	Production of Low Temperature: Liquefaction system, Liquefaction of gases, Hydrogen and Helium, Cascade System – Applications– Dry ice system.	6

III	Vapor absorption system – Simple and modified aqua – ammonia system – Representation on Enthalpy –Concentration diagram. Lithium – Bromide system Three fluid system – HCOP.	6
IV	Air Refrigeration: Applications – Air Craft Refrigeration -Simple, Bootstrap, Regenerative and Reduced ambient systems – Problems based on different systems. Steam Jet refrigeration system: Representation on T-s and h-s diagrams – limitations and applications. Unconventional Refrigeration system – Thermo-electric – Vortex tube & Pulse tube – working principles.	6
V	Air Conditioning: Psychometric properties and processes – Construction of Psychometric chart. Requirements of Comfort Air –conditioning – Thermodynamics of human body – Effective temperature and Comfort chart – Parameters influencing the Effective Temperature. Summer, winter and yearround air – conditioning systems. Cooling load Estimation: Occupants, equipments, infiltration, duet heat gain fan load, Fresh air load.	6
VI	Air Conditioning Systems: All Fresh air, Re-circulated air with and without bypass, with reheat systems – Calculation of Bypass Factor, ADP, RSHF, ESHF and GSHF for different systems. Components: Humidification and dehumidification equipment – Systems of Air cleaning – Grills and diffusers – Fans and blowers – Measurement and control of Temperature and Humidity.	6

Text Books

1.	Refrigeration & Air Conditioning by C.P. Arora, TMH
2.	Refrigeration & Air Conditioning by Arora & Domkundwar, Dhanpat Rai
3.	Refrigeration and Air Conditioning by Manohar Prasad
4.	Refrigeration and Air Conditioning by Stoecker, Mc Graw Hill

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<tr><td>Course Category</td><td colspan="7">Program Based Internship</td></tr>
<tr><td>Course title</td><td colspan="7">Internship</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td colspan="2">Total Contact Hours</td><td colspan="2">Total Credits</td></tr>
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Course Content

The course consists of a one-month internship in Minor Specific Industry. Students will be placed in companies or organizations that align with the particular sector. During the internship, students will engage in various activities, including but not limited to:

1. Shadowing industry professionals to observe and learn about different processes and operations.
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6. Documenting their internship experience through reports, presentations, or reflective journals.

The period of one month for this internship will be during the winter or summer vacations, any such slots 4^{th} Semester onwards.

Course Assessment Process

This particular evaluation will be the part of the structure of 7th Semester.

The evaluation for the Industrial Internship course will be conducted as follows:

Internal Evaluation (50 marks):

- Assessment by course teachers based on students' performance during the internship, including attendance, participation, attitude, and contribution to assigned tasks.
- Evaluation by industrial supervisors on students' professional conduct, technical skills, problem-solving abilities, and overall performance in the workplace.

External Evaluation (50 marks):

- Evaluation by an external examiner appointed by the institute, who will assess students' internship reports, presentations, or any other documentation submitted at the end of the internship period.
- The external examiner will review the quality of students' reflections on their internship experience, their ability to apply theoretical knowledge to practical situations, and the depth of their understanding of industry practices and challenges.

The final grades for the Industrial Internship course will be determined based on the combined assessment from both internal and external evaluations.

Year, Program, Semester	Specialization Minor II, 4th Semester onwards							
Course Code	PBL							
Course Category	Project Based Learning							
Course title	**Mini Project**							
Teaching Scheme and Credits	L	T	P	Total Contact Hours		Total Credits		
						02		
Evaluation Scheme	ISE		ESE	IOE	IPE	EOE	EPE	Total
	-		-	50	-	50	-	100
Pre-requisites(if any)								
Course Objectives	The course teacher will 1. Facilitate application of theoretical knowledge. 2. Guide the students about enhancement of practical skills. 3. Explain about development of industry-relevant competencies.							
Course Outcomes	Upon completion of this course, student should be able to 1. Demonstrate application of theoretical concepts with instructor guidance. 2. Collaborate effectively in instructor-led team-based projects. 3. Communicate findings and insights professionally under instructor supervision.							

Course Content
Minor Program Based Mini Project is a dynamic course designed to bridge the gap between classroom learning and real-world application. All the students will engage themselves in a series of tasks and challenge that will enable them to apply theoretical concepts learned in previous courses to solve practical problems. The project work need to be carried out independently covering a range of topics relevant to their field of study, allowing them to explore different facets of the particular discipline and develop versatile skill sets. This activity may be planned after 4th Semester and can be completed prior to 8th Semester of their Major studies.
Course Assessment Process

This particular evaluation will be the part of 8th Semester of the major structure.

The course evaluation for the internals will be at the course teacher end while there will also be the external evaluation of the Project work.

The teachers will follow the instructions as below:

Evaluation Format: The evaluation may be conducted using a combination of assessment methods, including:

- Rubric-based assessment for the project work and its report.
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- Overall course grading based on a weighted average of individual assessments and participation.

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