UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Production Engineering

Direct Second Year Admitted Students for the Academic Year

2020-21 (only)

(Rev -2019 'C' Scheme) from Academic Year 2019-20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE Guidelines)

Program Structure for Second Year Engineering
Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
PEC301	Engineering Mathematics-III	3	--	1	3	--	1	4
PEC302	Applied Thermodynamics and Fluid Mechanics	3		--	3		--	3
PEC303	Mechanics of Materials	3	--	--	3	--	--	3
PEC304	Manufacturing Processes	3	--	--	3	--	--	3
PEC305	Engineering Materials and Metallurgy	3	--	--	3	--	--	3
PEL301	Computer Aided Machine Drawing Lab.	--	2*+ 2	--	--	2	--	2
PEL302	Python Programming Lab.	--	2	--	--	1	--	1
PEL303	Material testing Lab.	--	2	--	--	1	--	1
PEL304	Skill based Lab. Course-I	--	4	--	--	2	--	2
PEM301	Mini Project – 1 A	--	4$	--	--	2	--	2
Total		**15**	**16**	**1**	**15**	**08**	**1**	**24**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Pract/ oral**	**Total**
		Internal Assessment			**End Sem. Exam**	**Exam. Duration (in Hrs)**			
		Test1	**Test2**	**Avg.**					
PEC301	Engineering Mathematics-III	20	20	20	80	3	25	--	125
PEC302	Applied Thermodynamics and Fluid Mechanics	20	20	20	80	3	--	--	100
PEC303	Mechanics of Materials	20	20	20	80	3	--	--	100
PEC304	Manufacturing Processes	20	20	20	80	3	--	--	100
PEC305	Engineering Materials and Metallurgy	20	20	20	80	3	--	--	100
PEL301	Computer Aided Machine Drawing Lab.	--	--	--	--	--	50	25	75
PEL302	Python Programming Lab.	--	--	--	--	--	25	--	25
PEL303	Material testing Lab.	--	--	--	--	--	25	--	25
PEL304	Skill based Lab. Course-I	--	--	--	--	--	50	--	50
PEM301	Mini Project – 1 A	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**200**	**50**	**750**

* Theory of entire class to be conducted.
$ indicates work load of Learner (Not Faculty) for Mini Project.

Mini Project 1A:
Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Credits
PEC301	Engineering Mathematics- III	03+01=04

Contact Hours			Credit Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	01	03	-	01	04

Theory					Term work / Practical / Oral			Total
Internal Assessment			End semester	Duration of End semester Exam	TW	PR	OR	
Test I	Test II	Average						
20	20	20	80	03 hrs.	25	-	-	125

Course Objectives:

1. To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, its applications.
2. To acquaint with the concept of Fourier series, its complex form and enhance the problem solving skills.
3. To familiarize with the concept of complex variables, C-R equations with applications.
4. To study the application of the knowledge of matrices and numerical methods in complex engineering problems.

Course Outcomes: Learner will be able to:

1. Apply the concept of Laplace transform to solve the real integrals in engineering problems.
2. Apply the concept of inverse Laplace transform of various functions in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4. Find orthogonal trajectories and analytic function by using basic concepts of complex variable theory.
5. Apply Matrix algebra to solve the engineering problems.
6. Solve Partial differential equations by applying numerical solution and analytical methods for one dimensional heat and wave equations.

Detailed Syllabus: (Module wise)		
Module No.	**Description**	**Duration**
1	**Module: Laplace Transform** 1.1 Definition of Laplace transform, Condition of Existence of Laplace transform, 1.2 Laplace Transform (L) of Standard Functions like e^{at}, $sin(at)$, $cos(at)$, $sinh(at)$, $cosh(at)$ and t^n $, where\ n \geq 0$. 1.3 Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by *t*, Division by *t*, Laplace Transform of derivatives and integrals (Properties without proof). 1.4 Evaluation of integrals by using Laplace Transformation. **Self-learning topics:** Heaviside's Unit Step function, Laplace Transform. of Periodic functions, Dirac Delta Function.	**06**

2	**Module: Inverse Laplace Transform** 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivative 2.2 Partial fractions method & first shift property to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof) **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	**06**
3	**Module: Fourier Series:** 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof) 3.2 Fourier series of periodic function with period 2π and $2l$, 3.3 Fourier series of even and odd functions 3.4 Half range Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, orthogonal and orthonormal set of functions, Fourier Transform.	**07**
4	**Module: Complex Variables:** 4.1 Function $f(z)$ of complex variable, limit, continuity and differentiability of $f(z)$, Analytic function, necessary and sufficient conditions for $f(z)$ to be analytic (without proof), 4.2 Cauchy-Riemann equations in cartesian coordinates (without proof) 4.3 Milne-Thomson method to determine analytic function $f(z)$ when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given. 4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories **Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations	**07**
5	**Module: Matrices:** 5.1 Characteristic equation, Eigen values and Eigen vectors, Properties of Eigen values and Eigen vectors. (**No theorems/ proof**) 5.2 Cayley-Hamilton theorem (without proof): Application to find the inverse of the given square matrix and to determine the given higher degree polynomial matrix. 5.3 Functions of square matrix 5.4 Similarity of matrices, Diagonalization of matrices **Self-learning Topics:** Verification of Cayley Hamilton theorem, Minimal polynomial and Derogatory matrix & Quadratic Forms (Congruent transformation & Orthogonal Reduction)	**07**
6	**Module: Numerical methods for PDE** 6.1 Introduction of Partial Differential equations, method of separation of variables, Vibrations of string, Analytical method for one dimensional heat and wave equations. (only problems) 6.2 Crank Nicholson method	**06**

	6.3 Bender Schmidt method **Self-learning Topics:** Analytical methods of solving two and three dimensional problems.	

Term Work:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practical's.
2. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

1. First test based on approximately 40% of curriculum contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I).
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

End Semester Examination:

Weightage of each module in end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4. Only **Four questions need to be solved.**

References:

1. Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication.
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
3. Advanced Engineering Mathematics, R. K. Jain and S.R.K. Iyengar, Narosa publication
4. Advanced Engineering Mathematics, H.K. Das, S. Chand Publication
5. Higher Engineering Mathematics B.V. Ramana, McGraw Hill Education
6. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education,
7. Text book of Matrices, Shanti Narayan and P K Mittal, S. Chand Publication
8. Laplace transforms, Murray R. Spiegel, Schaum's Outline Series.

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Course Code	Course Name	Credits
PEC302	Applied Thermodynamics and Fluid Mechanics	03

Contact Hours			Credit Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term work / Practical / Oral			Total
Internal Assessment			End semester	Duration of End semester Exam	TW	PR	OR	
Test I	Test II	Average						
20	20	20	80	03 hrs.	-	-	-	100

Objectives:

1. To acquaint with basic concepts, various processes and cycles of Thermodynamics and its applications.
2. To familiarize with the understanding about basic laws of thermodynamics and its applications.
3. To impart the fundamental knowledge of fluid, its properties and behavior under various conditions of internal and external flows.
4. To prepare the students to learn about energy losses during fluid flow through pipes.

Outcomes: learner will be able to:

1. Understand the concept of thermodynamics and laws of thermodynamics.
2. Apply the first law of thermodynamics for various systems.
3. Apply the second law of thermodynamics for various systems.
4. Understand various properties of fluid.
5. Analyze the various types of flow fields analytically and by using flow visualization.
6. Apply fluid mechanics principles to understand the dynamics of flow and various losses during flow through pipe.

Detailed Syllabus: (Module wise)		
Module No.	**Description**	**Duration**
01	**First law of Thermodynamics:** Statement, First law applied to cyclic and non-cyclic process, Application to non-flow processes viz. Constant volume, constant pressure, constant temperature, adiabatic and polytrophic processes.	**03**
02	**First law applied to open systems:** Flow work, Steady flow energy equation (SFEE), SFEE applied to nozzle, turbine, compressor, boiler, condenser etc.	**03**
03	**Second law of Thermodynamics:** Thermal reservoir, heat engine, thermal efficiency, reversed heat engine, coefficient of performance, Kelvin-Planck, Clausius statements, and their equivalence, Entropy.	**03**
04	**Fluid Kinematics:** Eulerian and Lagrangian description of fluid motion, Types of fluid flow, Types of flow lines, continuity equation in Cartesian coordinates, Velocity potential and stream function.	**03**
05	**Fluid dynamics:** Euler's equation of motion along a stream line, Bernoulli's equation, Application of Bernoulli's equation to Venturi meter, Orifice meter and Pitot tube (No derivation on rate of flow is required).	**03**
06	**Dynamics of Viscous Flow:** Flow of viscous fluid in circular Pipes - Hagen Poiseuille flow. Flow Through Pipes: Major and Minor losses in pipes, Pipes in series, Pipes in parallel and Equivalent pipe. **Introduction of CFD**: Applications of CFD, Conservation equations, Classification of partial differential equations and physical behavior, Approximate solution of PDE, Finite difference and Finite Volume Method.	**05**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

1. First test based on approximately 40% of curriculum contents and second test based on remaining contents (approximately 40%, but excluding contents covered in Test I).
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

End Semester Examination:

Weightage of each module in end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4. Only **Four questions need to be solved.**

Books Recommended:

Text books:

1. Fluid Mechanics & Hydraulic Machines, 9th Edition by R. K. Bansal, Laxmi Publications.
2. Introduction to Fluid Mechanics, 4th Edition by R. W. Fox, and A. T. McDonald, John Wiley and Sons.
3. Thermal Engineering, R. K. Rajput, Laxmi Publications.
4. Thermal Engineering, Ballaney, Khanna Publications.
5. A Course in Thermal Engineering, Domkundwar, Kothoraman and Khaju.

Reference Books:

1. Fluid Mechanics, 3rd Edition by Frank M. White, McGraw-Hill.
2. Fluid Machines and Fluid Power Engg., 7th Edition by D.S Kumar, S. K. Kataria publications.
3. Thermal Engineering, Mahesh Rathore, Tata McGraw Hill.
4. Engineering Thermodynamics by C.P. Arora, Tata McGraw Hill Publications.
5. Engineering Thermodynamics through Examples by Y V C Rao, Universities Press (India) Pvt. Lt.10. Internal Combustion Engine, S.L. Beohar.

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Course Code	Course Name	Credits
PEC303	Mechanics of Materials	03

Contact Hours			Credit Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term work / Practical / Oral			Total
Internal Assessment			End semester	Duration of End semester Exam	TW	PR	OR	
Test I	Test II	Average						
20	20	20	80	03 hrs.	-	-	-	100

Objectives:

1. To impart the concept of various types of forces, their modes of action and resulting stresses and strains on various materials under various operating conditions.
2 To impart the knowledge of Bending Moment, Shear force and Moment of Inertia as applied on various structures.

Outcomes: Learner will be able to:

1. Illustrate stress-strain behavior of various materials under load.
2. Demonstrate the basic concepts related to material properties and stress strain behavior of material.
3. Illustrate the basic concept of Bending moment and Shear force.
4. Illustrate basic concepts of bending, shear, torsion and buckling.
5. Illustrate basic concepts of deflection.
6. Develop skills for analysis of stresses under various loading conditions.

Detailed Syllabus: (Module wise)		
Module No	Description	Duration
01	**Direct stress and direct strain:** Concept of different types of stresses; Stress−Strain curves for ductile and brittle material; factor of safety; deformation of uniform/tapering rectangular and circular and circular cross−section bars; deformation of members made of composite materials; shear stress and shear strain, Poisson's ratio, volumetric strain, bulk modulus; relationship between Young's modulus, bulk modulus and modulus of elasticity; temperature stresses in simple and compound bars.	04
02	**Theory of Bending:** Flexure formula for straight beams; principal axes of inertia; moments of inertia about principal axes; transfer theorem. Simple problems involving application of flexure formula, section modulus and moment of resistance of a section	03

03	**Shear Stress in Beams:** Distribution of shear stress across plane sections used commonly for structural purposes; shear connectors.	**03**
04	**Deflection of Beams:** Deflection of cantilever, simply supported and overhanging beams using Macaulay's method for different types of loadings.	**03**
05	**Theory of Torsion:** Torsion of circular shafts-solid and hollow, stresses in shafts transmitting power, shafts in series and parallel.	**03**
06	**Principal Stresses:** General equations for transformation of stress; principal planes and principal stresses, determination using Mohr's circle maximum shear stress, principal stresses in beams, principal stresses in shafts subjected to torsion, bending and axial thrust; concept of equivalent torsion and bending moments.	**04**

Assessment:
Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**

1 First test based on approximately 40% of curriculum contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I).
2 Total duration allotted for writing each of the paper is 1 hr.
3 Average of the marks scored in both the two tests will be considered for final grading.

End Semester Examination:
Weightage of each module in end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total **six questions**, **each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3, then part (b) will be from any module other than module 3).
4. Only **Four questions need to be solved.**

Reference books

1. *Bansal, R. K., A Text Book of Strength of Materials*, Lakshmi Publications Pvt. Limited, New Delhi.
2. *Ferdinand P. Beer, and Rusell Johnston, E., Mechanics of Materials*, SI Metric Edition, McGraw Hill.
3. *S Ramamrutham, Strength of Materials*, Dhanpat Rai Publications.
4. *Beer and Johnston, Mechanics of Materials*, McGraw Hill Publications.
5. *James M. Gere, Mechanics of Materials Fifth Edition*, Brooks/Cole, USA, 2001.
6. *William A Nash, Theory and problems of strength of materials*, Schaum's outline Series, McGraw Hill International Edition.
7. *Shigley, J. E., Applied Mechanics of Materials*, International Student Edition, McGraw Hill Koyakusha Limited.
8. *Singer, Strength of Materials*, Longman Publishers.

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Course Code	Course Name	Credits
PEC304	Manufacturing Processes	03

Contact Hours			Credit Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term work / Practical / Oral			Total
Internal Assessment			End semester	Duration of End semester Exam	TW	PR	OR	
Test I	Test II	Average						
20	20	20	80	03 hrs.	-	-	-	100

Objectives:

1. To impart the knowledge of machine tools and basic machining processes, like turning, drilling, milling and broaching.
2. To impart the fundamentals of various metal cutting practices, fundamentals of machine tools and processes.
3. To familiarize with unconventional machining processes and techniques.
4. To understand the importance of CNC machining in metal cutting.

Outcomes: Learner will be able to:

1. Describe types of machine tools, their classification, specifications and constructional features.
2. Illustrate machine tools' capabilities, limitations of machining operations to generate cylindrical, circular and planar components.
3. Describe features and applications of screw thread processes and gear manufacturing processes.
4. Demonstrate finishing processes, like grinding, reaming, honing, lapping and burnishing.
5. To understand and analyze machining operations on CNC machines and the related programming details.
6. Illustrate the fundamentals of various non-conventional machining processes, its capabilities and their application areas.

Detailed Syllabus: (Module wise)		
Module No.	Description	Duration
01	**Introduction to Manufacturing Processes** Definition, need and classification of manufacturing process, based on chip-less and chip-removal processes. Various generating & forming processes. **Lathe, Drilling, Boring and Broaching Machines:** Lathe machine components, lathe accessories, Drilling machine, Boring machine, cutting-off machine, Broaching machine, Milling machine, shaping machine, Planning and Slotting machine.	02
02	**Milling Machine:** Milling machine components and their difference, Milling accessories, milling machines types, types of Milling cutters.	02

	Reciprocating Machine: Shaping machines: types of shapers, working of shaping machine, quick return mechanisms, shaper operations, Planning machines: types of planning machines. Slotting machines: types of slotting machines.	
03	**Thread Cutting, Gear cutting and Finishing processes** Thread rolling, Thread chasing, Gear hobbling, Gear shaping and Gear shaving. Grinding machines types, Grinding wheel specification. Trueing, Dressing and balancing of grinding wheel. Finishing processes like Reaming, Honing, Lapping, Buffing and Polishing.	**02**
04	**CNC Basics and Hardware** DNC, Motion controller, Interpolation, Adaptive control system, Spindle drive, Axis drive, Actuation and feedback devices, ATC, Tool presetter, Touch probe system. CNC Turning and Milling tools	**04**
05	**CNC Programming** Turning and Machining centre programming, Canned cycle, Looping, Jumping and Subprogram.	**06**
06	**Unconventional machining processes:** Classification of the Non-traditional machining process. Basic principles, machines, advantage, disadvantages, and applications of Electrical discharge machining (EDM), Electron beam machining (EBM), Plasma arc machining (PAM), Laser beam machining(LBM), Electrochemical machining (ECM), Chemical machining (CHM),Ultrasonic machining (USM), Abrasive jet machining (AJM), Water jet machining (WJM), Abrasive water jet machining (AWJM). Ultrasonic machining (USM), Abrasive jet machining (AJM), Water jet machining (WJM), Abrasive water jet machining (AWJM).	**04**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

1 First test based on approximately 40% of curriculum contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I).

2 Total duration allotted for writing each of the paper is 1 hr.

3 Average of the marks scored in both the two tests will be considered for final grading.

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
3. **Remaining questions will be mixed in nature** (for example, if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4. Only **Four questions need to be solved.**

Reference Books:

1. *Elements of Workshop Technology:* Machine Tools (Volume-2) by S. K. Hajra Choudhary, A. K. Hajra Choudhary, Nirjhar Roy, Media promoters (2010).
2. *A Course in Workshop Technology Vol.II (Machine Tools)* by B. S. Raghuwanshi, Dhanpat Rai & Co. (2001).
3. *Workshop Technology* Part 1, 2and 3. By W. A. J. Chapman, Taylor & Francis (1972).
4. *Production Technology*–HMT, Tata McGraw-Hill (1980).
5. *Manufacturing, Engineering and Technology*, 4th Edition by Serope Kalpakjian, Steven R. Schmid, Pearson (2005).

6. *A Text Book Of Production Technology* Vol. II by O. P. Khanna, Dhanpat Rai Publications (2000).
7. CAD CAM, Principle and Applications, P. N. Rao, Tata McGraw Hill, 3rd edition, 2012.
8. *Fundamentals of Modern Manufacturing*-Materials, Processes and Systems, 3rd Edition by Mikell P. Groover, Wiley India (2002).
9. *Manufacturing Processes for Engineering Materials*, 4th Edition by Serope Kalpakjian, Steven R. Schmid, Pearson (2007).

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Course Code	Course Name	Credits
PEC305	Engineering Materials & Metallurgy	03

Contact Hours			Credit Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term work / Practical / Oral			Total
Internal Assessment			End semester	Duration of End semester Exam	TW	PR	OR	
Test I	Test II	Average						
20	20	20	80	03 hrs.	-	-	-	100

Objectives:

1. To acquaint the importance of metallurgy through solidification, defects, deformation, alloying and phase diagrams.
2. To impart the knowledge of fracture and heat treatment of materials.
3. To acquaint with different new age materials like semiconductors, nano materials, smart materials, magnetic materials and biomaterials.

Outcomes: Learner will be able to:

1. Understand the process of solidification of metals along with various types of crystal imperfections and deformation mechanism.
2. Understand the difference between various modes of material failure.
3. Analyze various alloy phase diagrams including iron-carbide diagram with effects of alloying.
4. Select proper heat treatment process for steel in order to attain desirable properties.
5. Understand the properties and application of nano materials, biomaterials and composites.
6. Understand the properties and application of smart materials, semiconductors and magnetic material.

Detailed Syllabus: (Module wise)		
Module No.	Description	Duration
01	**Introduction to Metallurgy**: Need for Metallurgy, Processing-Structure-Properties-Performance interrelationships. **Deformation**: Strain hardening and its significance. Recovery, recrystallization and grain growth, Factors affecting recrystallization.	02
02	**Alloy phase diagrams:** Different types of alloy diagrams and their analysis. Tie bar and Lever rules and their application. Dispersion hardening/age hardening.	04

	The Iron-Iron Carbide Phase Diagram: Importance of Iron as engineering material, Allotropic forms of Iron. Iron-Iron carbide diagram and its analysis. Classification of Plain carbon steels and Cast irons.	
03	**Effect of Alloying Elements in Steels**: Effect of alloying elements on ferrite, carbide, austenite. Effect of alloying elements on phase transformation, hardening and tempering. Tool steels & Stainless steels: Important compositions and applications. **Non Ferrous Metals and their Alloys**: Aluminum, Copper, Tin, and Zinc – Their alloys, properties and applications.	04
04	**Principles of Heat treatment:** Technology of heat treatment. Classification of heat treatment process. TTT Diagram. CCT Diagram and Superimposition of cooling curves on diagram. **Heat treatment Process*:** Annealing: principle, process, properties and application: Full Annealing, Spheroidizing, Process annealing, Stress relieve annealing. Normalizing: principle, process and its applications. Hardening: Hardening media, Hardenability. Tempering, Austempering, Martempering, Maraging and Ausforming process. Surface hardening: Surface Hardening methods. Their significance and applications. Carburizing, Nitriding. Induction hardening and Flame hardening processes. **Heat treatment defects***: Defect during heat treatment process (Causes and remedies).	02
05	**Biomaterials**: Classes of materials used in medicine. Basic concepts: Tissue and cell interaction with biomaterials. Application of biomaterials: Cardiovascular medical devices, Orthopaedic, Dental applications. **Composites**: Basic concepts of composites, advantages over metallic materials, various types of composites and their applications, Manufacturing Processes for Thermoset Composites – Hand Lay Up, Spray Up, Filament Winding, Pultrusion, Resin Transfer Molding, Structural Reaction Injection Molding, Compression Molding.	04
06	**Smart materials**: Shape memory alloys (SMA): Characteristics, properties of NiTi alloy, application, advantages and disadvantages of SMA. Super conductors: Type I and Type II superconductors, applications. **Magnetic Material**: Introduction. Classification of magnetic materials. Ferromagnetism. Magnetic domain. Magnetisation. Magnetic anisotropy. Magnetostriction. Paramagnetism. Diamagnetism. Hysteresis. Hard and soft magnetic.	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

1 First test based on approximately 40% of curriculam contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I).

2 Total duration allotted for writing each of the paper is 1 hr.

3 Average of the marks scored in both the two tests will be considered for final grading.

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
3. **Remaining questions will be mixed in nature** (for example, if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4. Only **Four questions need to be solved.**

Reference Books:

1. *Materials Science and Engineering - A first course,* V. Raghvan, 'Prentice Hall of India, New Delhi (2001).
2. *Introduction to Physical Metallurgy,* 2nd Edition, S. H. Avner, Tata McGraw Hill (1997).
3. *Material Science and Engineering: An Introduction*, William D Callister, Adapted by R. Balasubramaniam, Wiley India (P) ltd (2010).
4. *Mechanical Metallurgy,* 3rd edition, G. E. Dieter, McGraw Hill International, New Delhi (1988).
5. *Introduction to Engineering Materials,* B. K. Agrawal, McGraw Hill Publishing Co. ltd. (1988).
6. *Physical Metallurgy: Principles and Practices,* V. Raghvan, PHI Publications.
7. *Composite Manufacturing- Materials, Product and Process Engineering,* Sanjay K Muzumdar, CRC Press (2002).
8. Material Science and Metallurgy for Engineers, V. D. Kodgire, Evercast Publishing House.
9. A textbook of Material Science and Metallurgy by O P Khanna, Dhanpat Rai Publications.
10. *Biomaterials Science: An Introduction to Materials in Medicine,* edited by B.D. Ratner, A.S. Hoffman, F.J. Schoen, and J.E. Lemons, 2nd Edition, Elsevier Academic Press (2004).
11. *Introduction to Materials Science for Engineer,* James F Shackelford, S 's', 6th edition, Macmillan Publishing Company, New York (2004).

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Course Code	Course Name	Credits
PEL301	Computer Aided Machine Drawing Lab.	02

Contact Hours			Credit Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	2* + 2	-	-	02	-	02

Theory					Term work / Practical / Oral			Total
Internal Assessment			End semester	Duration of End semester Exam	TW	PR	OR	
Test I	Test II	Average						
-	-	-	-	-	50	25	-	75

Objectives:

1. To prepare the students for insight of visualizing an object and converting it into a production drawing.
2. To impart the knowledge of conventional representation of various mechanical details.
3. To prepare the students to be conversant with 2D and 3D drafting, using a CAD Software.

Outcomes: Learner will be able to:

1. Prepare drawings, depicting interpenetration of simple solids and auxiliary views of machine parts.
2. Read and interpret detailed drawings from assembly drawings.
3. Prepare assembly drawings from detailed drawings of machine subassemblies.
4. Prepare production drawings.
5. Develop 3D models of machine parts using various CAD softwares.
6. Convert 3D models to 2D drawings using various CAD softwares.

Detailed Syllabus: (Module wise)	
Module No.	Description
01	**Machine Elements:** Preparation of 2D drawings of standard machine elements (nuts, bolts, keys, cotter, screws, spring etc.). **Conventional representation** of assembly of threaded parts in external and sectional views, Types of threads; thread designation, Conventional representation of machine components and materials, Designation of standard components.

02	**Detailed and assembly drawings**: Introduction to the unit assembly drawing, steps involved in preparing assembly drawing from details and vice-versa, Sequence in assembly. Preparation of details and assembly drawings of: Clapper block, Single tool post, square tool post, Lathe Tailstock.
03	**Preparation of detailed and assembly drawings of Bearings:** Simple, solid, Bushed bearing. I.S. conventional representation of ball &roller bearing. Pedestal bearing & footstep bearing.
04	**Preparation of detailed and assembly drawings of pulleys & Pipe Joints.** Classification of Pulleys, pipe joints Pulleys: Flat belt, V-belt, rope belt, Fast and loose pulleys. Pipe joints: Flanged joints, Socket and spigot joint, Gland and stuffing box expansion joint. **Limits, Fits &Tolerances** Representation of Dimensional Tolerances on drawings - Methods of showing limit dimensions, Deviations, Allowances, Types of Fits and Tolerances. Hole basis and Shaft basis systems. Representation of Geometrical Tolerances on drawings.
05	**Preparation of detailed and assembly drawings of Valves & I. C. Engine parts:** Types of Valves, introduction to I.C. Engine Preparation of detailed and assembly drawings of Stop valve, Non return Valve, I. C. Engine parts: Piston, Connecting rod, Crosshead, Crank shaft and Spark plug.
06	**Preparation of detailed and assembly drawings of Jigs and Fixtures:** Introduction to Jigs and fixtures. **Jigs and Fixtures** : Reverse Engineering of a physical model: disassembling of any Physical model having not less than five parts, sketch the minimum views required for each component, measure all the required dimensions of each component, convert the sketches into 3D model and create an assembly drawing with actual dimensions.

Term work:

A. Questions from theory part of each module should be solved as home working A-3size sketch book, as follows: -

1. Minimum3 questions from module 1.
2. Minimum2 questions from module 2.
3. Minimum1 question/module from module 3 to 6.

B. Printouts/plotsoftheproblemssolvedinpracticalclassfromthepracticalpartofeach module, as follows: -

1. 3 two dimensional detailed drawings:- Preparation of 3D models of parts from given 2D assembly drawing. Converting the 3D parts into 2-D detailed drawings.
2. 3 two dimensional Assembly drawings:- Preparation of 3D models of parts, from given 2D detailed drawings. Assembling the 3D parts and Converting 3D Assembly into 2D drawing.

Problems from practical parts of each module should be solved using standard CAD packages

Like IDEAS, PRO-E, CATIA, Solid Works or Inventor etc.

The distribution of marks for Term work shall be as follows:

Homework: sketch book ……. 20 marks

Printouts/Plots ……. 20 marks

Attendance (theory and practical) …… 10 marks

Practical/Oral examination:

1. Practical examination duration is of three hours, based on Part-B of the Term work and should contain two sessions as follows:
   Session-I: Preparation of 3D models of parts, assembling parts and preparing production drawings of these parts and assembly with appropriate tolerancing from given 2D detailed drawings.

   Session-II: Preparation of minimum five detailed 3D part drawings from given 2D assembly drawings.

   Oral examination should also be conducted to check the knowledge of conventional and CAD drawing.
2. Questions provided for practical examination should contain minimum five and not more than ten parts.
3. The distribution of marks for practical examination shall be as follows:

   Session-I …… 25 marks

   Session-II …… 15 marks

   Oral …… 10 marks
4. Evaluation of practical examination to be done, based on the printouts submitted by students.
5. Students' work along with evaluation report to be preserved till the next examination.

Reference Books:

1. *Machine Drawing* by N.D. Bhatt and V. M. Panchal, Charotar Publishing House, Gujarat.
2. *Machine Drawing* by P. S. Gill, S. K. Kataria & Sons.
3. *A textbook of Machine Drawing*, Laxminarayan & M. L. Mathur (Jain brothers, Delhi).
4. *Machine Drawing*, Kamat & Rao.
5. *Machine Drawing*, M.B. Shah.
6. *A text book of Machine Drawing*, R. B .Gupta (Satyaprakashan, Tech. Publication).
7. *Machine Drawing*, K. I. Narayana, P. Kannaiah and K.Venkata Reddy.
8. Machine Drawing, Sidheswar, Kannaiah and Sastry, Tata McGraw Hill Education, New Delhi.
9. *Autodesk Inventor 2020 for Designers*, Sham Tickoo, CAD CIM Series.
10. *Text book of Machine Drawing* by K. C. John, PHI, New Delhi.

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Course Code	Course Name	Credits
PEL302	Python Programming Lab.	01

Contact Hours			Credit Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term work / Practical / Oral			Total
Internal Assessment			End semester	Duration of End semester Exam	TW	PR	OR	
Test I	Test II	Average						
-	-	-	-	-	25	-	-	25

Objective:

The course will help the students to get familiar with:

1. Basics of Python programming.
2. Decision Making and Functions in Python.
3. Object Oriented Programming, using Python.
4. Files Handling in Python.
5. GUI Programming and Databases operations in Python.
6. Network Programming in Python.

Outcomes: Learner will be able to:

1. Describe the Numbers, Math functions, Strings, List, Tuples and Dictionaries in Python.
2. Express different Decision Making statements and Functions.
3. Interpret Object oriented programming in Python.
4. Understand and summarize different File handling operations.
5. Explain how to design GUI Applications in Python and evaluate different database operations.
6. Design and develop Client Server network applications using Python.

Detailed Syllabus: (Module wise)	
Module No	Description
01	Write python programs to understand Expressions, Variables, Quotes, Basic Math operations, Strings: Basic String Operations & String Methods, List, Tuples, Dictionaries, Arrays. (Minimum Three Programs based on math operations, Strings and List/Tuples/ Dictionaries).
02	Write python programs to understand different decision making statements and Functions. (Minimum Three Programs based on Decision making, Looping Statements and Functions).
03	Write python programs to understand different Object oriented features in Python (Minimum four programs based on a) Classes & objects, b) Constructors, c) Inheritance & Polymorphism and d) Exception handling).
04	Write python programs to understand different File handling operations.

05	Write python programs to understand GUI designing and database operations. (Minimum Three programs based on GUI designing using Tkinter, Mysql database creation & Database connectivity with DML operations using python.
06	Write python programs to understand TCP and UDP Sockets in Python (Minimum One programs based on TCP or UDP Sockets).

Assessment:

Term Work:

Distribution of Term work Marks

Laboratory work …….20 Marks

Attendance ……..05 Marks

Reference Books:

1. Wesley J Chun," Core Python Applications Programming", Third Edition, Pearson Publication.
2. E. Balguruswamy," Introduction to Computing and Problem Solving using Python", McGraw Hill Publication.
3. Learn to Master Python, from Star EDU solutions, by Script Demics.
4. James Payne,"Beginning Python: Using Python 2.6 and Python 3.1",Wrox Publication.
5. Dr. R. Nageswara Rao,"Core Python Programming", Dreamtech Press, Wiley Publication.
6. Magnus Lie Hetland,"Beginning Python From Novice to Professional", Second Edition", Apress Publication.

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Course Code	Course Name	Credits
PEL 303	Materials Testing Lab.	01

Contact Hours			Credit Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term work / Practical / Oral			Total
Internal Assessment			End semester	Duration of End semester Exam	TW	PR	OR	
Test I	Test II	Average						
-	-	-	-	-	25	-	-	25

Objectives:

1. To familiarize with the use of stress and strain measuring instruments.
2. To familiarize with the process of metallographic sample preparation.
3. To familiarize with various Non-Destructive Testing methods.
4. To familiarize with various heat treatment processes.
5. To familiarize with hardness testing methods.

Outcomes: Learner will be able to:

1. Conduct tensile and torsion tests on mild steel specimens.
2. Determine the Young's modulus using deflection test on different structural specimens.
3. Prepare sample for metallographic observations.
4. Conduct impact testing, hardness and hardenability testing of given specimen.
5. Conduct NDT test on materials.
6. Perform the heat treatment processes with its relevance in the manufacturing industry.

Sr. no.	Experiments
01	Tensile test on mild steel rod.
02	Torsion test on mild steel rod.
03	Deflection test on steel/wood / aluminium specimen.
04	Charpy and Izod impact test on steel specimen.
05	Double shear test on steel rod.
06	Compression test on brick/concrete blocks/wood.
07	Tension and compression test on helical springs.
08	Brinell, Rockwell or Vickers hardness test.
09	Sample preparation for metallographic observations.
10	Experiments based on any two heat treatment methods.
11	Jominy end quench test.
12	Experiments based on any two NDT tests.

Term Work

Term work shall consist of any four experiments covering the experiments mentioned from Sr. no 1 to 7. In all, total 7 experiments are to be performed. A detailed report, based on an Industrial visit to a manufacturing firm, covering the syllabus discussed in the subject of Metallurgy & New Age Materials, needs to be submitted along with the write-up on above experiments.

Experiments (1- 7)	: **10** marks
Experiments (8 -12) and report on Industrial visit	: **10** marks
Attendance	: **05** marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work as well as the industrial visit and minimum passing in the term work.

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Course	Course Name	Credits
PEL304	Skill based Lab. Course-I Machine Shop Practice Lab.	02

Contact Hours			Credit Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	04	-	-	02	-	02

Theory					Term work / Practical / Oral			Total
Internal Assessment			End semester	Duration of End semester Exam	TW	PR	OR	
Test I	Test II	Average						
-	-	-	-	-	50	-	-	50

Objectives:

1. To prepare the students gain expertise with various lathe operations like turning, taper turning, thread cutting etc.
2. To familiarize with the practice of machining of flat surfaces on shaping and milling machines.

Outcomes: Learner will be able to:

1. Follow safe machine practices while working.
2. Select the right tool, setup of the machine/job for machining.
3. Perform operations like cylindrical turning, thread cutting etc. on lathe machine.
4. Perform operations for flat surfaces like Keyway cutting, T-slot cutting etc. on shaper/miller
5. Understand capabilities of CNC.

List of Experiments:

Sr.no	Experiments/Job
01	One job on Power hacksaw/Band saw and Drilling machine.
02	One job on plain turning, taper turning, screw cutting and other operation performed on lathe machine.
03	One job on shaping /milling machine to make horizontal and inclined surfaces.
04	One job on any unconventional machining process.
05	Demo on CNC Turning and CNC Milling

Term Work

Term work shall consist of exercises as per the above List. A detailed report, based on an Industrial visit to a manufacturing firm, covering various machining practices as mentioned in the subject of

Manufacturing Processes, also needs to be submitted. The report should contain various machining practices, followed as applicable in the industry visited.

The distribution of marks for term work shall be as follows:

Laboratory work (4 Experiments)	:40 Marks.
Industrial visit report on Machining practices	: 05 Marks.
Attendance (Practical)	: 05 Marks.

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Course	Course Name	Credits
PEM301	Mini Project - 1A	02

Contact Hours			Credit Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	04	-	-	02	-	02

Theory					Term work / Practical / Oral			Total
Internal Assessment			End semester	Duration of End semester Exam	TW	PR	OR	
Test I	Test II	Average						
-	-	-	-	-	25	-	25	50

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to:

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyze the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution.
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

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