SHIVAJI UNIVERSITY, KOLHAPUR

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

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 2026-27 ONWORDS)

A. Engineering Graduate Attributes

Domain specific Engineering Knowledge

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

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.

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.

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
School of Engineering and Technology
Second Year B. Tech (Mechanical Engineering), Semester- III
Teaching and 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	04	-	-	04	04	40:60	00:00
2.	Professional Core Courses	PCC211	Metal Cutting and Machine Tools	04	-	-	04	04	40:60	00:00
3.	Professional Core Courses	PCC212	Fluid Mechanics	03	-	02	05	04	40:60	00:50
4.	Professional Core Courses	PCC213	Material Science and Engineering	03	-	02	05	04	40:60	00:50
5.	Professional Core Courses	PCC214	Engineering Thermodynamics	03	-	02	05	04	40:60	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
				-	-	-	-	**22**	**500**	**300**
8.	Project Based Learning	PBL211	Mini Project I & Industrial Visit	-	01	-	01	IE 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
School of Engineering and Technology
Second Year B. Tech (Mechanical Engineering), Semester- IV
Teaching and 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	40:60	50:50
2.	Professional Core Course	PCC 222	Strength of Materials	03	-	-	03	03	40:60	00:00
3.	Professional Core Course	PCC 223	Manufacturing Processes	03	-	02	05	04	40:60	50:50
4.	Professional Core Course	PCC 223	Kinematics of Machines	03	-	02	05	04	40:60	00:50
5.	Professional Core Course	PCC 224	Machine Design I	03	-	02	05	04	40:60	00:50
6.	MDM Course	MDM311	Multidisciplinary Minor Course I*	03	-	-	03	03	40:60	00:00
				-	**-**	**-**	**-**	**22**	**600**	**300**
7.	Indian Knowledge System	IKS221	Introduction to Performing Arts	01	-	-	01	IE at Course in charge end		
8.	Mandatory Audit Course	MAC 222	Aptitude Enhancement Course I	-	01	-	01	IE at Course in charge end		
9.	Project Based Learning	PBL221	Mini Project II & Industrial Visit	-	01	-	01	IE at Course in charge end		
10.	Humanities, Social Sciences, Management Environment	HSMEC 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.

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**	
	04	-	-	04		04	
Evaluation Scheme	**ISE**	**ESE**	**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	40	60	-	-	-	-	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
1	**Linear Differential Equations** Linear Differential Equations with constant coefficients, Homogenous Linear differential equations, Method of variation of parameters.	7
2	**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
3	**Partial Differential Equations** Introduction to partial differential equations, Four standard forms of partial differential equations of first order.	7
4	**Applications of Partial Differential Equations** Introduction to second order partial differential equations, Classification, Wave Equation, One dimensional heat flow equation, The Laplace equation in two-dimensional heat flow (Steady State), method of separation of variables, use of Fourier series.	7
5	**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
6	**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,	6

	volume integral, Gauss's Divergence theorem, Stoke's theorem, Green's theorem (Without proof).	

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

Course Code	PCC211						
Course Category	Professional Core Courses						
Course title	**Metal Cutting and Machine Tools**						
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**	
	04	-	-	04		04	
Evaluation Scheme	**ISE**	**ESE**		**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	40	60		-	-	-	-	100
Pre-requisites(if any)	Nil						
Course Objectives	**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.						
Course Outcomes	**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						

Unit No.	Course Content	Hours
1	**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
2	**Drilling and Milling Machines:** 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. Milling Machines - Fundamental aspects, cutter types and geometry, Operations performed on a milling machine, types of milling machines, up milling and down milling.	6
3	**Shaping, planning and broaching Machines:**	6

	Construction, working and operations performed on the shaper, planer, and broaching machines, Reaming processes and reamer types.	
4	**Grinding and superfinishing:** 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. Superfinishing: Honing, lapping, super finishing, buffing and burnishing processes. Safety and environmental aspects of various machine tools.	6
5	**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 of this unit)	6
6	**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

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**
	40	60	-	-	-	-	100
Pre-requisites (if any)	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
1	**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
2	**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
3	**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
4	**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
5	**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
6	**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 - l",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/#**

Course Code	PCC212
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)	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.						

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

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
	40	60	-	-	-	-	100

Pre-requisites (if any)	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. Analyzeand 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
1	**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 5. Construction of equilibrium diagrams from cooling curves, Isomorphous system (Solid Solution), Eutectic, Partial solubility Peritectic and Intermetallic Compounds Lever arm principles.	06
2	**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
3	**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
4	**Heat Treatment Processes** **a) Heat Treatment of Steels:** 1. Annealing – Types-Full, Partial and Sub critical annealing (Various types) and purposes 2. Normalizing- Purposes 3. Hardening (Hardening types), Purposes, Austempering and Martempering, Mechanism of quenching and Quenching media, Hardenability- Concept and methods of determination	06

	of hardenability- Grossmans critical diameter method and Jominy end quench test. 4. Tempering Types, Structural transformations during tempering, purposes subzero 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.	
5	**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
6	**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) 3. Compaction- types- Conventional, Isostatic, HERF, Powder rolling and extrusion 4. Sintering- Types of liquid stage and solid stage sintering 5. Finishing operations: Sizing, Machining, Infiltration and Impregnation	06
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/**	

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)	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.						

Sr. 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.	

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**
	40	60	-	-	-	-	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/**	

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.							

Sr. 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.

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
1	**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
2	**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
3	**Surface Roughness and Production Drawing** 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.	2
4	**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

Sr. 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/
2	https://nptel.ac.in/courses/112/104/112104172/
3	http://moodle.unishivaji.ac.in/course/search.php?search=engineering+graphics
4	http://web.iitd.ac.in/~achawla/public_html/201/lectures/sp46.pdf

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	**The teacher will** 1. Help to enhance communication, teamwork, problem-solving skills. 2. Help to foster adaptability and resilience in engineering contexts.						
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 and 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:

Quizzes/Tests (10 marks)

Periodic quizzes or tests to evaluate students' understanding of key concepts and their ability to apply them.

Activity 1 (10 marks)

Group activity focusing application of creative thinking and teamwork; designed to assess both individual and group performance

Activity 2 (20 marks)

Group activity focusing application of creative thinking and teamwork; designed to assess both individual and group performance

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.

Course Code	PBL211							
Course Category	Project Based Learning							
Course title	**Mini Project I and 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	--

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: 60 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) Aquaticecosystems (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 resources, use of alternate energy sources. Solar energy, Biomass energy, nuclear energy, Role of Indian traditions and culture in conservation of the environment	8
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-	7

	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	

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

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**
	40	60	-	-	-	-	100
Pre-requisites (if any)	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
1	**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
2	**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
3	**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
4	**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
5	**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
6	**Rotodyanamic Air Compressors** Centrifugal compressor- velocity diagram, pre whirl, slip factor, performance calculations. Axial	6

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

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)	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 compressors	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.

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**
	40	60	-	-	-	-	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. 2. To learn about applications of first law to various conversion devices. 3. To familiarize about finding shear force, bending moment, deflection and slopes in various types of beams with different load conditions. 4. To enable students to solve practical problems related to shafts & springs. 5. 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 and 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 and 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 Publisher
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/**

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**
	40	60	-	-	-	-	100	**4 hours**
Pre-requisites (if any)	Metal Cutting and Machine Tools							
Course Objectives	**The course is aimed at:** 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	**Upon completion of this course, student should 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
1	**Foundry: Pattern making, moulding and casting** 1. 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 and remedies 5. Advanced casting methods: Lost wax processes, shell moulding and investment casting. Permanent mould dies casting- Die-casting, centrifugal casting, and continuous casting. 6. safety and environmental aspects of manufacturing processes.	06
2	**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

3	**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
4	**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
5	**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
6	**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. 5, includes drawing a jigs/ fixture for simple objects whereas unit no. 6, 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

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)	Metal Cutting and Machine Tools						
Course Objectives	**The course is aimed at:** 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	**Upon completion of this course, student should be able to:** 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.						

Sr. 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

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

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**
	40	60	-	-	-	-	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
1	**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
2	**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- relative motion between two bodies- three centres in-line theorem, locating instantaneous centres for simple mechanism and determination of angular velocities of point and joints.	
3	**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
4	**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
5	**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
6	**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	

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						

Sr. 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

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**
	40	60		- / -	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 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
1	**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
2	**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
3	**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
4	**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. (Note: The unit includes numerical treatment on the appropriate topics.)	6
5	**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.)	

6	**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

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	**The course teacher will ensure:** 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.

Course Code	IKS221						
Course Category	Indian Knowledge system						
Course title	**Introduction to Performing Arts**						
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)							
Course Objectives	**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.						
Course Outcomes	**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.						

Unit No.	Course Content	Hours
1	**Foundations of Performing Arts:** • Introduction to Performing Arts: Definition, scope, and significance. • Historical overview: Evolution of performing arts across cultures and civilizations.	2
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	**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	**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	**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	**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

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

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	**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	Inter-Personal and Inter-Organizational Communication	2
2	Creative and Critical Thinking	2
3	Group Dynamics and Decision-Making Techniques	2
4	Emotional Intelligence and 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. Students 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.

Course Code	PBL221						
Course Category	Project Based Learning						
Course title	**Mini Project II and 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
1	**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)

2	**Industrial Visit:** • 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. • 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	--

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: 60 marks, Project/Visit based IOE: 40 Marks				
Pre-requisites (if any)	Basic Physics, Basic Chemistry				
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
Assignments:		

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