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UNIVERSITY OF MUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Production Engineering

Second Year with Effect from AY 2017-18
Third Year with Effect from AY 2018-19
Final Year with Effect from AY 2019-20

As per **Choice Based Credit and Grading System**
with effect from the AY 2016-17

Co-ordinator, Faculty of Technology's 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 Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEOs) and give freedom to affiliated Institutes to add few (PEOs). It is also 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. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

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. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. 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.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman's Preamble:

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, 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 and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this 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 from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Mechanical Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives of the Undergraduate Program in Production Engineering, which comes under the same board, were finalized during the multiple brain storming sessions, which was attended by more than 25 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Production Engineering. The Program Educational Objectives finalized for the undergraduate program in Production Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals related to Manufacturing and its strategies.
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems.
3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process.
4. To prepare the learner to face industrial challenges through practical exposure in an industrial environment.
5. To prepare the Learner for a successful career in Indian and Multinational Organizations.

In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Dr. S. M. Khot

Chairman, Board of Studies in Mechanical Engineering, University of Mumbai

Program Structure for
B.E. in Production Engineering
University of Mumbai
(With Effect from 2017-2018)
S.E. (Production) Sem.-III

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
PEC301	Applied Mathematics – III**	04	--	04	--	04
PEC302	Applied Thermodynamics	04	--	04	--	04
PEC303	Manufacturing Engineering-I	04	--	04	--	04
PEC304	Material Science and Engineering	03	--	03	--	03
PEC305	Mechanics of Solids	04	--	04	--	04
PEL301	Computer Aided Machine Drawing Laboratory	--	2*+2	--	02	02
PEL302	Data Base Information Retrieval Laboratory	--	2*+2	--	02	02
PEL303	Material Testing Laboratory	--	02	--	01	01
PEL304	Manufacturing Process - I Laboratory	--	04	--	02	02
	Total	**19**	**14**	**19**	**07**	**26**

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.					
PEC301	Applied Mathematics – III**	20	20	20	80	03	--	--	100
PEC302	Applied Thermodynamics	20	20	20	80	03	--	--	100
PEC303	Manufacturing Engineering-I	20	20	20	80	03	--	--	100
PEC304	Material Science and Engineering	20	20	20	80	03	--	--	100
PEC305	Mechanics of Solids	20	20	20	80	03	--	--	100
PEL301	Computer Aided Machine Drawing Laboratory	--	--	--	--	--	50	50	100
PEL302	Data Base Information Retrieval Laboratory	--	--	--	--	--	50	50	100
PEL303	Material Testing Laboratory	--	--	--	--	--	25	--	25
PEL304	Manufacturing Process - I Laboratory	--	--	--	--	--	50	--	50
	Total			**100**	**400**		**175**	**100**	**775**

*** <u>Theory for entire class to be conducted</u>.**

**** Common with Automobile Engineering, Mechanical Engineering and Civil Engineering**

S.E. (Production) Sem.-IV

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
PEC401	Applied Mathematics – IV**	04	--	04	--	04
PEC402	Dynamics of Machines	04	--	04	--	04
PEC403	Manufacturing Engineering-II	04	--	04	--	04
PEC404	Fluid & Thermal Engineering	04	--	04	--	04
PEC405	Electrical & Electronics Engineering	04	--	04	--	04
PEL401	Dynamics of Machines Laboratory	--	02	--	01	01
PEL402	Fluid & Thermal Engineering Laboratory	--	02	--	01	01
PEL403	Electrical & Electronics Engineering Laboratory	--	02	--	01	01
PEL404	Manufacturing Process – II Laboratory	--	04	--	02	02
	Total	**20**	**10**	**20**	**05**	**25**

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	Applied Mathematics IV **	20	20	20	80	03	--	--	100
PEC402	Dynamics of Machines	20	20	20	80	03	--	--	100
PEC403	Manufacturing Engineering-II	20	20	20	80	03	--	--	100
PEC404	Fluid & Thermal Engineering	20	20	20	80	03	--	--	100
PEC405	Electrical & Electronics Engineering	20	20	20	80	03	--	--	100
PEL401	Dynamics of Machines Laboratory	--	--	--	--	--	25	25	50
PEL402	Fluid & Thermal Engineering Laboratory	--	--	--	--	--	25	25	50
PEL403	Electrical & Electronics Engineering Laboratory	--	--	--	--	--	25	--	25
PEL404	Manufacturing Process – II Laboratory	--	--	--	--	--	50	50	100
	Total			**100**	**400**		**125**	**100**	**725**

** **Common with Automobile Engineering, Mechanical Engineering and Civil Engineering**

Course Code	Course Name	Credits
MEC301	**Applied Mathematics III****	**04**

Objectives

1. To provide sound foundation in the mathematical fundamentals necessary to formulate, solve and analyse engineering problems.
2. To study the basic principles of Laplace Transform, Fourier Series, Complex variables.

Outcomes: Learner will be able to…

1. Demonstrate the ability of using Laplace Transform in solving the Ordinary Differential Equations and Partial Differential Equations
2. Demonstrate the ability of using Fourier Series in solving the Ordinary Differential Equations and Partial Differential Equations
3. Solve initial and boundary value problems involving ordinary differential equations
4. Identify the analytic function, harmonic function, orthogonal trajectories
5. Apply bilinear transformations and conformal mappings
6. Identify the applicability of theorems and evaluate the contour integrals.

Module	Detailed Contents	Hrs
1	**Laplace Transform** 1.1 Function of bounded variation, Laplace Transform of standard functions such as 1, t^n, e^{at}, $\sin at$, $\cos at$, $\sinh at$, $\cosh at$ 1.2 Linearity property of Laplace Transform, First Shifting property, Second Shifting property, Change of Scale property of L.T. (without proof) $L\{t^n f(t)\}, L\left\{\frac{f(t)}{t}\right\}, L\left\{\int_0^t f(u)du\right\}, L\left\{\frac{d^n f(t)}{dt^n}\right\}$ Laplace Transform. of Periodic functions 1.3 Inverse Laplace Transform: Linearity property, use of theorems to find inverse Laplace Transform, Partial fractions method and convolution theorem(without proof). 1.4 Applications to solve initial and boundary value problems involving ordinary differential equations with one dependent variable	**12**
2	**Complex variables:** 2.1 Functions of complex variable, Analytic function, necessary and sufficient conditions fo $f(z)$ to be analytic (without proof), Cauchy-Riemann equations in polar coordinates. 2.2 Milne- Thomson method to determine analytic function $f(z)$ when it's real or imaginary or its combination is given. Harmonic function, orthogonal trajectories **2.3** Mapping: Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations such as Rotation and magnification, inversion and reflection, translation	**08**
3	**Complex Integration:** 3.1 Line integral of a function of a complex variable, Cauchy's theorem for analytic functions(without proof)Cauchy's integral formula (without proof))Singularities and poles: 3.2 Taylor's and Laurent's series development (without proof) 3.3 Residue at isolated singularity and its evaluation 3.4 Residue theorem, application to evaluate real integral of type	**08**

	$\int_0^{2\pi} f(\cos\theta, \sin\theta)\, d\theta,$ & $\int_{-\infty}^{\infty} f(x)\, dx$	
4	**Fourier Series:** 5.1 Orthogonal and orthonormal functions, Expressions of a function in a series of orthogonal functions. Dirichlet's conditions. Fourier series of periodic function with period 2π and $2l$ 5.2 Dirichlet's theorem(only statement), even and odd functions, Half range sine and cosine series,Parsvel's identities (without proof) 5.3 Complex form of Fourier series	**10**
5	**Partial Differential Equations:** 5.1. Numerical Solution of Partial differential equations using Bender-Schmidt Explicit Method, Implicit method (Crank- Nicolson method). 5.2. Partial differential equations governing transverse vibrations of an elastic string its solution using Fourier series. 5.3. Heat equation, steady-state configuration for heat flow 5.4. Two and Three dimensional Laplace equations	**09**
6	**Correlation and curve fitting** 6.1. Correlation-Karl Pearson's coefficient of correlation- problems, Spearman's Rank correlation problems, Regression analysis- lines of regression (without proof) –problems 6.2. Curve Fitting: Curve fitting by the method of least squares- fitting of the curves of the form, $y = ax + b$, $y = ax^2 + bx + c$ and $y = ae^{bx}$	**05**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

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**.

References:

1. Higher Engineering Mathematics, Dr B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
3. Higher Engineering Mathematics, B.V. Ramana, McGraw Hill Education, New Delhi
4. Complex Variables: Churchill, Mc-Graw Hill
5. Integral Transforms and their Engineering Applications, Dr B. B. Singh, Synergy Knowledgeware, Mumbai
6. Numerical Methods, Kandasamy, S. Chand & CO
7. Fundamentals of mathematical Statistics by S.C.. Gupta and Kapoor

Course Code	Course Name	Credits
PEC302	**Applied Thermodynamics**	**04**

Objectives:

1. To acquaint with basic concepts of Thermodynamics and its applications
2. To familiarize with the use of thermodynamic tables and charts to obtain appropriate property data to solve relevant problems.
3. To familiarize with the application of ideal cycle analysis to simple heat engine cycles.

Outcomes: Learner will be able to ….

1. Illustrate the basic concepts related to a thermodynamic system, surrounding, thermodynamic properties and processes.
2. Apply first law of thermodynamics to solve different types of problems on open and closed systems.
3. State the Second Law of Thermodynamics with its practical significance.
4. Demonstrate the importance of entropy and clausius inequality with its application to solve problems.
5. Apply properties of steam to solve problems using steam table and Mollier chart.
6. Analyze various thermodynamic cycles generating powers to solve problems.

Module	Contents	Hrs.
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, asistatic process, thermodynamic work, heat, temperature, thermodynamic equilibrium and Zeroth law of thermodynamics. **First law of Thermodynamics:** Statement, First law applied to cyclic and non-cyclic process, Application to non-flow processes viz. Constant volume, constant pressure, constant temperature, adiabatic and polytrophic processes. Heat and work calculations.	**12**
02	**First law applied to open systems:** Flow work, Steady flow energy equation (SFEE), SFEE applied to nozzle, turbine, compressor, boiler, condenser etc.	**06**
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.	**08**
04	**Entropy:** Definition of entropy, a property, change of entropy, temperature-entropy plot, Clausius inequality theorem, principle of increase of entropy, entropy changes of an ideal gas during reversible processes. **Introduction to Availability and irreversibility:** Available and Unavailable energy, Dead state, Useful work and Maximum work.	**08**

05	**Properties of steam:** Dryness fraction, enthalpy, internal energy and entropy. Critical point and Triple point, Use of steam tables and h-s diagram for calculating steam properties. **Vapour power cycle:** Rankine cycle, Modified Rankine cycle, variables affecting the efficiency of Rankine cycle, Reheat cycle and Regenerative cycle.	**08**
06	**Gas power cycle:** Otto, Diesel, Dual and Brayton cycle. Comparison and representation on P-V and T-S diagram.	**06**

Theory Examination:
1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from the module 3 then part (b) will be from any module other than module 3)

In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Internal Assessment:
Assessment consists of two tests out of which; one should be a compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or a course project.

Reference Books:

1. *Engineering Thermodynamics* by P. K. Nag, Tata McGraw Hill Publications.
2. *Engineering Thermodynamics* by R. K. Rajput, Laxmi Publications.
3. *Thermal Engineering* by Mahesh Rathod, McGraw-Hill Publications.
4. *Thermodynamics*– An Engineering Approach by Y. Cengel & Boles, Tata McGraw Hill Publications
5. *Thermal Engineering* by P. L Ballany, Khanna Publishers
6. *Engineering Thermodynamics* by C.P. Arora, Tata McGraw Hill Publications
7. *Thermodynamics and Heat Engines* by R Yadav, Central Publishing house.
8. *Engineering Thermodynamics* through Examples by Y V C Rao, Universities Press (India) Pvt. Lt.

Course Code	Course Name	Credits
PEC303	**Manufacturing Engineering - I**	**04**

Objectives:

1. To impart the knowledge of machine tools and basic machining processes like turning, drilling, milling, broaching etc.
2. To impart the fundamentals of various metal cutting practices, fundamentals of machine tools and processes.

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. Demonstrate different kinds of cutting tools with their significance of work-piece interface.
4. Describe features and applications of screw thread processes.
5. Describe features and applications of gear manufacturing processes.
6. Demonstrate finishing processes like grinding, reaming, honing, lapping and burnishing.

Module	Contents	Hrs.
01	**Introduction to Manufacturing Processes:** Definition, need and classification of manufacturing process based on chip-less and chip-removal processes. Various generating & forming processes. Classification of machine tools based on form of the work piece and on field of application. **Cutting off Machines:** Power hacksaws, band saw and circular saw, friction saw and abrasive cutting off machines, field of applications and limitations.	**06**
02	**Lathe Machine:** Lathe operations, Turning parameters (speed, feed, depth of cut, MMR), Lathe Components, Lathe specifications, work and tool holding devices & accessories, single point cutting tool nomenclature, Taper turning types, lathe machines types and their difference. Machining time (Numerical).	**08**
03	**3.1 Drilling machine:** Drilling operations, work and tool holding devices, Drill nomenclature, Drilling machine types, Deep hole drilling (fundamentals only), Introduction to Boring & Boring machine. Machining time (Numerical). **3.2 Broaching Machine:** Broaching process, circular broach nomenclature and types of broaches, broaching machine types, Advantages and Limitations.	**06**
04	**4.1 Milling Machine:** Milling operations and their difference, Milling Parameters, special attachments (Dividing head) and accessories, milling machines types, Types of Milling cutters and Machining time (Numerical). **4.2 Reciprocating Machine:** Shaping machines: types of shapers, working of shaping machine, quick return mechanisms, shaper operations, Machining time. Planning machines: types of planning machines, shaper vs. planer. Slotting machines types of slotting machines.	**10**

05	**Screw Threads:** Thread production process – Machining (thread chasing, thread milling, thread whirling, and die threading & tapping), Thread rolling, Thread grinding. (Tool geometry omitted). **Gear Teeth:** Gear hobbing, principles of hobbing (kinematics omitted). Hobbing techniques, hob material (tool geometry omitted). Gear finishing processes-gear shaving, gear lapping, gear grinding and gear burnishing.	**08**
06	**6.1Grinding Machine:** Grinding principle, Grinding machines types and operations, grinding wheels specification, balancing of grinding wheels, truing, dressing and shaping of grinding wheels. **6.2 Finishing Process:** Reaming and Honing process, Lapping−process, lap materials, medium, vehicles. Super finishing process (Polishing, Buffing) – equipment and fluids. Roller burnishing-process.	**10**

Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from the module 3 then part (b) will be from any module other than module 3).

In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Internal Assessment:

Assessment consists of two tests out of which; one will be a compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or a course project.

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, 2 and 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 Publication (2000).
7. *Fundamentals of Modern Manufacturing*- Materials, Processes and Systems, 3rd Edition by Mikell P. Groover, Wiley India (2002).
8. *Manufacturing Processes for Engineering Materials*, 4th Edition by Serope Kalpakjian, Steven R. Schmid, Pearson (2007).

Course Code	Course Name	Credits
PEC304	**Materials Science and Engineering**	**03**

Objectives:

1. To familiarize with basic engineering materials, their structure-properties-performance relationship and applications.
2. To acquaint with different types and causes of failure of components in various Engineering applications.
3. To familiarize with properties, manufacturing processes and applications of polymer matrix composites.

Outcomes: Learner will be able to…

1. Demonstrate the process of solidification of metals along with various types of crystal imperfections.
2. Distinguish between various modes of material failure.
3. Analyze various alloy phase diagrams including iron – iron carbide diagram.
4. Select proper heat treatment process for steel in order to attain desirable properties.
5. Describe the properties with applications of alloy steels/ non - ferrous metals.
6. Describe the properties with applications of composites/ nano structured materials.

Module	Contents	Hrs.
01	**1.1 Introduction to Materials Science and Engineering:** Why study Materials Science and Engineering, Classification of materials, Processing-Structure-Properties-Performance Correlations. Types of atomic bonding – metallic, ionic and covalent (basics). **1.2 Crystal imperfection:** Definition, Classification, Point defects: their formation and effects. Dislocations: edge and screw dislocations, their significance. Surface defects: grain boundary, sub-angle grain boundary, stacking fault, and their significance. Dislocation generation by Frank Reed sources. Dislocation interactions. **1.3 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. Necessity of Process Annealing. Recovery, Recrystallization and Grain Growth; Factors affecting Recrystallization.	**07**
02	**2.1 Fracture**: Definition and types of facture. Brittle fracture and Ductile fracture. Ductile-to-Brittle transition. Definition and significance (fundamental understanding only). **2.2 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. **2.3 Creep:** Definition and significance of creep. Effect of temperature and creep on mechanical behavior of materials. Creep testing and data presentation & analysis. Mechanism and types of creep.	**07**
03	**3.1 Solidification of metals:** Formation of solids from liquids of pure metals and alloys. Ingot defects and their remedies. Single crystal and polycrystalline materials. Anisotropy. Noncrystalline solids. **3.2 Theory of Alloying:** Significance of alloying: definition, classification and properties of different types of alloys.	**08**

	3.3 Alloy Phase Diagrams: Different types of alloy diagrams and their analysis. Tie bar and Lever rules and their application. Dispersion hardening/age hardening. **3.4 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.	
04	**4.1 Principles of Heat treatment:** Technology of heat treatment. Classification of heat treatment process. TTT Diagram. CCT Diagram and Superimposition of cooling curves on Diagram. **4.2 Heat treatment Process:** Annealing: Principle, process, and properties developed on Full Annealing; Spheroid zing; Process annealing, Stress relieve annealing. Normalizing: The process and its applications Hardening: Hardening media, Salt baths, Hardenability. Tempering, Subzero treatment, Austempering, Martempering, Maraging and Ausforming process. Surface hardening: Surface Hardening methods. Their significance and applications. Carburizing, Nitriding, Cyaniding, Carbon-nitriding. Induction hardening and Flame hardening processes. **4.3 Heat treatment defects:** Defect during heat treatment process. Typical design guidelines in Heat treatment.	**09**
05	**5.1 Effect of Alloying Elements in Steels:** Limitation of plain carbon steels. Significance of alloying elements. Effects of major and minor constituents, Effect of alloying elements on ferrite, carbide, austenite, Effect of alloying elements on phase transformation, decomposition, hardening and tempering. Tool steels: Important compositions and applications. Stainless steels : Important compositions and applications **5.2 Non Ferrous Metals and their Alloys:** Basic Treatment Only. Important non-ferrous materials like Aluminum, Copper, Nickel, Tin, and Zinc – Their alloys, properties and applications.	**06**
06	Introduction to New Materials: (Fundamental understanding only) **6.1 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. **6.2 Nano-structured materials:** Introduction, Concepts, synthesis of nano materials, examples, applications and nano composites. **6.3 Biomaterials**: Introduction, examples and applications. **6.4 Smart materials:** Introduction, examples and applications.	**05**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

End Semester Examination:

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

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

Reference Books:

1. *Materials Science and Engineering*: An Introduction, 8th Edition by William D. Callister Jr. – Adapted by R. Balasubramaniam. Wiley India (P) Ltd (2010).
2. *Introduction to Physical Metallurgy*, 2nd Edition by S. H. Avner, Tata McGraw Hill (1997).
3. *Essentials of Materials Science and Engineering*, 3rd Edition by Donald R Askeland, Wendelin J Wright, Cengage Learning (2013).
4. *Composite Materials – Science and Engineering*, 3rd Edition, Krishnan K. Chawla, Springer (2013).
5. *Composites Manufacturing* – Materials, Product, and Process Engineering, Sanjay K. Muzumdar, CRC Press (2002).
6. *Materials for Engineers and Technicians*, 6th Edition, W. Bolton, R.A. Higgins, Routledge (2015).
7. *Mechanical Metallurgy*, 3rd Edition by G. E. Dieter. McGraw Hill International New Delhi (1988).
8. *Introduction to Engineering Materials*, B. K. Agrawal. McGraw Hill Publishing Co. ltd. (1988).
9. *The Science and Engineering of Materials*, 7th Edition by Donald R. Askeland, Wendelin J Wright, Cengage Learning (2015).

Course Code	Course Name	Credits
PEC305	**Mechanics of Solids**	**04**

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. Develop skills to analyze the stresses and deformation due to axial loading.
5. Illustrate basic concepts of bending, torsion, buckling, deflection and strain energy.
6. Develop skills to visualize with analysis of stresses under various loading conditions.

Module	Contents	Hrs
01	**Direct stress and direct strain:** Concept of different types of stresses; Stress−strain curves for ductile and brittle material; factor of safety; deformation of uniform/tapering rectangular and circular and circular cross−section bars; deformation of members made of composite materials; shear stress and shear strain; Poisson's ratio; volumetric strain; bulk modulus; relationship between Young's modulus, bulk modulus and modulus of elasticity; temperature stresses in simple and compound bars. **Introduction to Moment of Inertia:** Theorem of parallel and perpendicular Axis, Polar Moment of Inertia.	**10**
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.	**08**
03	**3.1 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. **3.2 Shear Stress in Beams:** Distribution of shear stress across plane sections used commonly for structural purposes; shear connectors.	**10**
04	**4.1 Bending Moment Combined with Axial Loads:** Application to members subjected to eccentrics loads, core of section. **4.2 Deflection of Beams:** Deflection of cantilevers sample supported and overhanging beams using double integration and Macaulay's method for different types of loadings	**08**
05	**5.1 Theory of Torsion:** Torsion of circular shafts−solid and hollow, stresses in shafts transmitting power, shafts in series and parallel. **5.2 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.	**08**

06	**6.1 Struts:** Struts subjected to axial loads, concept of buckling. Euler's formula for struts with different support conditions. Euler's and Rankin's design formulae. **6.2 Strain energy:** Strain energy due to axial loads gradually applied transverse loads and under impact load.	**06**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

End Semester Examination:

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

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

Reference books

1. *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*, Dhanpatrai Publication.
4. *Beer and Johnston, Mechanics of Materials*, McGraw Hill Publication.
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.

Course Code	Course Name	Credits
PEL301	**Computer Aided Machine Drawing**	**02**

Objectives:

1. To prepare the students gain the 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 2-D and 3-D 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 software's.
6. Convert 3D models to 2D drawings using various CAD software's.

Module	Contents	Hrs
01	1.1 **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. 1.2 **Machine Elements:** Preparation of 2-D drawings of standard machine elements (nuts, bolts, keys, cotter, screws, spring etc.). 1.3 **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**: 2.1 Introduction to the unit assembly drawing, steps involved in preparing assembly drawing from details and vice-versa, Sequence in assembly. 2.2 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:** 3.1 Simple, solid, Bushed bearing. I.S. conventional representation of ball & roller bearing. 3.2 Pedestal bearing & footstep bearing.	**10**
04	**Preparation of detailed and assembly drawings of pulleys, Pipe Joints. Limits, Fits & Tolerances -** 4.1 Classification of Pulleys, pipe joints 4.2 Pulleys: Flat belt, V-belt, rope belt, Fast and loose pulleys. 4.3 Pipe joints: Flanged joints, Socket and spigot joint, Gland and stuffing box, expansion joint.	**04**
05	**Preparation of detailed and assembly drawings of Valves, I.C. Engine parts:** 5.1 Types of Valves, introduction to I.C. Engine	**08**

	5.2 Preparation of detailed and assembly drawings of Stop valve, Non return Valve, I.C. Engine parts: Piston, Connecting rod, Cross head, Crankshaft and Spark plug.	
06	**Preparation of detailed and assembly drawings of Jigs and Fixtures:** 6.1 Introduction to Jigs and fixtures, 6.2 Jigs and Fixtures 6.3 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 these sketches into 3-D 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 work in A-3 size sketch book, as follows :-
1. Minimum 4 questions from module 1.
2. Minimum 3 questions from module 2.
3. Minimum 1 question/module from module 3 to 6.

B. Printouts/plots of the problems solved in practical class from the practical part of each module, as follows :-
1. 5 two dimensional detailed drawings: - Preparation of 3-D models of parts from given 2-D assembly drawing. Converting the 3-D parts into 2-D detailed drawings.
2. 5 two dimensional Assembly drawings: - Preparation of 3-D models of parts, from given 2-D detailed drawings. Assembling the 3-D parts and Converting the 3-D
3. Assembly into 2-D assembly drawing.

Problems from practical parts of each module should be solved using standard CAD packages like IDEAS, PRO-E, CATIA, Solid Works and 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 3-D models of parts, assembling parts and preparing production drawings of these parts and assembly with appropriate tolerancing from given 2-D detailed drawings.
   Session-II: Preparation of minimum five detailed 3-D part drawings from given 2-D assembly drawing.
   Oral examination should also be conducted to check the knowledge of conventional and CAD drawing.
2. Questions provided for practical examination should contain minimum five and not more than ten parts.

3. The distribution of marks for practical examination shall be as follows:
   Session-I …… 25 marks
   Session-II …… 15 marks
   Oral …… 10 marks
4. Evaluation of practical examination to be done based on the printout of students work.
5. Students work along with evaluation report to be preserved till the next examination.

Reference Books:

1. *Machine Drawing*, N.D. Bhatt.
2. *Machine Drawing* by P. S. Gill
3. *A text book 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, Sidheshwar and Kanheya
9. *Autodesk Inventor 2011 for Engineers and Designers*, Sham Tickoo, S. Raina (dreamtech Press).

Course Code	Course Name	Credits
PEL302	**Data Base and Information Retrieval**	**02**

Objective:

1. To acquaint with data modelling/database design using the entity-relationship
2. To study use of Structured Query Language (SQL) and learn SQL syntax
3. To familiarize Graphical User Interface techniques to retrieve information from database
4. To study needs of database processing and controlling the consequences of concurrent data access

Outcomes: Learner will be able to…

1. Identify data models and schemes in DBMS
2. Demonstrate the features of database management systems and Relational database
3. Use SQL- the standard language of relational databases
4. Demonstrate understanding of functional dependencies and design of the database
5. Design graphical user Interface for specific application
6. Create visual software entities

Module	Detailed Contents	Hrs.
01	**Introduction to Database Concept:** What is a database?, Characteristics of database, Example of database, File system V/s Database system, What is DBMS?, Users of database system, Advantage of using an enterprise database, Concerns when using an enterprise database, Data independence, DBMS systems architecture, Database administrator	02
02	**Entity-Relationship Data Model:** Introduction, Benefits of Data Modelling, Types of Models, Phases of Database Modelling, The Entity-Relationship (ER) Model, Generalisation, Specialization and Aggregation, Extended Entity-Relationship (EER) Model	04
03	**Rational Model and Algebra:** Introduction, Mapping the ER and EER Model to the relational Model, Data Manipulation, Data Integrity, Advantages of Relational Model, Relational Algebra, Relational Algebra Queries, Relational Calculus	04
04	**Structured Query Language (SQL):** Overview of SQL, Data definition commands, set operations, aggregrate functions, null values, Data manipulation commands, Data control commands, Views- using virtual tables in SQL, Nested and complex queries	04
05	**Introduction to Transactions Management and Co-currency:** Transaction concept, transaction states, ACID properties, Implementation of atomicity and durability, Concurrent Executions, Serializability, Recoverability, **Co-currency Control:** Lock-based, Timestamp-based, Validation-based protocols, Deadlock handling, Recovery system, Failure classification, Storage structure, Recovery and atomicity, Log based recovery, Shadow paging	04
06	**Graphical User Interface:** Murphy's law of GUI design, Features of GUI, Icons and graphics, Identifying visual cues, clear communication, colour selection, GUI standard, planning GUI Design Work **Visual Programming:** ***Sharing Data and Code:*** Working with projects, introduction to basic language, Using inbuilt controls and ActiveX controls, creating and using classes, introduction to collections, usinf and creating ActiveX components, dynamics data exchange, Object linking and embedding, ***Creating visual software entities:*** Working with text, graphics, working with files, file management, serial communication, multimedia control interfaces	06

Assessment:

Term Work:
Assign minimum two case studies for each student. On their case studies following exercises to be performed

1. Problem Definition and draw ER/EER diagram
2. Design Relational Model
3. Perform DDL operation
4. Perform DML and DCL operations
5. Design Forms using Visual programming
6. Retrieve the information through GUI.

Distribution of Term work Marks

Laboratory work	40 Marks
Attendance	10 Marks

End Semester Practical/Oral Examination:

1. Practical examination of 2 hours duration followed by viva to be conducted by Pair ofInternal and External Examiner based on contents
2. Evaluation of practical examination to be done by examiner based on the printout of students work
3. Distribution of marks

Practical examination:	40 marks
Viva based on practical examination	10marks

4. Students work along with evaluation report to be preserved till the next examination

Reference Books:

1. Database Management Systems, G K Gupta, McGraw – Hill
2. Database System Concepts, Korth, Slberchatz, Sudarshan, 6thEdition, McGraw – Hill
3. GUI Design for dummies, IDG books
4. Visual Basic 2005, How to program, Deitel and Deitel,3rdEdition, Pearson Education
5. SQL and PL/SQL for Oracle 10g,Black Book, Dr P S Deshpande, Dreamtech Press
6. Introduction to Database Management, Mark L Gillenson, Paulraj Ponniah, Wiley
7. Oracle for Professional, Sharaman Shah, SPD.
8. Database Management Systems, Raghu Ramkrishnan and Johannes Gehrke, TMH
9. Fundamentals of Database Management System, Mark L Gillenson, Wiley India

Course Code	Course Name	Credits
PEL303	**Material Testing Laboratory**	**01**

Objectives

1. To familiarize the students with the use of stress, strain measuring instruments.
2. To familiarize the students with the process of metallographic sample preparation.
3. To familiarize the students with various Non-Destructive Testing methods.
4. To familiarize the students with various Heat Treatment Processes.

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. Measure the hardness 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/Job
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 and concrete blocks.
07	Tension and compression test on helical springs.
08	Brinell and Rockwell hardness test. Sample Preparation for Metallographic observations.
09	Experiments based on any two NDT tests.
10	Experiments based on any two heat treatment methods.

Term Work

Term work shall consist of any four experiments covering the tests 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 Material Science and Engineering needs to be submitted along with the write-up on above experiments.

Experiments (1to 7) : **10** marks
Experiments (8-10) 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.

Course	Course Name	Credits
PEL304	**Machine Shop Practice - I**	**02**

Objectives:

1. To prepare the students with various lathe operations like turning, taper turning, thread cutting etc.
2. To familiarize the students with the practice of machining of flat surfaces on shaping/milling machines.
3. To prepare the students understand various concepts related to molding processes of plastic materials.

Outcomes: Learner will be able to…

1. Practice safe machine shop practices with working.
2. Select the right tool, set up 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. Use metals/plastics components in engineering applications.
6. Produce metal/plastic components from different manufacturing processes.

Sr. no	Experiments/Job
01	One job on plain and taper turning.
02	One job on precision turning, taper turning and screw cutting.
03	One job on shaping/milling machine to make horizontal and inclined surfaces.
04	Demo of turning operation on plastic rod to know the difference in machining of metals and plastics (Any of the commercial plastics like Nylon-6, Nylon-66, Polyster, PET etc.).

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 Engineering- I, 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 practises : 05 Marks.
Attendance (practicals) : 05 Marks.

Course Code	Course Name	Credits
MEC401	**Applied Mathematics IV****	**04**

Objectives:

1 To inculcate an ability to relate engineering problems to mathematical context
2 To provide a solid foundation in mathematical fundamentals required to solve engineering problem
3 To study the basic principles of Vector analyses, complex integration, probability, test of hypothesis and correlation between data.
4 To prepare students for competitive exams

Outcomes: Learner will be able to…

1 Solve the system of linear equations using matrix algebra with its specific rules
2 Demonstrate basics of vector calculus
3 Apply the concept of probability distribution and sampling theory to engineering problems
4 Apply principles of vector calculus to the analysis of engineering problems
5 Identify, formulate and solve engineering problems
6 Illustrate basic theory of correlations and regression

Module	Details	Hrs
1	**Matrices:** 1.1 Brief revision of vectors over a real field, inner product, norm of a vector 1.2 Eigen values and Eigen vectors: Characteristic polynomial, characteristic equation, characteristic roots and characteristic vectors of a square matrix, properties of characteristic roots and vectors of different types of matrices such as orthogonal matrix, Hermitian matrix, Skew-Hermitian matrix, Cayley Hamilton theorem (without proof) . Similarity of matrices. Functions of a square matrix	**08**
2	**Matrices:** 2.1 Minimal polynomial and Derogatory matrix 2.2 Quadratic forms: Linear transformations of a quadratic form, congruence of a square matrix, reduction to Canonical form under congruent transformations, orthogonal transformations, determining the nature of a quadratic form, Applications of Eigen Values and Eigen Vectors **Vector calculus** 2.3 Brief revision of Scalar and vector point functions. Gradient of a scalar function, Divergence and curl of a vector function 2.4 Line integrals, circulation of a vector, condition for independence of the path in the line integral	**09**
3	**Vector calculus:** 1.1 Green's theorem(without proof) for plane regions and properties of line integrals, Stokes theorem (without proof), Gauss divergence theorem (without proof) related identities and deductions.(No verification problems on Stoke's Theorem and Gauss Divergence Theorem) **Linear Programming problems** 1.2 Types of solutions to linear programming problems, standard form of L.P.P. Simplex method to solve L.P.P	**09**
4	**Linear Programming problems Probability Distributions:** 4.1 Big M method (Penalty method) to solve L.P.P, Duality, Dual simplex method and Revised simplex method to solve L.P.P.	**09**

	Probability Distributions 4.2 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expected value, Variance. 4.3 Probability Distributions: Binomial, Poisson and Normal Distributions	
5	**Sampling theory:** 5.1. Sampling theory: Sampling distribution. Test of Hypothesis. Level of significance, critical 5.2. region. One tailed and two tailed tests. Interval Estimation of population parameters. Large and small samples 5.3. Test of significance for Large samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two samples. **5.4.** Student's t-distribution and its properties. Test of significance of small samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two Samples, paired t-test	**09**
6	**Sampling theory and ANOVA** 6.1. Chi-square test, Test for the Goodness of fit , Association of attributes and Yate's correction 6.2. Analysis of Variance(F-Test): One way classification, Two-way classification(short-cut method)	**08**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

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**.

References:

1. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publication
3. Advanced Engineering Mathematics, H. K. Dass, S. Chand & co
4. Vector Analysis by Murray R. Spiegel, Shaum Series
5. Operations Research, S.D. Sharma, S. Chand & CO.
6. Fundamentals of Mathematical Statistics, S C Gupta & V K Kapoor, S. Chand & Co
7. Elements of Applied mathematics, P N & J N Wartikar, Pune Vidyarthi Gruha Prakashan
8. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
9. Operations Research, Kantiswearup, Manmohan, P K Gupta, S. Chand & CO

Course Code	Course Name	Credits
PEC402	**Dynamics of Machines**	**04**

Objectives:

1. To prepare the students to understand the Mechanics of machines, principles and its application areas.
2. To familiarize the students 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 the students 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.
2. Design of four bar mechanisms, gyroscopic devices etc.
3. Determine the velocity and acceleration of various links in motion.
4. Illustrate different types of cams, followers with their different motions for their application.
5. Develop profiles of cams for engineering applications.
6. Illustrate various types of gears/ their terminology areas of application along with parameters pertaining to spur gears and gear trains.
7. Develop basic concepts pertaining to balancing/vibrations in evaluation of simple machine components.
8. Illustrate different types of clutches, brakes and dynamometers for evaluation of braking force.

Module	Contents	Hrs.
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).	**06**
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.	**08**
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.	**08**
04	**GEARS:** Introduction: Types of gears and applications, Gear terminology, condition for constant velocity ratio−conjugate profiles, profiles used in gears.	**08**

	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).	
05	5.1 **Balancing:** Introduction. Rotary masses: several masses in same plane, several masses in different planes. Balancing of reciprocating masses, primary balancing and secondary balancing. Balancing of locomotives− Variation of Tractive Effort, Swaying Couple and Hammer blow 5.2 **Vibrations:** Introduction−free vibrations; longitudinal, transverse and torsional vibrations. Dunkerly's equation, critical or whirling speed of shaft. Torsional vibrations of two rotor system-torsionally equivalent shaft.	**10**
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, braking of vehicles. Types of dynamometers, classification, Prony brake, Rope brake belt transmission dynamometers	**08**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

End Semester Examination:

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

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

Reference Books:

1. *Theory of Machines*, 3rd edition by Thomas Bevan, Pearson publication.
2. *Theory of Machines*, 11th Edition by P.L. Ballaney, Khanna Publications (1980).
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 & RC Stephen.
7. *Theory of Machines,*V. Ravi, PHI Learning publication (2011).

Course Code	Course Name	Credits
PEC403	**Manufacturing Engineering – II**	**04**

Objectives:

1. To familiarise the students with the fundamentals of molding process for metal, polymers and ceramics.
2. To familiarize the students with unconventional modern machine tools & manufacturing practices.
3. To prepare the students understand various metal joining processes and powder metallurgy.

Outcomes: Learner will be able to...

1. Illustrate the fundamentals of various non-conventional machining processes, capabilities with their application areas.
2. Demonstrate the knowledge pertaining to sheet metal fabrication/different types of joints with their trouble shooting.
3. Illustrate the concepts of various metal casting processes.
4. Demonstrate the basic knowledge of powder metallurgy Process.
5. Demonstrate the basic knowledge of plastic/ceramic molding processes.
6. Demonstrate the basic knowledge of fabrication of reinforced polymer/Polymeric composites with their applications.

Module	Contents	Hrs.
01	**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).	**08**
02	**Types of joints:** Mechanical & fabricated joints. Gas, Arc welding, Resistance, Radiation, Solid state and Thermo-chemical welding processes, soldering and brazing processes, welding defects, inspection & testing of welds, Safety in welding.	**08**
03	**Mold Theory:** Introduction to foundry, advantages and disadvantages. Pattern: Types, pattern making, allowances and materials. Core: types, core materials, core boxes, core sand. Molding: Types of sands, sand properties, sand control tests, sand preparation, sand molding techniques, special molding processes. Casting techniques: pressure die casting, squeeze casting, Thixo casting, Rheo Casting, investment, Shell molding and fettling. Defects and inspections.	**08**
04	**4.3 Powder Metallurgy:** Powder manufacturing methods; Powder Metallurgy Process. Advantages, disadvantages, and applications powder metallurgy. Case studies like Oil Impregnated Bearings.	**08**

05	**5.1 Plastics Molding:** Plastic material types, properties and processing methods. **5.2 Ceramics Molding:** Slip casting, Tape casting, Blow molding and extrusion of glass.	**08**
06	**Polymeric composites manufacturing processes:** Basic steps in composite manufacturing process, advantages, disadvantages of thermoset and thermoplastic composite processing. 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.	**08**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

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

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

Reference Books:

1. *Elements of Workshop Technology:* Machine Tools (Volume - 2), S. K. Hajra Choudhary, A. K. Hajra Choudhary, Nirjhar Roy, Media promoters (2010).
2. *A Course in Workshop Technology Vol. II (Machine Tools)*, B. S. Raghuwanshi, Dhanpat Rai & Co. (2001).
3. *Workshop Technology* Part 1, 2 and 3, W. A. J. Chapman, Taylor & Francis (1972)
4. *Production Technology* – HMT, Tata McGraw-Hill (1980).
5. *Composites Manufacturing* – Materials, product, and Process Engineering by Sanjay K. Muzumdar, CRC Press (2002).
6. *Manufacturing, Engineering and Technology*, 4th Ed – Kalpakjian, Schmid. Pearson (2005).
7. *Text Book of Production Technology* Vol. II, O. P. Khanna, Dhanpat Rai & Co. (2000).
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).
10. *Metal Casting*: Principles And Practice by Ramana Rao
11. *Welding Technology* by O. P. Khanna, Dhanpat Rai & Co.
12. *Friction Stir Welding and Processing*: by R. Mishra, S. De Partha, N. Kumar, Springer, (2014).

Course Code	Course Name	Credits
PEC404	**Fluid and Thermal Engineering**	**04**

Objectives:

1. To impart the fundamental knowledge of fluid, its properties and behavior under various conditions of internal and external flows.
2. To familiarize the students with the understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow.
3. To prepare the students with the ability to determine energy losses due to friction and pipe fittings.
4. To prepare the students learn about various modes of heat transfer, what governs the rate of heat transfer and importance of heat transfer.
5. To impart the ability to evaluate the gas turbine and compressor performance, with a strong emphasis on T-S property plane representations.

Outcomes: Learner will be able to...

1. Illustrate the different properties of fluids along with the solution of related problems.
2. Solve problems on Bernoulli's equation with its application.
3. Determine energy losses due to friction and pipe fittings.
4. Apply thermodynamic and fluid mechanics principles to evaluate the performance of compressors.
5. Apply thermodynamic and fluid mechanics principles to evaluate the performance of gas turbines.
6. Apply heat transfer principles to solve problems related to composite wall and heat exchangers.

Module	Contents	Hrs.
01	**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. **Fluid Statics:** Pascal's law, Pressure at a point, Hydrostatic law, Total Pressure and Centre of pressure, Hydrostatic forces on a plane (Horizontal, Vertical, Inclined) surfaces, **Buoyancy and Flotation:** Archimedes' Principle, Buoyancy, Centre of Buoyancy, Metacenter, Metacentric height, Stability of floating and submerged bodies. (Only Theory on Buoyancy and Flotation)	**10**
02	**Fluid Kinematics:** Eulerian and Lagrangian description of fluid motion, Types of fluid flow, Types of flow lines, continuity equation in Cartesian co-ordinates, 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)	**08**
03	**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.	**08**

04	**Reciprocating Air Compressors**: Classification, Terminology, Work and power calculations with and without clearance for single and two stage compression, Volumetric efficiency and FAD, Intercooling and advantages of Multistage compression.	**06**
05	**Gas Turbines:** Classification, Application, open cycle and closed cycle gas turbine. Calculation of thermal efficiency. Methods for improvements of thermal efficiency of gas turbine plants (Numericals only on calculating thermal efficiency and work ratio).	**06**
06	**Heat Transfer:** Modes of heat transfer, Conduction: Fourier's Law of heat conduction thermal conductivity, heat transfer coefficient (convective and overall), 1D steady state heat conduction through composite wall and hollow cylinder. Convection: Free and Forced convection. Heat Exchangers: Classification, LMTD for parallel flow and Counter flow. (Numericals only on 1D heat conduction and LMTD of heat exchanger).	**10**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

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

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

Reference Books:

1. *Fluid Mechanics & Hydraulic Machines*, 9th Edition by R. K. Bansal, Laxmi Publications
2. Fluid Machines and Fluid Power Engg., 7th Edition by D.S Kumar, S. K. Kataria publications
3. *Introduction to Fluid Mechanics, 4th Edition* by R. W. Fox, and A. T. McDonald, John Wiley and Sons.
4. *Fluid Mechanics, 3rd Edition* by Frank M. White, McGraw-Hill
5. *Thermal Engineering*, Mahesh Rathore, Tata McGraw Hill
6. *Thermal Engineering*, R. K. Rajput, Laxmi Publication
7. *Thermal Engineering*, Ballaney, Khanna Publication
8. A Course in Thermal Engineering, Domkundwar, Kothoraman and Khaju

Course Code	Course Name	Credits
PEC405	**Electrical and Electronics Engineering**	**04**

Objectives

1. To familiarize the students with different types of machines.
2. To familiarize the students with various performance curve for dc motor and induction motor.
3. To familiarize the students with various electronic switching devices.

Outcomes: Learner will be able to...

1. Illustrate the principles of operation with their main features of electric machines.
2. Develop the concepts of Electronics used in the application of controlling electrical machines.
3. Demonstrate the knowledge of Electrical and electronics engineering in processing industries.
4. Illustrate the application requirements for various types of motors
5. Demonstrate the details/applications of Transformers along with different power generation concepts.
6. Illustrate the fundamentals of Power electronics applications.

Module	Contents	Hrs
01	**DC Generator and DC Motor:** Construction, working principle and EMF equation of dc generator, Working principle of dc motor, Types of dc motor, Torque equation, Characteristics curves, Speed control of DC motor, Starters and types 3-point starter and 4 point starters, Problems based on torque equation and speed control of dc motor.	**08**
02	**Induction Motor(IM):** Construction and working principle of three phase IM ,Torque-speed characteristics, Torque equation, Problems based on torque equation and speed-torque characteristics, Working principle of single phase induction motor, Types of single phase IM, Applications	**08**
03	**Stepper motor** Principle of operation, Types of stepper motor, Applications of stepper motor	**04**
04	**Transformers :** Single Phase, Three Phase — construction, working principle, Use of Equivalent circuit, Efficiency and Voltage regulations of transformer, Problems based on efficiency and voltage regulation **Power system:** Basic power generation concepts, Transmission system, Fuse, Circuit breakers and its types, Distribution transformers, primary distribution system, Radial distribution system, ring main distribution system	**08**
05	**Operational Amplifiers:** OP –AMP, Characteristics of ideal OP-AMP, Comparison between ideal and practical op-amp, applications, Introduction to Boolean algebra, Boolean algebra law, Problems based on binary to decimal or octal or hexa- decimal and vice versa, logic gates, Multiplexers and de-multiplexers, Encoder and Decoders.	**10**

06	**Oscillators and power electronics** Principle of Oscillator, Positive Feedback in Oscillators, Conditions For Sustained Oscillations(Barkhausen criteria), Tuned Collector Oscillator, Phase Shift Oscillator, Hartley Oscillator, **Power Electronics** Characteristics of SCR, Diac and Triac, Single Phase Half-Wave Circuit With R-L Load, Freewheeling Diode, Full Wave Controlled Rectifier.	**10**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

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

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

Reference Books:

1. Bimbhra P.S., *Electric Machinery*, Khanna Publisher,
2. G.K. Dubey, *Fundamentals of electrical drives*, Narosa Publications
3. Nagrath I.J., Kothari D.P., *Electric Machines*, TMH Publications
4. M H Rashid, Power *electronics*
5. *Power system*, V K Mehta.

Course Code	Course Name	Credits
PEL401	**Dynamics of Machines Laboratory**	**01**

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 the students to learn as to how to use graphical methods to compute velocity and acceleration in mechanisms.

Outcomes: Learner will be able to ….

1. Compute the natural frequencies 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. Carryout Cam analysis.
6. Demonstratethe 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	Coriollic 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.

Oral Examination:

1. Oral examination shall be conducted based on term work and the syllabus content.
2. Examiners are expected to give a small task or ask questions either to evaluate the understanding of basic fundamentals or to evaluate their capability of applying basic theory to practical applications.

Course Code	Course Name	Credits
PEL402	**Fluid Mechanics and Thermal Engineering Laboratory**	**01**

Objectives:

1. To prepare the students understand Bernoulli's theorem and study its applications.
2. To familiarize the students with the concept of stability of floating bodies.
3. To prepare the students compute Reynolds' number and observe the laminar, transitional and turbulent flow.
4. To impart the knowledge of studying energy losses in a piping system.
5. To demonstrate the concepts discussed in the Heat Transfer course.
6. To prepare the students with the knowledge of Fourier law of heat conduction and its application.
7. To impart the students with the knowledge of working and performance of reciprocating compressors.
8. To familiarize the students with the effectiveness of heat exchangers.

Outcomes: Learner will be able to...

1. Apply Bernoulli's theorem to determine the Cd / flow rate by using Orifice meter and Venturi meter.
2. Illustrate the floatation characteristics.
3. Determine metacentric height of ship model.
4. Determine critical Reynolds number for laminar, transition and turbulent flow of fluids.
5. Determine Major/Minor losses in piping systems.
6. Determine thermal conductivity and heat transfer coefficient of materials.
7. Improve effectiveness of heat exchangers.
8. Improve effectiveness of reciprocating compressor systems.
9. Determine the emissivity of the surface.

Exp. No.	List of Experiments
01	To determine the Cd of Venturi meter/ Orifice meter.
02	To determine Metacentric Height of Ship Model.
03	To Verify Bernoulli's Theorem.
04	To determine types of flow by Reynolds's Experiment.
05	To determine Major losses/Minor in pipes.
06	To determine the thermal conductivity of a given metal rod.
07	To determine the overall heat transfer coefficient of a composite wall.
08	To determine the emissivity of the given surface.
09	To determine LMTD for Parallel flow and Counter flow heat exchanger.
10	To determine the performance of single stage / multi stage air compressor test rig.

Term Work

Term work shall consist of at least one assignment from each module of syllabus and a minimum of 06 experiments mentioned above (minimum three experiments each from Fluid Mechanics and Thermal sections) and a detailed report based on an Industrial visit to a Thermal power plant.

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

Laboratory work (Experiment/ programs and journal):	12 marks
Assignments	: 06 marks
Industrial visit Report	: 02 marks
Attendance (Theory and Practical)	: 05 marks

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

Course Code	Course Name	Credits
PEL403	**Electrical and Electronics Engineering Laboratory**	**01**

Objectives

1. To familiarize the students with different types of machines.
2. To familiarize the students with the various performance curve for dc motor and induction motor.
3. To familiarize the students with various electronic switching devices.

Outcomes: Learner will be able to...

1. Identify the principles of operation along with features of electric machines.
2. Develop the concepts of Electronics used in controlling electrical machines.
3. Use their knowledge of Electrical and electronics engineering in processing industries.
4. Understand and comprehend application requirements for various types of motors.
5. Use different power generation concepts.
6. Demonstrate the fundamentals of Power electronics applications in industry.

Exp. No.	List of Experiments
01	Speed control of dc shunt motor.
02	Load characteristics of series generator.
03	Load characteristics of 3phase induction motor.
04	No-load and blocked rotor test of induction motor.
05	Integrator and differentiator using op-amps.
06	Multiplexer and DE multiplexer.
07	SCR characteristics curve.
08	TRIAC characteristics curve
09	Logic gates.
10	Hartley oscillators.

Term Work

Term work shall consist of any seven experiments from sr,no 1 to 10. In all total 9 experiments.

Experiments (1to 10) : 10 marks

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

Course	Course Name	Credits
PEL404	**Manufacturing Process - II Laboratory**	**02**

Objectives:

1. To prepare the students practice machining of flat surfaces on shaping and grinding machines.
2. To impart the practical knowledge of milling, boring and thread cutting operations.

Outcomes: Learner will be able to:-

1. Perform machining of composite jobs involving different operations.
2. Apply significance of maintaining tolerance level during machining to facilitate assembly requirement.
3. Practice basic understanding of safe machine shop practices and safe working.
4. Select the right tool and set up the machine, job and tool for machining practices.
5. Demonstrate practical aspects involved in operation and applications of milling, shaping, grinding, boring etc.

Sr no	Experiments/Job
01	One assembly job employing operations on lathe, precision turning, screw cutting, boring etc. and involving the use of shaping, milling and grinding operations. OR One job on any unconventional machining process.
02	Demo on machining of Glass Fibre Reinforcement Plastic (GFRP) composite material, Drilling and edge milling operation are to be studied (Any of the commercial available GFRP/Epoxy plates are to be used).

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 the practical aspects of syllabus mentioned in the subject of Manufacturing Engineering- II also needs to be submitted.

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

Laboratory work (Assembly Job)	: 30 marks
Demo on machining of Composite material	: 10 marks
Industrial Visit Report	: 05 Marks.
Attendance (practicals)	: 05 Marks.

Practical Examination:

Practical examination will be held for 4 hours and shall consist of a job containing a minimum of 4 operations including precision turning, boring, screw cutting, drilling, milling, shaping, grinding etc.