Item No. 147

AC- 23/07/2020

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Production Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

Item No. 147

AC- 23/07/2020

UNIVERSITY OF MUMBAI

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B.E. Production Engineering**
2	Eligibility for Admission	**After Passing First Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	**New** / ~~Revised~~ (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

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Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of ‘C ‘ scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD’s/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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Preface By BoS

Engineering education in India is changing fast and is set to face multiple challenges in the near future. Academic institutes are expected to prepare good quality engineers and Industries are expected to come good with the wealth generation activity. Manufacturing, among the industry sectors, is currently emerging as one of the high growth sectors in India. Government of India (GOI) has launched the 'Make in India' program to place India on the world map as a manufacturing hub. The GOI has set an ambitious target of increasing the contribution of manufacturing output to 25% of GDP by 2022, from the current 16 %. In this context, the major challenge is to ensure high quality in all aspects related to education & industry practices. Accreditation of the program is one of the principal ways, by which the quality can be assured. The major emphasis of the accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation. Keeping this in mind, the Faculty of Science and Technology of the University of Mumbai has taken the lead in ensuring that the outcome based education is stressed upon in the curriculum development.

At the Board of Studies (Adhoc) in Production Engineering of the University of Mumbai, we are happy to state that, the Program Educational Objectives (PEOs) of the UG Program in Production Engineering, were discussed in detail and finalized during the multiple brain storming sessions, attended by more than 20 members from different colleges affiliated to the University of Mumbai. Experts from the industry were also invited for their inputs and suggestions. Thus the PEOs were finalized as follows:

To prepare the Learner with sound foundation in STEM subjects, related to Manufacturing and its strategies.

To motivate the Learner for self-learning and to use modern tools for solving real life problems.

To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process.

To prepare the learner to face industrial challenges through practical exposure in an industrial environment.

To prepare the Learner for a successful career in Indian and Multinational Organizations.

In addition to PEOs, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to achieve the goal of outcome based education. We hope to achieve the desired goals in our efforts to prepare high quality Production Engineers. Thank you very much.

Board of Studies (Adhoc) in Production Engineering
Dr. Hari Vasudevan: Chairman
Dr. Arun B. Rane: Member
Dr. Yogesh Padia: Member
Dr. K. H. Inamdar: Member

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 Member) for Mini Project.

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

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PEC401	Engineering Mathematics-IV.	3	--	1	3	--	1	4
PEC402	Mould and Metal Forming Technology.	3	--	--	3	--	--	3
PEC403	Theory of Machines.	3	--	--	3	--	--	3
PEC404	Applied Electrical and Electronics.	3	--	--	3	--	--	3
PEC405	Advanced Manufacturing Processes.	3	--	--	3	--	--	3
PEL401	Mould and Metal Forming Technology Lab.	--	2	--	--	1	--	1
PEL402	Theory of Machine Lab.	--	2	--	--	1	--	1
PEL403	Applied Electrical and Electronics Lab.	--	2	--	--	1	--	1
PEL404	Skill based Lab. Course-II	--	4	--	--	2	--	2
PEM401	Mini Project – 1 B.	--	4[$]	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**7**	**1**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
PEC401	Engineering Mathematics-IV.	20	20	20	80	3	25	--	125
PEC402	Mould and Metal Forming Technology.	20	20	20	80	3	--	--	100
PEC403	Theory of Machines.	20	20	20	80	3	--	--	100
PEC404	Applied Electrical and Electronics.	20	20	20	80	3	--	--	100
PEC405	Advanced Manufacturing Processes.	20	20	20	80	3	--	--	100
PEL401	Mould and Metal Forming Technology Lab.	--	--	--	--	--	25	25	50
PEL402	Theory of Machine Lab.	--	--	--	--	--	25	--	25
PEL403	Applied Electrical and Electronics Lab.	--	--	--	--	--	25	--	25
PEL404	Skill based Lab. Course-II	--	--	--	--	--	50	25	75
PEM401	Mini Project – 1 B	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**75**	**750**

$ indicates work load of Learner (Not Faculty Member) for Mini Project.

Mini Project 1B:

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 Hrs.**
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.	**07**

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)	**06**
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. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. 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 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.**
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

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	**Thermodynamic concepts:** Microscopic and Macroscopic viewpoints in thermodynamics, thermodynamic system, thermodynamic properties of system state, path, processes and cycles, point function and path function internal energy and enthalpy, reversible and irreversible process, thermodynamic work, heat, temperature, thermodynamic equilibrium and Zeroth law of thermodynamics.	07
02	**First law of Thermodynamics:** Statement, First law applied to cyclic and non-cyclic process, Application to non-flow processes viz. Constant volume, constant pressure,	06

	constant temperature, adiabatic and polytrophic processes. Heat and work calculations. **First law applied to open systems:** Flow work, Steady flow energy equation (SFEE), SFEE applied to nozzle, turbine, compressor, boiler, condenser etc.	
03	**Second law of Thermodynamics:** Limitations of first law of thermodynamics, thermal reservoir, heat engine, thermal efficiency, reversed heat engine, coefficient of performance, Kelvin-Planck and Clausius statements and their equivalence. PMM I and PMM II, Carnot cycle, Carnot's theorem, its Corollaries, Entropy.	**06**
04	**Fluid Properties:** Concept of fluid and flow, continuum concept, Types of fluids, Mass Density, Specific Weight, Specific Gravity, Newton's Law of Viscosity, Dynamic Viscosity, Kinematics Viscosity, Surface Tension Capillarity, Compressibility, Vapour pressure.	**05**
05	**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. **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).	**06**
06	**Dynamics of Viscous Flow:** Introduction to Laminar and Turbulent 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.	**09**

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.**
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

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	**Introduction to Moment of Inertia:** Theorem of parallel and perpendicular Axis, Polar Moment of Inertia. **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.	07
02	**Shear Force and Bending Moment:** Axial force, shear force and bending moment diagrams for statically determinate beams excluding beams with internal hinges for different types of loading.	07

03	**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. **Shear Stress in Beams:** Distribution of shear stress across plane sections used commonly for structural purposes; shear connectors.	**07**
04	**Deflection of Beams:** Deflection of cantilever, simply supported and overhanging beams using double integration and Macaulay's method for different types of loadings.	**06**
05	**Theory of Torsion:** Torsion of circular shafts−solid and hollow, stresses in shafts transmitting power, shafts in series and parallel. **Columns**: Columns subjected to axial loads, concept of buckling. Euler's formula for column with different support conditions. Euler's and Rankin's design formulae.	**06**
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.	**06**

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.**
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

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:** Machine specifications, Types of cutting off machines with their applications, Lathe machine components, Types of Lathe and accessories, Lathe operations, Types and working of Drilling, Boring and Broaching machines, Drilling operations, Drill nomenclature and Milling machines. Various milling operations. Study of Broaching, Shaping, Planning and Slotting machines. Numerical on Machining time estimation.	07

02	**Milling Machine:** Milling operations and their difference, Milling Parameters, special attachments (Dividing head) and accessories, milling machines types, Types of Milling cutters and numerical on Machining time. **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.	**06**
03	**Thread Cutting, Gear cutting and Finishing processes** Principles and operation of Thread rolling, Thread chasing, Gear hobbing, Gear shaping and Gear shaving. Types of Grinding machines, their working and operations, Grinding wheel specification. Trueing, Dressing and balancing of grinding wheel. Finishing processes like Reaming, Honing, Lapping, Buffing and Polishing.	**06**
04	**CNC Basics and Hardware** DNC, Motion controller, Interpolation, Adaptive control system, Spindle drive, Axis drive, Actuation and feedback devices, ATC, APC, Tool presetter, Touch probe system.	**04**
05	**CNC Tooling and Programming** CNC Turning and Milling tools. Tool nose, radius and length compensation. Canned cycle, Looping, Jumping and Subprogram. Turning and Machining centre programming.	**09**
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).	**07**

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.**
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

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. **Solidification of metals**: Formation of solids from liquids of pure metals and alloys. Single crystal and polycrystalline materials. Anisotropy. Non crystalline solids. Theory of alloying. **Imperfections in solids**: Definition, Classification, Point defects: their formation and effects. Dislocations: edge and screw dislocations, their significance. Surface defects: grain boundary, sub-angle grain boundary,	07

	stacking fault, and their significance. Dislocation generation by Frank Reed sources. Dislocation interactions. **Deformation**: Mechanisms of deformation; Critical resolved shear stress. Slip systems of FCC, BCC, HCP metals. Deformation in Single and Polycrystalline materials. Strain hardening and its significance. Recovery, recrystallization and grain growth, Factors affecting recrystallization.	
02	**Fatigue failure**: Definition of fatigue and significance of cyclic stress. Mechanism of fatigue. Fatigue testing. Test data presentation. S. N. Curve and its interpretation. Influence of important factors on fatigue. **Creep**: Definition and significance of creep. Effect of temperature and creep on mechanical behaviour of materials. Creep testing. Mechanism and types of creep.	06
03	**Alloy phase diagrams:** Different types of alloy diagrams and their analysis. Tie bar and Lever rules and their application. Dispersion hardening/age hardening. **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. **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.	07
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).	07
05	**Nano materials**: Introduction. Classification of Nano materials. Fabrication methods: Top down processes - Milling, Lithographics, machining process. Bottom-up process – Physical vapour deposition, Chemical vapour deposition, Sputtering, Plasma-assisted deposition process, Solgel processing. **Biomaterials**: Classes of materials used in medicine. Basic concepts: Tissue and cell interaction with biomaterials. Application of biomaterials: Cardiovascular medical devices, Orthopaedic, Dental applications.	06

	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.	
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. **Semiconductors**: Introduction. Intrinsic and extrinsic semiconductors. Material preparation - Czochralski's technique. Commonly used materials for semiconductor. Applications of semiconductor materials. **Magnetic Material**: Introduction. Classification of magnetic materials. Ferromagnetism. Magnetic domain. Magnetisation. Magnetic anisotropy. Magnetostriction. Paramagnetism. Diamagnetism. Hysteresis. Hard and soft magnetic.	06

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.**
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

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	Duration
01	**Solid Geometry:** Intersection of surfaces and interpenetration of solids-Intersection of prism or cylinder with prism; cylinder or cone, both solids in simple position only Primary auxiliary views and auxiliary projections of simple machine parts. **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.	10

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.	**10**
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.	**08**
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.	**06**
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.	**08**
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.	**10**

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 three 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 …… 10 marks
   Session-II …… 10 marks
   Oral …… 05 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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Course Code	Course Name	Credits
PEC401	Engineering Mathematics IV	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

Objectives:

1) To study the concept of Vector calculus & its applications in engineering.
2) To study Line and Contour integrals and expansion of complex valued function in a power series.
3) To familiarize with the concepts of statistics for data analysis.
4) To acquaint with the concepts of probability, random variables with their distributions and expectations.
5) To familiarize with the concepts of probability distributions and sampling theory with its applications.

Outcomes: Learner will be able to:

1) Apply the concept of Vector calculus to evaluate line integrals, surface integrals using Green's theorem, Stoke's theorem & Gauss Divergence theorem.
2) Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
3) Apply the concept of Correlation, Regression and curve fitting to the engineering problems in data science.
4) Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
5) Apply the concept of probability distribution to engineering problems & Testing hypothesis of small samples using sampling theory
6) Apply the concepts of parametric and nonparametric tests for analyzing practical problems.

Detailed Syllabus: (Module wise)		
Module No.	Description	Duration Hrs.
1	**Module : Vector Calculus** 1.1 Solenoidal and irrotational (conservative) vector fields. 1.2 Line integrals – definition and problems. 1.3 Green's theorem (without proof) in a plane, Stokes' theorem (without Proof), Gauss' Divergence theorem (without proof) and problems (only evaluation). **Self Learning Topics**: Identities connecting Gradient, Divergence and Curl, Angle between surfaces. Verifications of Green's theorem, Stoke's theorem & Gauss-Divergence theorem, related identities & deductions.	07

2	**Module: Complex Integration** 2.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 2.2 Taylor's and Laurent's series (without proof). 2.3 Definition of Singularity, Zeroes, poles of *f(z)*, Residues, Cauchy's Residue Theorem (without proof). **Self-learning Topics:** Application of Residue Theorem to evaluate real integrations.	**07**
3	**Module: Statistical Techniques** 3.1 Karl Pearson's Coefficient of correlation (r) and related concepts with problems. 3.2 Spearman's Rank correlation coefficient (R) (Repeated & non repeated ranks problems), 3.3 Lines of regression, 3.4 Fitting of first and second degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	**06**
4	**Module: Probability Theory:** 4.1 Conditional probability, Total Probability and Baye's Theorem. 4.2 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, 4.3 Expectation, Variance, Co-variance, moments, Moment generating functions, (Four moments about the origin &about the mean). **Self- learning Topics:** Properties variance and covariance,	**06**
5	**Module: Probability Distribution and Sampling Theory-I** 5.1 Probability Distribution: Poisson and Normal distribution. 5.2 Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. 5.3 Students't-distribution (Small sample). Test the significance of single sample mean and two independent sample means and paired t-test) **Self -learning Topics: Test** of significance of large samples, Proportion test, Survey based project.	**07**
6	**Module: Sampling theory-II** 6.1 Chi-square test: Test of goodness of fit and independence of attributes (Contingency table) including Yate's Correction. 6.2 Analysis of variance: F-test (significant difference between variances of two samples) **Self- learning Topics:** ANOVA**:** One way classification, Two-way classification (short-cut method).	**06**

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. 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 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.**
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

References:

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
2. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication,
3. Vector Analysis, Murray R. Spiegel, Schaum's Series
4. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education
6. Probability, Statistics and Random Processes, T. Veerarajan, McGraw Hill education.

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Course Code	Course Name	Credits
PEC402	Mould and Metal Forming Technology	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 study and analyze casting and forming processes like forging, rolling, extrusion and drawing for ferrous and nonferrous metals.
2. To study and design sand moulds, die casting dies, roll grooves and multi impression forging die etc.

Outcomes: Learner will be able to:

1. Illustrate intricacies involved in sand mould castings, pressure die castings, rolled products and forged products.
2. Illustrate various forming and casting processes used in manufacturing.
3. Illustrate various forming and rolling processes used in manufacturing.
4. Classify equipment and machines used in manufacturing processes, such as casting, rolling, forging, extrusion and drawing.
5. Identify melting units used in casting.
6. Identify process defects and their remedies.

Detailed Syllabus: (Module wise)		
Module No.	Description	Duration
01	**Design of Sand moulds:** 1.1 Mould materials: Moulding sand; Constituents of moulding sand and its property requirements; Testing of sand properties. 1.2 Design and manufacture of Patterns and Cores: Pattern allowances, Types of patterns, Core print, pattern design and manufacture, Core making. 1.3 Design and manufacturing of gating system: Pouring basin, Sprue, Runners and Ingates. 1.4 Design and manufacturing of feeding system: Caine's equation, Use of chills, padding and risering.	08
02	2.1 Melting practices: Cupola, Arc and Induction furnaces. 2.2 Defects in cast components and their remedies.	02
03	**Special Casting Processes** 3.1 Principle of Hot chamber and Cold chamber die casting processes, 3.2 Lost Wax Process Investment Casting : Use of wax as the moulding material; Process description; Features and advantages; Fields of application;	05

	3.3 Shell Mould casting: Working principle and application.	
04	**Forging of metals** 4.1 Forging hammers, high speed forging machines, Presses and Horizontal upset forging machines: Construction and principle of operation. 4.2 Single and multi-impression closed die forging process. 4.3 Design and drawing of multi-impression drop forging, die set using fuller, edger, bender, blocker and finisher, cavities with flash and gutter. 4.4 Defects in forged products and their remedies.	12
05	**Rolling of metals** 5.1 Design and drawing of Continuous Billet Mill Roll grooves using diamond, square, oval and round passes. Roll passes for rolling rails, beams, angles and channels. 5.2 Defects in Rolled products and their remedies.	10
06	**Extrusion of Metals and Miscellaneous Metal Forming Processes** 6.1 Introduction to metal extrusion and basic concepts of extrusion dies. 6.2 Wire Drawing of metals: Principle of operation and applications.	02

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.**
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Reference Books:

1. *Metal Casting: A Sand Casting Manual for the Small Foundry-Vol. 2*, Stephen D. Chastain.
2. *Principles of Metal Casting,* R W Heine, C R Loper, P. C. Rosenthal.
3. *Metal Casting*, T.V. Ramana Rao.
4. *Manufacturing Technology*, P.N. Rao.
5. *Foundry Engineering*, P.L.Jain.
6. *Die Casting*, H.H. Doehler
7. *The Diecasting Handbook*, A.C.Street , Portcullis Press, Redhill, U.K.
8. *Mechanical Metallurgy*, George E. Dieter.
9. *Metals Hand Book−Vol. 14 Forming and Forging*, ASM International.
10. *Forging Die Design*, Sharan, Prasad and Saxena.
11. *Forging Handbook-Forging Methods*, A. Thomas, Publisher-Drop Forging Research Association, Shepherd Street, Sheffie.

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Course Code	Course Name	Credits
PEC403	Theory of Machines	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 prepare the students to understand the Mechanics of machines, principles and its application areas.
2. To familiarize with various types of Mechanisms and Motion analysis.
3. To develop the students with the problem solving capabilities in the topics of velocity and acceleration.
4. To familiarize with the kinematics and kinetics of simple machine elements and devices.
5. To provide an understanding and appreciation of the variety of mechanisms employed in modern complex machines, such as automobiles, machine tools etc.

Outcomes: learner will able to:

1. Understand the common mechanisms used in machines, correlate the concepts of kinematics with kinetics of rigid body dynamics and Design of four bar mechanisms, gyroscopic devices etc.
2. Analyze the velocity and acceleration of various links in motion.
3. Illustrate different types of cams, followers with their different motions for their application and Develop profiles of cams for engineering applications.
4. Illustrate various types of gears/ their terminology areas of application along with parameters pertaining to spur gears and gear trains.
5. Develop basic concepts pertaining to balancing/vibrations in evaluation of simple machine components.
6. Illustrate different types of clutches, brakes and dynamometers for evaluation of braking force.

Detailed Syllabus: (Module wise)		
Module No.	Description	Duration
01	**Basic Concepts:** Links, kinematics pairs, kinematics pairs giving one, two and three degrees of freedom, kinematics chains, degree of freedom and mobility criterion. Constrained kinematics chains as mechanism. Inversions of four bar, single and double slider crank chains and their applications, Introduction to gyroscope (no numerical problems).	05

02	**Motion Characteristics of Mechanisms:** Velocity and acceleration analysis of mechanisms with single degree of freedom system with Coriollis component using graphical method. Instantaneous centre, Kennedy's theorem; analysis of velocities of mechanism using instantaneous centre method (introduction).	**07**
03	**CAMS:** Introduction to types of cams, types of followers. Follower motions. viz. simple harmonic motions, constant velocity, uniform and constant acceleration and retardation and cycloidal motion, layout of cam profile for specified displacement characteristics. Cams with oscillating follower systems.	**06**
04	**GEARS:** Introduction: Types of gears and applications, Gear terminology, Condition for constant velocity ratio−conjugate profiles, profiles used in gears. Interference of involute teeth, methods of preventing interferences through undercutting, length of path of contact and contact ratio, no of teeth to avoid interference. Gear trains: Simple, compound, planetary and epicyclic gear trains (with numerical).	**07**
05	**Balancing:** Introduction. Rotary masses: several masses in same plane, several masses in different planes. Balancing of locomotives− Variation of Tractive Effort, Swaying Couple and Hammer blow, The concept of primary and secondary balancing (No numerical problems) **Vibrations:** Introduction−free vibrations; longitudinal, transverse and torsional vibrations, critical or whirling speed of shaft. Torsional vibrations of two rotor system - torsionally equivalent shaft. Basics of vibration measuring concepts.	**07**
06	**Clutches Brakes and Dynamometers:** Study and analysis of single plate clutch, multiple plate clutches and cone clutches. Types of brakes. viz. block and shoe brakes, band brake, band and block brakes Types of dynamometers, classification, Prony brake, Rope brake belt transmission dynamometers	**07**

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.**
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Reference Books:

1. *Theory of Machines*, 3rd edition by Thomas Bevan, Pearson publication.
2. *Theory of Machines*, 11th Edition by P.L. Ballaney, Khanna Publications (2005).
3. *Theory of Machines*, 2nd Edition by S.S.Ratan, Tata McGraw Hill(2005)
4. *Theory of Machines and Mechanisms*, 3rd Edition by John, J Shighley, Oxford University.
5. *Theory of Machines*, Pandya & Shah.
6. *Mechanisms of Machines*, J. Hannah & R C Stephen.
7. *Theory of Machines*, V. Ravi, PHI Learning publication (2011).

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Course Code	Course Name	Credits
PEC404	Applied Electrical and Electronics	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 the basic concepts involved in electrical machines and their control circuits.
2. To familiarize with different types of electrical machines such as ac machines, dc machines, brushless dc machines, stepper motor, servomotor etc.
3. To familiarize with generation, transmission and distribution of electrical energy. Also the use of renewable energy resources and its advantages over conventional machines.
4. To familiarize with different types of electronic devices, control systems etc.
5. To expose the students to domain knowledge in various applications of Production engineering.

Outcomes: learner will be able to:

1. Understand the principles of operation and the main features of different types of electrical machines.
2. Interpret various characteristics of ac, dc machines, brushless dc motor, stepper motor and servomotor.
3. Understand the complete layout of generation, transmission and distribution of power system and the importance of solar and wind energy resources.
4. Explain different types of power electronic devices.
5. Classify application areas for various ac machines, dc machines, stepper motor, brushless dc motor, OP-AMP, SCR, DIAC-TRIAC.
6. Explain different types of sensors and transducers, control system devices for automation.

Detailed Syllabus: (unit wise)		
Module No.	Description	Duration
1	**DC Machines:** Introduction to DC machines, Classification, Comparison and Characteristics of DC machines, Speed control of DC motor, Torque equation of dc motor, Starter, Applications of DC machines.	07
2	**AC Machines**: Introduction to AC machines (Induction Motor), Classification and Comparison of AC machines, Speed-torque characteristics of IM, Torque equation of 3-phase	06

	IM, Applications ac machines.	
3	**Stepper motor & BLDC:** Introduction to stepper motor and BLDC, types and its applications, Driver circuit for controlling BLDC motor. **Solar and wind energy:** Introduction, working and layout of solar energy system and wind energy system and its applications, Necessity of energy storage, specifications of energy storage devices.	**08**
4	**Sensors & Transducers:** Introduction, classification and characteristics of sensors, Speed sensor, Temperature sensor, proximity sensor, pressure sensor, flow and level sensor, humidity sensor, Classification and characteristics of transducers and its applications.	**08**
5	**Power electronics:** Working of SCR, DIAC, TRIAC characteristics and applications. Rectifiers, single phase half controlled and fully controlled rectifier and inverters, oscillators and its types. Filters, Active filters and passive filters and its types.	**07**
6	**Control systems:** Block reduction techniques, open loop and closed loop control systems, PID controllers, Servomotors in control systems. Data acquisition systems, Automation system design.	**06**

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.**
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Books Recommended:

Text Books:

1. *Electrical machinery fundamentals by Stephen Chapman*, Mc Graw hill.
2. *Electric machinery sixth edition* by A Fitzgerald , Charles Kingsley , Stephen Umans . Mc Graw hill.
3. *Electrical machinery by P.S Bimbhra,*, Khanna publications.

Reference Books:

1. *Electrical machines by D.P Kothari and I.J Nagarth* . Mc Graw hill.
2. *Power system engineering system second edition by D.P Kothari and I.J Nagarth* . Mc Graw hill.
3. *Stepper motors fundamentals, applications and design by V V Athani.* New Age international publishers.
4. Kleitz, Wm., ***Digital Electronics: A Practical Approach***, Pearson Prentice Hall, latest ed.
5. *Electrical power system by C.L Wadhwa* . New Age international publishers.
6. *Charles H Roth , Fundamentals of logic design by Cennage learning.*
7. *Power electronics by M.D Singh and K.B Khanchandani by Khanna publications.*
8. *Control systems engineering by I.J Nagarth and M. Gopal*. New Age international publishers.

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Course Code	Course Name	Credits
PEC405	Advanced Manufacturing Process	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 Additive Manufacturing processes, working principle and process parameters of hybrid machining processes and to prepare the students with Micro Machining techniques like Meso, Micro and Nano manufacturing techniques.
2. To impart the knowledge on finishing techniques, like Abrasive flow machining, magnetic abrasive machining, Magneto rheological abrasive flow techniques etc.
3. To impart knowledge on Metal joining processes and composite manufacturing techniques.

Outcomes: learner will be able to:

1. Differentiate between traditional and additive manufacturing techniques including solid-based, liquid-based and powder-based techniques.
2. Describe the working principle, material removal mechanism and process parameters for Hybrid machining.
3. Illustrate the MEMS and Non-MEMS based manufacturing techniques.
4. Describe basic Nano finishing techniques.
5. Describe metal joining processes along with their advantages, disadvantages and applications.
6. Illustrate the Composite manufacturing and powder metallurgy process along with its advantages, disadvantages and applications.

Detailed Syllabus: (Module wise)		
Module No.	**Description**	**Duration**
01	**Introduction to Additive Manufacturing (AM)** Subtractive manufacturing v/s Additive Manufacturing, Discussion on different materials used in AM, Role of solidification rate in AM, Grain structure and microstructure in AM. Powder-based AM processes involving sintering and melting (selective laser sintering (SLS), electron beam melting). Solid-based AM process (extrusion based fused deposition modelling (FDM), Laminated object manufacturing (LOM)). Liquid based AM Process (Stereo lithography(SLA))	07
02	**Introduction to Hybrid machining** Electric discharge grinding (EDG), Electro chemical grinding (ECG), Electro stream drilling (ESD), Electro chemical deburring (ECD), Laser assisted machining (LAM) and Shaped tube electrolytic machining (STEM). Working principle, Material removal mechanism, Identification of process parameters, Advantages, Disadvantages and Applications.	06
03	**Introduction to Micro Manufacturing Techniques** Challenges in Meso, Micro, and Nano manufacturing. NON – MEMS based - Traditional Micromachining (Micro turning, Micro Milling, Micro grinding, Diamond turning). MEMS based - Overview about micro fabrication methods - Chemical vapor deposition (CVD); Physical vapor deposition (PVD), optical and electron beam lithography; Dry and wet etching.	07
04	**Introduction to Nano Finishing Techniques** Abrasive Flow Machining (AFM), Magnetic Abrasive Finishing (MAF), Magneto rheological Finishing (MRF), Magneto rheological Abrasive Flow Finishing (MRAFF), Magnetic Float Polishing (MFP), Elastic Emission Machining (EEM), Chemical Mechanical Polishing (CMP).	06
05	**Metal Joining Processes:** Gas welding, Arc welding, Resistance, Radiation, Solid state and Thermo-chemical welding processes, soldering and brazing processes, welding defects, inspection & testing of welds, Safety in welding.	06
06	**Polymeric composites manufacturing processes:** Thermoset and Thermoplastic composite processing, advantages & disadvantages. Manufacturing process for thermoset composites (applications, basic processing steps, advantages and limitations only) prepeg layup, wet layup, spray up, filament winding, pultrusion and resin transfer molding. **Powder Metallurgy:** Powder manufacturing methods; Advantages, disadvantages, and applications of powder metallurgy. Case studies like Oil Impregnated Bearings.	07

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.**
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Reference Books:

1. Ian Gibson, David W. Rosen, Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing Springer, 2010.
2. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011.
3. Waqar Ahmed, Mark J. Jackson, *Emerging Nanotechnologies for Manufacturing*, 2nd Edition, Elsevier, 2015.
4. Jain V. K. - 'Introduction to Micromachining' - Narosa Publishing House – 2010.
5. Mark J. Jackson, Micro and Nanomanufacturing, Springer, 2007.
6. A Text Book of Production Technology Vol. II by O. P. Khanna, Dhanpat Rai Publication (2000).
7. Welding Technology by O. P. Khanna, Dhanpat Rai & Co.
8. Composites Manufacturing – Materials, product, and Process Engineering by Sanjay K. Muzumdar, CRC Press (2002).
9. Workshop Technology Part 1, 2 and 3, W. A. J. Chapman, Taylor & Francis (1972)

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Course Code	Course Name	Credits
PEL 401	Mould & Metal Forming 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	50

Objectives

1. To prepare the learner study sand moulds and pressure die casting dies in detail.
2. To prepare the learner study multi impression forging dies and roll passes in detail.
3. To prepare the learner study design & draw sand moulds dies in detail.
4. To prepare the learner study design & draw multi impression forging dies and roll pass grooves in detail.

Outcomes: Learner will be able to:

1. Illustrate various forming and casting processes used in manufacturing of various components.
2. Classify the equipments and machines used in manufacturing processes, such as casting, rolling, forging, extrusion and wire drawing.
3. Design and draw the moulds required for castings processes.
4. Design and draw the dies required for forging processes.
5. Design and draw the grooves required for rolling processes.
6. Demonstrate various trends in the foundry/forging industries.

Sr.no	Design Exercise/Assignments
01	Assignment on Sand casting
02	Assignment on Special casting and Extrusion
03	Assignment on Forging
04	*Design of sand casting moulds
05	*Design of Forging dies
06	*Design of Roll pass grooves

*Designing on any of the platforms like Solid works, Autodesk Inventor, Unigraphics NX, Pro-E etc

Term Work:

Term work shall consist of exercises listed in the above table and also a detailed report based on an Industrial visit to a Casting/Forging plant.

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

Assignments	**07**
Industrial visit Report	**03**
Design Exercises with Drawings (scaled model)	**10**
Attendance	**05**

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

Oral Examination:

1. Oral examination shall be conducted based on term work and syllabus content.

2. Examiners are expected to give the students a small task or ask questions either to evaluate understanding of basic fundamentals or to evaluate their capability of applying basic theory to practical applications.

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Course Code	Course Name	Credits
PEL402	Theory of Machines 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 equip the students with the understanding of the fundamental principles and techniques for identifying different types of dynamic systems.
2. To prepare the students understand static and dynamic balancing of point masses.
3. To prepare the students understand as to how to determine the natural frequencies of continuous systems.
4. To familiarize with the use of graphical methods to compute velocity and acceleration in mechanisms.

Outcomes: Learner will be able to:

1. Compute the natural frequency of 1 DOF system.
2. Apply the working principles of gyroscope and Cam.
3. Demonstrate the understanding of static and dynamic balancing.
4. Compute velocity and acceleration in mechanisms.
5. Carry out Cam analysis.
6. Demonstrate the practical significance of interference and undercutting in gears.

Exp. No.	List of Experiments (Any 6)
01	Gyroscope
02	Longitudinal Vibrations of Helical Spring
03	Torsional Vibrations of Shaft
04	Torsional Vibrations of Single Rotor System
05	Torsional Vibrations of Two Rotors System
06	Compound Pendulum
07	Transverse Vibrations - Whirling Speed of Shaft
08	Cam Analysis
09	Coriolli's Component of Acceleration
10	Interference and Undercutting in Gears
	(**Any 2 Assignments)**

01	Velocity and Acceleration Analysis
02	Cam and Follower
03	Balancing of Rotary and Reciprocating Masses

Term Work

Term work shall consist of the exercises listed in the above table. The distribution of marks for term work shall be as follows:

Experiments …… **10**marks

Exercises/Assignments ..……..**10**marks

Attendance: ……..**05**marks

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

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Course Code	Course Name	Credits
PEL403	Applied Electrical & Electronics 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 acquaint with the basic concepts involved in electrical machines and their control circuits.
2. To familiarize with different types of Hardware and software based simulation for electrical and electronic devices.
3. To familiarize with electrical and mechanical characteristics for different types of machines.
4. To familiarize with different types of electronic devices, power electronics, control systems etc.
5. To expose the students to domain knowledge in various applications of Production engineering.

Outcomes: Learner will be able to:

1. To design and simulate different types of electrical machines.
2. Explain and interpret various characteristics of ac, dc machines, brushless dc motor, stepper motor and servomotor.
3. Classify application areas for various ac machines, dc machines, stepper motor, brushless dc motor, OP-AMP, SCR, DIAC-TRIAC.
4. Explain different types of power electronic devices.

Any Three from SIMULATION based (as below)

1. To design and simulate speed control of dc motor using simulation.
2. To design and simulate speed-torque characteristics of induction motor using simulation.
3. To design and simulate bldc motor using simulation.
4. To design and simulate solar based system for driving ac or dc motor using simulation.
5. To design multiplexer and de-multiplexer using simulation.

Any four from HARDWARE based circuits (as below)

1. To design speed control of dc motor using field flux control method and armature control method.
2. To design speed-torque characteristics of induction motor.
3. To design multiplexer, de-multiplexer.

4. To design encoder and decoder.
5. To explain and perform characteristics of SCR AND TRIAC.
6. To explain and perform characteristics of DIAC.
7. To explain applications of SCR.
8. To explain applications of DIAC-TRIAC.
9. To explain different controllers.
10. To design and explain open loop control systems and closed loop control systems.
11. Experiments based on heat treatment methods.
12. Sensor and transducers based experiments.

Any other experiment, assignments, mini-projects and detail reports of industrial visit based on syllabus may be included, which would help the learner to understand topic/concept.

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Course Code	Course Name	Credits
PEL 404	Skill based Lab. Course-II **Advanced Machining Process 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	25	-	75

Objectives:

1. To prepare the students make the assembly involving various operations as per the specifications.
2. To impart the practical knowledge of 3D printing.
3. To impart the practical knowledge of CNC matching.
4. To adopt various safety practices, while working on various machines.

Outcomes: Learner will be able to:

1. Perform machining of composite jobs involving different operations.
2. Develop a component using 3D printing.
3. Generate CNC Lathe part program for Turning, Facing, Chamfering, Grooving, Step turning, Taper turning, Circular interpolation etc.
4. Simulate Tool Path for different Machining operations of small components using CNC Lathe & CNC Milling Machine.
5. Generate CNC Mill Part programming for Point to point motions, Line motions, Circular interpolation, Contour motion, Pocket milling- circular, rectangular, Mirror commands etc.
6. Use Canned Cycles for Drilling, Boring, Tapping, Turning, Facing, Taper turning Thread cutting etc.

Sr.No.	Experiments/Job
01	One simple assembly job, involving the use of Lathe, Shaping, Milling and Grinding machines.

02	Introduction to 3D printing, Introduction to machine and software, Modeling, STL file generation, 3D printing on machine.
03	Introduction to CNC lathe and milling, Use of measuring instruments, Coordinate system, Explanation of codes. Getting familiar with control, MDI, Offset measurement, Simulation of programs. Practicing various turning cycles like OD / ID turning, grooving, threading etc. and canned cycles like drilling, reaming, boring etc.
04	One job involving various operations on CNC Turning Centre.
05	One job involving various operations on CNC Vertical Machining Centre.

Term work

Term work shall consist of exercises as given in the above list. A detailed report, based on an Industrial visit to a manufacturing firm, covering the practical aspect s of syllabus mentioned in the subject of Advanced Machining Processes, also needs to be submitted.

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

Laboratory work (4 Experiments) :40Marks.

Industrial visit report on Advanced Machining practices :05 Marks

Attendance (Practical) :05Marks.

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and up on fulfilling minimum passing criteria in the term work.

Practical Examination:

Practical examination will be held for 4 hours and shall consist of a composite job containing a minimum of 4 operations including precision, turning, boring, screw cutting, drilling, shaping, grinding etc. **Or** One composite job involving various operations on CNC Lathe / Milling machine and verification on simulation software.

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Course	Course Name	Credits
PEM401	Mini Project – 1B	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 organisations 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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