AC 29/4/2013 Item no. 4.82

UNIVERSITY OF MUMBAI

Revised Syllabus

Program- Bachelor of Engineering

Course -Production Engineering

(Second Year – Sem. III & IV)

Under

FACULTY OF TECHNOLOGY

(As per Credit Based Semester and Grading System from 2013-14)

Deans 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 (PEO's) and give freedom to affiliated Institutes to add few (PEO's) and course objectives and course outcomes 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.

Semester 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 3-2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

Chairman's Preamble:

Engineering education in India is expanding and is set to increase manifold. Themajor 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 University of the Mumbai, I am happy to state here that, the Program Educational Objectives were finalized in a brain storming session, which was attended by more than 20 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.
2. To prepare the Learner to use modern tools effectively in order to solve real life problems.
3. To prepare the Learner for a successful career in Indian and Multinational Organisations and to excel in their Postgraduate studies.
4. To encourage and motivate the Learnerin the art of self-learning.
5. To inculcate a professional & ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process.

In addition to the above, 2 to3 more program educational objectives of their own may be added by affiliated Institutes.

In addition to Program Educational Objectives, for each course of undergraduate program, objectives and expected outcomes from the point of view of a learner 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 stake holders.

Dr. S. M. Khot
Chairman, Board of Studies in Mechanical Engineering, University of Mumbai

Program Structure for B. E. Production Engineering

S. E. (Production) Sem.-III

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
PEC301	Applied Mathematics-III[@]	4	--	4	--	4
PEC302	Strength of Materials	4	2	4	1	5
PEC303	Manufacturing Engineering-I	4	--	4	--	4
PEC304	Fluid Mechanics and Fluid Power	4	2	4	1	5
PEL305	Computer Aided MachineDrawing[+]	--	2*+4	--	3	3
PEL306	Data Base Information Retrieval System [#]	--	2*+2	--	2	2
PEL307	Workshop Practice-III	--	4	--	2	2
Total		**16**	**18**	**16**	**9**	**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.					
PEC301	Applied Mathematics-III[@]	20	20	20	80	03	--	--	100
PEC302	Strength of Materials	20	20	20	80	03	25	--	125
PEC303	Manufacturing Engineering-I	20	20	20	80	03	--	--	100
PEC304	Fluid Mechanics and Fluid Power	20	20	20	80	03	25	--	125
PEL305	Computer Aided Machine Drawing[+]	--	--	--	--	--	50	50	100
PEL306	Data Base &Information Retrieval System[#]	--	--	--	--	--	50	50	100
PEL307	Workshop Practice-III	--	--	--	--	--	50	--	50
Total		**--**	**--**	**80**	**320**	**--**	**200**	**100**	**700**

* Theory for entire class to be conducted, [@] Course common to Mech/Auto/Prod/Civil, [+]Course common to Mech/Auto/Prod, [#] Course common to Mech/Auto/Prod/Civil

S. E. (Production) Sem.-IV

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
PEC401	Applied Mathematics-IV[@]	4	--	4	--	4
PEC402	Theory of Machines	4	2	4	1	5
PEC403	Manufacturing Engineering-II	3	--	3	--	3
PEC404	Electrical and Electronics Engineering	4	2	4	1	5
PEC405	Applied Thermodynamics	3	--	3	--	3
PEC406	Materials Technology	4	2	4	1	5
PEL307	Workshop Practice-IV	--	4	--	2	2
Total		**22**	**10**	**22**	**5**	**27**

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)	Term Work	Pract. /oral	Total
		Test1	Test 2	Avg.					
PEC401	Applied Mathematics-IV[@]	20	20	20	80	03	--	--	100
PEC402	Theory of Machines	20	20	20	80	03	25	--	125
PEC403	Manufacturing Engineering-II	20	20	20	80	03	--	--	100
PEC404	Electrical and Electronics Engineering	20	20	20	80	03	25	25	150
PEC405	Applied Thermodynamics	20	20	20	80	03	--	--	100
PEC406	Materials Technology	20	20	20	80	03	25	--	125
PEL307	Workshop Practice-IV	--	--	--	--	--	50	50	100
Total		**--**	**--**	**120**	**480**	**--**	**125**	**75**	**800**

[@] Course common to Mech/Auto/Prod/Civil

Course Code	Course/Subject Name	Credits
PEC301	**Applied Mathematics –III[@]**	**4**

Objectives:

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

Outcomes: Learner should be able to:-

1. Demonstrate the ability of using Laplace Transform and Fourier Series in solving the Ordinary Differential Equations and Partial Differential Equations.
2. Identify the analytic function, harmonic function, orthogonal trajectories and to apply bilinear transformations and conformal mappings.
3. Identify the applicability of theorems and evaluate the contour integrals.

Module	Details	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) $L\{t^n f(t)\}, L\left\{\frac{f(t)}{t}\right\}, L\left\{\int_0^t f(u)du\right\}, L\left\{\frac{d^n f(t)}{dt^n}\right\}$ Heaviside Unit step function, Direct Delta function, Periodic functions and their Laplace Transform.	6
2	**Inverse Laplace Transform** 2.1 Linearity property, use of theorems to find inverse Laplace Transform, Partial fractions method and convolution theorem. 2.2 Applications to solve initial and boundary value problems involving ordinary differential equations with one dependent variable.	5
3	**Complex variables:** 1.1 Functions of complex variable, Analytic function, necessary and sufficient conditions for $f(z)$ to be analytic (without proof), Cauchy-Riemann equations in polar coordinates. 1.2 Milne- Thomson method to determine analytic function $f(z)$ when it's real or imaginary or its combination is given. Harmonic function, orthogonal trajectories. 1.3 Mapping: Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations such as Rotation and magnification, invertion and reflection, translation.	10
4	**Complex Integral** 4.1 Line integral of a function of a complex variable, Cauchy's theorem for analytic function, Cauchy's Goursat theorem (without proof), properties of line integral,Cauchy's integral formula and deductions. 4.2 Singularities and poles: 4.3 Taylor's and Laurent's series development (without proof) 4.4 Residue at isolated singularity and its evaluation. 4.5 Residue theorem, application to evaluate real integral of type $\int_0^{2\pi} f(\cos\theta, \sin\theta)\, d\theta$, & $\int_{-\infty}^{\infty} f(x)\, dx$	10

5	**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 & $2l$. 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
6	**Partial Differential Equations** 4.1 Numerical Solution of Partial differential equations using Bender-Schmidt Explicit Method, Implicit method(Crank- Nicolson method) Successive over relaxation method. 4.2 Partial differential equations governing transverse vibrations of an elastic string its solution using Fourier series. 4.3 Heat equation, steady-state configuration for heat flow. 4.4 Two and Three dimensional Laplace equations.	10

[@] Course common to Mech/Auto/Prod/Civil

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 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 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 course project.

Reference Books:

1. Elements of Applied mathematics, P N & J N Wartikar, Pune VidyarthiGruhaPrakashan
2. Higher Engineering Mathematics, Dr B. S. Grewal, Khanna Publication
3. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
4. Integral Transforms and their Engineering Applications, Dr B. B. Singh, Synergy Knowledgeware, Mumbai
5. Complex Variables: Churchill, Mc-Graw Hill
6. Numerical Methods, Kandasamy, S. Chand & CO.

Course Code	Course/Subject Name	Credits
PEC302	**Strength of Materials**	**4+1**

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 should be able to:-

1. Understand stress-strain behavior of various materials under load.
2. Select various materials for machine parts.
3. Understand the concept of Bending moment, Shear force, Torsion and Moment of inertia in designing of various machine parts and components.

Module	Details	Hrs.
01	**1.1 Direct stress and direct strain:** Types of forces (External forces, Inertia forces, Centrifugal forces, Magnetic forces, Thermal load); 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.	08
02	2.1 **Introduction to Moment of Inertia:** Theorem of parallel and perpendicular axis, Polar Moment of Inertia. 2.2 **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.	12
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 energydue to axial loads gradually applied transverse loads and under impact load.	06

Term Work:

Term work shall consist of:

1. Assignments: On topics drawn from syllabus [At least 1 assignment per module].
2. Minimum 06 experiments from the list have to be conducted and presented with inferences.

List of Experiments:

1. Tension test on Mild steel bars (Stress strain behavior, Modulus of elasticity determination).
2. Tension test on Tor Steel bar.
3. Shear test on Mild steel, Aluminium and Brass bars.
4. Flexure test on wood (Determination of bending stress of wooden beam).
5. Deflection test (single central point load and two point load).
6. Izod impact Test on Mild steel / Aluminium / Cast iron / Brass.
7. Charpy impact Test on Mild steel / Aluminium / Cast iron / Brass.
8. Torsion test on mild steel bar/ cast iron bar.

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

Laboratory work (Experiments/Assignments): 20 Marks.
Attendance (practicals&theory): 05 Marks.

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 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 course project.

ReferenceBooks:

1. *Mechanics of Materials*,Eigth Edition by Gere ,Pretice Hall (1984).
2. *Engineering Mechanics of Solids, 2nd Edition by* E.P. Popov, Prentice Hall (1998).
3. *Strength of Materials,* 4th edition by Singer and Pytel , Harper and Row Publication.
4. *Elements of Strength of Materials,* Timoshenko and Young – Strength of materials, CBS Publication.
5. *Mechanics of Materials,* 4th Edition by Beer and Johnston, McGraw Hill Publication.
6. *Strength of Materials*, S B Junnarkar.
7. *Strength of Materials*, R K Rajput , S. Chand Publication (1996).
8. *Strength of materials*, S S Rattan– Tata McGraw Hill Publication Co. Ltd (2008).
9. *Strength of Materials,* Dr. R. K. Bansal ,Laxmi publication Pvt. Ltd., New Delhi (2010).
10. *Strength of Materials*,6thEdition byS.Ramamrutham, Dhanpatrai Publication (1981).

Course Code	Course/Subject Name	Credits
PEC303	**Manufacturing Engineering – I**	**4**

Objectives:

1. To study machine tools and basic machining processes like turning, drilling, milling, broaching etc.
2. To know the fundamentals of various metal cutting practices, fundamentals of machine tools and processes.
3. To study manufacturing processes for plastics.

Outcomes: Learner should be able to:-

1. Understand features and applications of lathe, milling, drilling and broaching machines.
2. Understand manufacturing processes for plastics.
3. Understand features and applications of reciprocating machine tools like shaper, planer and slotter.

Module	Details	Hrs.
01*	1.1 **Classification of Manufacturing Processes**:Definition, need and classification of machine tools based on relative motion between tool and work piece. Classification and nomenclature of cutting tools like single point cutting tool, twist drill and milling cutters. 1.2**Cutting Off Machines**: Power hack−saws, band saw and circular saw, friction saw and abrasive cutting off machines, field of applications and limitations. 1.3 **Turning Machines and Processes:** Lathe as general purpose turning machine, principle of generating surfaces, functions of lathe, principle parts, Gear drive, feed mechanism, lathe accessories and attachments. Lathe operations, taper turningmethods, thread cutting. Capstan and turret lathes: difference between capstan and turret lathe, stopper rod mechanism (turret), tool layout for simple components like bolt, nut, pin, shaft etc. Machining time in turning.	12
02*	**Drilling & Boring machines and Processes:** Drilling machine types−sensitive, upright, radial, gang, multiple spindle, work and tool holding devices, Drilling machine operations, Counter boring, Spot facing, Countersinking, types and materials of drills, twist drill nomenclature. Machining time in drilling. Deep hole drilling (only fundamentals to be covered): Gun drills. Boring Machine types- horizontal, vertical, jig, fine and deep hole boring machines.	07
03*	**Reciprocating Machine Tools:** Shaping machines: types of shapers, working of shaping machine, quick return mechanisms, shaper operations, machining time. Planning machines: types of planning machines, planer mechanisms, feed mechanisms, work holding devices, shaper vs. planer. Slotting machines types of slotting machines.	11
04*	**Milling Machines :** Types of milling machines−column and knee type, fixed bed type, planer type and special type, milling processes conventional and climb milling, milling cutters types- peripheral, face and shell milling cutters, geometry & materials of milling cutters attachments, special accessories for milling and universal dividing head. Indexing methods – direct, plain, compound and differential indexing. Calculations of machining time and copy milling machines.	10

05*	**Broaching Machines:** Broaching process, elements of typical internal broach, types of broaches, broaching machines-vertical, horizontal, surface and continuous broaching vs. other processes.	04
06	6.1**Moulding with plastics:** Basic concepts related to Injection Molding, Compression moulding, Transfer moulding, Blow Molding, Rotational Molding, Thermoforming and Extrusion. (coverage should be limited to outline of moulding equipment, mould/die and moulding cycle). 6.2**Moulding with ceramics:** Blow moulding and extrusion of glass.	08
*** Machine tool specifications as per IS.**		

Theory Examination:

1. Question paper will comprise of total 6 questions, each question 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 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 course project.

Reference Books:

1. *Elements of Workshop Technology: Machine Tools (Volume – 2)*by S. K. HajraChoudhary, A. K. HajraChoudhary, Nirjhar Roy, Media promoters (2010).
2. *A Course in Workshop Technology Vol. II (Machine Tools)* by B. S. Raghuwanshi, DhanpatRai& 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*bySeropeKalpakjian, Steven R. Schmid, published by Pearson (2005).
6. *A Text Book Of Production Technology Vol. II* by O. P. Khanna, DhanpatRai 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* bySeropeKalpakjian, Steven R. Schmid, published by Pearson (2007).

Course Code	Course/Subject Name	Credits
PEC304	**Fluid Mechanics and Fluid Power**	**4+1**

Objectives:

1. To impart understanding of fluid mechanics, including mass, energy and momentum balances etc.
2. To set up and solve fluid mechanics problems both analytically and numerically, wherever appropriate.
3. To develop and understand the terms and concepts related to fluid power.
4. To examine related concepts on distributions systems, hydraulic flow in pipes, sources of hydraulic power, rotary & linear actuators and control components in fluid power systems.

Outcomes: Learner should be able to:-

1. Gain the knowledge of concepts of fluid mechanics and its application in practice.
2. Understand the use and accordingly develop the ability to apply hydraulic schematics on fluid power trainer units.
3. Understand the fluid power terms, concepts and calculations.

Module	Details	Hrs.
01	**Fluid Properties and Fluid Statics**: Concept of fluid and flow, continuum concept, properties of fluids, Pascal's law, hydrostatic equation, hydrostatic forces on plane and curved surfaces, Buoyancy and the concept of stability of floating and submerged bodies.(No numerical on Buoyancy and Floatation)	10
02	2.1 **Fluid Kinematics**: Eulerian and Lagrangian description of fluid flow; stream, streak and path lines; types of flows, flow rate and continuity equation.(No numerical on Fluid Kinematics) 2.2 **Fluid dynamics**: Euler's and Bernoulli's equations, Application of Bernoulli's equation; Pitot tube, Venturi meter and Orifice meter (No derivations), mentum equation and its application on force on pipe bend.	08
03	3.1 **Dynamics of Viscous Flow**: Introduction to Laminar and Turbulent flow. Flow regimes and Reynold's number, Introduction to Navier Stokes equation, Fully developed flow through circular Tube/Pipe (Hagen Poisuille flow). 3.2 **Flow Through Pipes**: Major and minor losses in pipes, Darcy Weisbach equation, hydraulic gradient and total energy lines, pipes in series and parallel, branched pipes and equivalent pipe problems	10
04	4.1 **Introduction to Fluid power**: Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids General types of fluids, Fluid power symbols. 4.2 **Hydraulic Pumps and Motors**: Introduction, variable capacity and fixed capacity types gear, vane and piston pumps, pump performance. 4.3 **Fluid Power Actuators**: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, Double acting special cylinders, Rotary actuators – Fluid motors, Gear, Vane and Piston motors	08
05	**Control Components in Hydraulic Systems**: Directional Control Valves, Check valve – Classification, constructional features and symbolic representation. Pressure control valves – Constructional features and symbolic representations (Pressure relief valve, pressure reducing valves, sequence valves, Unloading valve and counter balance valve). Flow control valves – Constructional features and symbolic representations (Needle	08

	valve, Pressure compensated flow control valve and Pressure & temperature compensated flow control valve).	
06	**Hydraulic Circuit**: Control of single and double acting hydraulic cylinders. Meter-in, Meter-out and Bleed-off circuit. Regenerative circuit, counter balance valve circuit, sequencing circuits, Fail and safe circuit and Fast approach and slow transverse circuit	08

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 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 course project.

Term Work:

Term work shall consist of:

1. Assignments: on topics drawn from syllabus.
2. Minimum six experiments have to be conducted and presented with inferences.

List of Experiments (Any Six)

1. To determine the Cd of Venturi meter.
2. To determine the Cd of Orifice meter.
3. To determine velocity of flow in pipe by using Pitot tube.
4. To determine Metacentric Height of Ship Model.
5. To Verify Bernoulli's Theorem.
6. To determine types of flow by Reynold's Experiment.
7. To determine Major losses in pipes.
8. To determine Minor losses in pipes.

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

- Laboratory work (assignments/ Practicals): 20 Marks.
- Attendance (practical & theory): 05 Marks.

Reference Books:

1. *Fluid mechanics and hydraulic machines,* R. K. Rajput, S Chand (2008).
2. *Fluid Mechanics & Hydraulic Machines*, 9th Edition by R.K.Bansal, Laxmi Publications (2005).
3. *Fluid Machines and Fluid Power Engg.*, 7th Edition by D.S Kumar, S K Kataria publications (2009).
4. *Introduction to Fluid Mechanics*, 4th Edition by R. W. Fox, and A. T. McDonald, John Wiley and Sons, Inc., (1992).
5. *Fluid Mechanics*, 3rd Edition by Frank M. White, McGraw-Hill, Inc., (1994).
6. *Industrial Hydraulics Manual,* Sperry & Vickers Co.
7. *Hydraulic and Pneumatic Power,* H. L. Stewart
8. *Hydraulic and Pneumatic controls,*ShanmugaSundaram.K, Chand& Co. (2006).

Course Code	Course/Subject Name	Credits
PEL305	**Computer Aided Machine Drawing**$^{+}$	**3**

Objectives:

1. To gain insight of visualizing an object and convert it into a drawing.
2. To gain knowledge of conventional representation of various machining and mechanical details as per IS.
3. To become conversant with 2-D and 3-D drafting.

Outcomes: Learner should be able to:-

1. Visualize and prepare detailed drawing of a given object.
2. Draw details and assembly of mechanical systems.
3. Read and interpret a given drawing.
4. Create 2-D and 3-D models using standard CAD software with manufacturing considerations.

Module	Details	Hrs.	
		Th.	Pract.
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.	08	--
	1.2**Machine Elements:** Preparation of 2-D drawings of standard machine elements (nuts, bolts, keys, cotter, screws, spring etc.)	--	04
	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.	01	--
02	2.1 **Limits fits and tolerances:** Dimensioning with tolerances indicating various types of fits in details and assembly drawings, Types of assembly drawings, part drawings, drawings for catalogues and instruction manuals, patent drawings, drawing standards.	04	--
	2.2**Details and assembly drawing**: Introduction to the unit assembly drawing, steps involved in preparing assembly drawing from details and vice-versa, Sequence in assembly.	02	--
	2.3 Preparation of details and assembly drawings of *any two*from: Clapper block, Single tool post, Lathe and Milling tail stock.	--	05
	2.4 Cotter, Knuckle joint, Keys and Couplings: keys-sunk, parallel woodruff, saddle, feather etc. Coupling: simple, muff, flanged.	03	--
	2.5 Protected flange coupling, Oldham's coupling, Universal coupling.	--	06
03	3.1**Preparation of details and assembly drawings of Bearings:** Simple, solid, Bushed bearing. I.S. conventional representation of ball and roller bearing.	01	--
	3.2 Pedestal bearing, footstep bearing	--	04
04	4.1**Preparation of details and assembly drawings of pulleys, Pipe joints:**ClassificationofPulleys, pipe joints	02	--
	4.2 Pulleys: Flat belt, V-belt, rope belt, Fast and loose pulleys.	--	05
	4.3 Pipe joints *(any two)*: Flanged joints, Socket and spigot joint, Gland and stuffing box, expansion joint.	--	06

05	5.1 **Preparation of details and assembly drawings of Valves, I.C. Engine parts:** Types of Valves, introduction to I.C. Engine 5.2 Preparation of details and assembly drawings of *(any three):* Air cock; Blow off cock, Steam stop valve, Gate valve, Globe valve, Non return Valve, I.C. Engine parts: Piston, Connecting rod, Cross head, Crankshaft, Carburetor, Fuel pump, injector, and Spark plug.	02 --	-- 08
06	6.1 **Preparation of details and assembly drawings of Jigs and Fixtures:** Introduction to Jigs and fixtures, 6.2 Jigs and Fixtures (*any two from each*) 6.3 Reverse Engineering of a physical model: disassembling of any physicalmodel 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	01 -- --	-- 06 04

[+] Course common with Mech/Auto/Prod

Term work:

A. Minimum two questions from theory part of each module should be solved as a home work in A-3 size sketch book.

B. A-3 size Printouts/plots of the problems solved in practical class from the practical part of each module

Problems from practical parts of each module should be solved using standard CAD packages like IDEAS, PRO-E, CATIA, Solid Works,Inventor etc.

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

Home work sketch book	…….	20 marks
Printouts/Plots	…….	20 marks
Attendance (Theory and practicals)	…….	10 marks

Practical/Oral examination:

1. Practical examination duration is 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 views of assembly from given 2-D detailed drawing.
   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	……	20 marks
Session-II	……	20 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. *A text book of Machine Drawing*, Laxminarayan&M.L.Mathur.(Jain brothers Delhi).
3. *Machine Drawing*, Kamat&Rao.
4. *Machine Drawing,* M.B.Shah
5. *A text book of Machine Drawing*,R.B.Gupta(Satyaprakashan, Tech. Publication)
6. *Machine Drawing*, K.I.Narayana, P.Kannaiah and K.Venkata Reddy.
7. Machine Drawing, Sidheshwar and Kanheya
8. *Autodesk Inventor 2011 for Engineers and Designers*,ShamTickoo,SurinderRaina (dreamtech Press).
9. *Engineering Drawing*, P J Shah
10. *Engineering Drawing*, N D Bhat

Subject Code	Subject Name	Credits
PEL306	**Database & Information Retrieval system#**	**02**

Objective:

1. Learn and practice data modeling using the entity-relationship and developing database designs.
2. Understand the use of Structured Query Language (SQL) and learn SQL syntax.
3. Apply Graphical User Interface techniques for retrieval of information from database.
4. Understand the needs of database processing and learn the techniques for controlling the consequences of concurrent data access.

Outcome: The student should be able to:-

1. To describe data models and schemas in DBMS.
2. To understand the features of database management systems and Relational database.
3. To use SQL- the standard language of relational databases.
4. To understand the functional dependencies and design of the database.
5. To understand the graphical user Interface design.

Module	Detailed content	Hours
1	**Introduction Database Concepts:** What is a database?, Characteristics of databases, 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 system architecture, Database Administrator,	02
2	**Entity–Relationship Data Model :** Introduction,Benefits of Data Modeling, Types of Models,Phases of Database Modeling, The Entity-Relationship (ER) Model,Generalization, Specialization and Aggregation,Extended Entity-Relationship (EER) Model.	04
3	**Relational Model and Algebra :** Introduction , Mapping the ER and EER Model to the Relational Model , Data Manipulation , Data Integrity ,Advantages of the Relational Model, Relational Algebra , Relational Algebra Queries, Relational Calculus.	04
4	**Structured Query Language (SQL) :** Overview of SQL , Data Definition Commands,Set operations , aggregate function , null values, , Data Manipulation commands, Data Control commands , Views-Using Virtual Tables in SQL, Nested and complex queries .	04
5	**Introduction to Transactions Management and Concurrency:** Transaction concept, Transaction states, ACID properties, Implementation of atomicity and durability, Concurrent Executions, Serializability, Recoverability, Concurrency Control: Lock-based , Timestamp-based , Validation-based protocols, Deadlock handling, Recovery System: Failure Classification, Storage structure, Recovery & atomicity, Log based recovery, Shadow paging.	04

6	6.1**Graphical User Interface** : Murphy 's Law of G U I Design, Features of G U I, Icons and graphics, Identifying visual cues, clear communication, color selection, GUI standard, planning GUI Design Work. 6.2**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, Using and creating ActiveX Components, dynamic 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

* 2hours theory can be taught to entire class followed by 2hours practical in batches
# Course common with Mech/Auto/Prod/Civil

Term Work:

Assign minimum two case studies for each student to perform on their case studies following experiments-

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 marks for Term work shall be as follows:

Laboratory work (programs/printouts): 40 marks
Attendance (Theory and practicals): 10 marks

Practical/Oral Examination:

1. Practical examination duration is 2hours and questions to be based on the list of experiments mentioned in Term Work.
2. Evaluation of practical examination to be done by examiner based on the printout of students work
3. Practical examination: 40 marks, oral examination based on practical examination: 10 marks
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*, 6th Edition by Korth, Slberchatz,Sudarshan, McGraw – Hill
3. *GUI Design for dummies*,IDG books.
4. *Visual Basic 2005*, How to program (3RD Edition) Deitel&Deitel, Pearson Education.
5. *SQL and PL/SQL for Oracle 10g*,Dr. P.S. Deshpande,Black Book, Dreamtech Press
6. *Introduction to Database Management*,Mark L. Gillenson, PaulrajPonniah,Weley
7. *Oracle for Professional*", SharamanShah 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/Subject Name	Credits
PEL307	**Workshop Practice-III**	**2**

Objectives:

1. To practice lathe operations like turning, taper turning, thread cutting etc.
2. To practice machining of flat surfaces on shaping machine.
3. To understand various concepts related to moulding processes of plastic materials.

Outcomes: Learner should be able to:-

1. Perform different types of lathe operations like cylindrical turning, thread cutting etc.
2. Perform Shaping operations for flat surfaces like Keyway cutting and T-slot cutting.
3. Understand difference between metals and plastics, considering their applications.

Term Work:

1. One job on plain and taper turning.
2. One job on precision turning, taper turning and screw cutting.
3. One job on shaping machine to make horizontal and inclined surfaces.
4. One simple exercise on welding – preparing a component comprising of welding joints.
5. 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.)

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

- Laboratory work (experiments): 40 Marks.
- Attendance (practicals): 10 Marks.

Course Code	Course/Subject Name	Credits
PEC401	**Applied Mathematics –IV@**	**4**

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 problems.
3. To study the basic principles of Vector analyses, statistics and probability and complex integration.
4. To prepare the students with a strong foundation for competitive exams/professional practices.

Outcomes: Learner should be able to:-

1. Use matrix algebra with its specific rules to solve the system of linear equations.
2. Understand and apply the concept of probability distribution and sampling theory to engineering problems.
3. Apply principles of vector differential and integral calculus to the analysis of engineering problems.
4. Identify, formulate and solve engineering problems.

Module	Details	Hrs
01	**Matrices:** 1.1 Brief revision of vectors over a real field, inner product, norm, Linear Dependance and Independence and orthogonality of vectors. 1.2 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) Functions of a square matrix, Minimal polynomial and Derogatory matrix.	09
02	**Vector calculus:** 2.1 Brief revision of Scalar and vector point functions, Gradient, Divergence and curl. 2.2 Line integrals, Surface integrals, Volume integrals. 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)	11
03	**Non Linear Programming:** 3.1 Unconstrained optimization, problems with equality constraints Lagranges Multiplier method. 3.2 Problem with inequality constraints Kuhn-Tucker conditions.	06
04	**Probability Distributions:** 4.1 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expected value, Variance. 4.2 Probability Distributions:Binomial, Poisson and Normal Distributions. For detailed study.	10
05	**Sampling Theory:** 5.1 Sampling distribution. Test of Hypothesis. Level of significance, critical region. One tailed and two tailed tests. Interval Estimation of population parameters. Large and small samples.	10

	5.2 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. 5.3 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. 5.4 Analysis of Variance(F-Test): One way classification, Two-way classification(short-cut method) 5.5 Chi-square distribution and its properties, Test of the Goodness of fit and Yate's correction.	
06	**Correlation and Regression:** 6.1 Correlation,Co-variance, Karl Pearson Coefficient of Correlation & Spearman's Rank Correlation Coefficient (non-repeated & repeated ranks) 6.2 Regression Coefficients & lines of regression	06

[@] Course common to Mech/Auto/Prod/Civil

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 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 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 course project.

Reference Books:

1. *Fundamentals of Mathematicals Statistics*, S C Gupta & V K Kapoor, S. Chand & Co.
2. *Higher Engineering Mathematics,*Dr B. S. Grewal, Khanna Publication.
3. *Elements of Applied mathematics*, P N & J N Wartikar, Pune VidyarthiGruhaPrakashan.
4. *Advanced Engineering Mathematics*, E Kreyszing, Wiley Eastern Limited.
5. *Operations Research*, S.D. Sharma, S. Chand & CO.
6. *Vector Analysis,* Murray R. Spiegel, Shaum Series.
7. *Operations Research*, Kantiswarup, Manmohan and P K Gupta, S. Chand & CO.

Course Code	Course/Subject Name	Credits
PEC402	**Theory of Machines**	**4+1**

Objectives:

1. To study Mechanics of machines, principles and also it's related application areas.
2. To familiarize with various types of Mechanisms and Motion analysis.
3. To develop problem solving capabilities in the topics of velocity and acceleration.
4. To study 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: The learner should able to:-

1. Understand the rigid body dynamics (kinematics) of linkages, design of four bar mechanisms, gyroscopic devices etc.
2. Understand the direct relevance of problems discussed in engineering practice.
3. Understand validation of certain theoretical models thorough laboratory experiments.

Module	Details	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 simple mechanisms− pantograph, straight line motion mechanism, automobile steering mechanism; 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.	09
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. 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 numericals).	09
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 vibrationsof two rotor system-torsionally equivalent shaft. Free torsional vibrations of a geared system. (Damped and forced vibrations are excluded)	12

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

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 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 course project.

Term Work:

Term work shall consist of

1. Assignments: On topics drawn from syllabus [at least 1 from each module].
2. Practical: Based on topics from syllabus, experiments are to be conducted and presented with inferences.

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

Laboratory work (Experiments and Assignments): 20Marks.

Attendance (Theory and Practicals): 05 Marks.

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/Subject Name	Credits
PEC403	**Manufacturing Engineering – II**	**3**

Objectives:

1. To study machine tools and basic machining processes.
2. To know the fundamentals of metal cutting.
3. To familiarize with modern machine tools & manufacturing practices.
4. To study manufacturing processes for polymeric composites.

Outcomes: Learner should be able to:-

1. Understand features and applications of automats, NC & CNC turning and machining centers.
2. Understand gear and thread production processes.
3. Understand and distinguish between the conventional and unconventional machining processes.

Modules	Details	Hrs.
01	1.1 **Automats:** Major classification, horizontal and vertical, single spindle and multi-spindle, bar type and chuck type, screw type and Swiss type, tools and tool holders, typical tooling setup for simple work pieces, chutes, magazines, and hoppers for feeding. 1.2 **Numerically Controlled Machines:** Difference between NC and CNC machine tools, CNC turning centers, Machining centers- horizontal spindle, vertical spindle, universal, three axis, five axis, and seven axis. Characteristics and capabilities of machining centers. Special purpose machines. Working principles and applications only.	10
02	2.1 **Grinding Machines:** Grinding process, grinding machines−cylindrical, centre type, universal, plain, plunge, centre type, chucking type, centre less grinding machines−through feed, in feed, end feed, internal grinding machines− horizontal, vertical spindle-rotary/reciprocating types, tool and cutter grinders, special grinding machines. 2.2 **Grinding Wheels:** Types of abrasives−natural, artificial, grain size, types of bonds, grade, structure, shapes and sizes, marking system of grinding wheel, selection of grinding wheels, balancing of grinding wheels, truing, dressing and mounting of grinding wheels. 2.3 **Finishing Processes:** Reaming process, Honing process, machine, honing stone and tools, abrasive, grit size. Lapping−process, hand and machine lapping, flat internal and external cylindrical lapping, lap materials, medium, vehicles. Super finishing process- equipment, stones and fluids. Roller burnishing-process, tools and applications.	08
03	**Screw Thread Cutting Machines:** Thread production process, thread chasing, thread milling, thread whirling, die threading & tapping, thread rolling, thread grinding, self opening die heads, chasers -radial and tangential (tool geometry omitted).	03
04	**Gear Teeth Cutting Machines:** Gear milling, gear hobbing, principles of hobbing (kinematics omitted). Hobbing techniques, hob size, material (tool geometry omitted) and gear shaping process (tool geometry omitted). Gear finishing processes-gear shaving, gear lapping, gear grinding and gear burnishing.	04

05	**Unconventional machining processes:** Classification according to type of energy used for machining, basic principles, machines, 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) and Abrasive water jet machining (AWJM).	08
06	**Polymeric composites manufacturing processes:** Basic steps in composite manufacturing process, advantages and disadvantages of thermoset & thermoplastic composite processing. Manufacturing process for thermoset composites- (**major applications, raw material, basic processing steps, advantages and limitations only**) prepeg layup, wet layup, spray up, filament winding, pultrusion and resin transfer moulding.	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 one 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 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 course project.

Reference Books:

1. *Elements of Workshop Technology: Machine Tools (Volume - 2)***,** S. K. HajraChoudhary, A. K. HajraChoudhary, Nirjhar Roy, Media promoters (2010).
2. *A Course in Workshop Technology Vol. II (Machine Tools)*, B. S. Raghuwanshi, DhanpatRai& 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, 4thEdition*bySeropeKalpakjian, Steven R. Schmid, published by Pearson (2005).
7. *A Text Book Of Production Technology Vol. II* , O. P. Khanna, DhanpatRai Publication (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* bySeropeKalpakjian, Steven R. Schmid, published by Pearson (2007).

Course Code	Course/Subject Name	Credits
PEC404	**Electrical & Electronics Engineering**	**4+1**

Objectives:

1. To acquaint the students with the basic concepts involved in electrical machines and their control circuits.
2. To expose the students to domain knowledge in various applications of Production engineering.

Outcomes: Learner should be able to:-

1. Develop basic understanding of Electrical and Electronics Engineering concepts: with this, students should be able to utilize their knowledge in the future to interact with the Electrical & Electronics Engineering personnel in Manufacturing Industries.

Modules	Details	Hrs.
01	1.1 **DC Generator**: Construction, working principle and EMF equation. 1.2 **DC motor**: Working principle, types torque equation, Characteristics curves, speed control of DC motor, starting methods. Stepper Motor – construction, working principle, types, and applications. (Selection of various Motors for different applications)	06
02	2.1 **Three Phase Induction Motor**: Construction, working principle, Torque, speed characteristics. Torque equation 2.2 **Single phase Induction Motor**: Working principle type (Problem of DC Motor speed torque characteristics and 3 phase Induction Motor Torque speed characteristics only).	06
03	**Transformers:** Single Phase, Three Phase – construction, working principle, use of Equivalent circuit. Efficiency and regulation calculation methods. (Problems). (Equivalent circuit. Development not necessary). Transmission and distribution of electric power (scope limited to preliminary expose to the topics e.g. 11KV, 33KV Lines. Circuit breakers, Isolators, Distribution transformers and Distribution Network like Ring Bus System). Basic utility services network.	08
04	**Operational Amplifiers**: Basics- ideal OP –AMP. OP-AMP Applications (elementary configurations). Introduction to BOOLEAN ALGEBRA Digital IC's, registers, timers, counters, multiplexers, de-multiplexers, encoder, decoders (Internal Architecture not necessary, only functions). Introduction to microprocessor 8085. Functions of micro-controllers and their applications. Introduction to PLC and applications.	14
05	Solid state controls and application timers, relays and overload protection devices. SCR working principle. SCR characteristics curve. SCR Application in DC & AC motor control and welding.	10
06	Single Phase A.C. commutator Motors working principle. Performance curves. Area of application in industry (Mathematical Derivations not necessary also problems excluded).	08

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 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 course project.

Term work:

Term work shall consist of

1. Assignments: On topics drawn from syllabus.
2. Practical's: Based on topics from syllabus, experiments can be conducted and presented with inferences.
3. Three experiments covering module no. 1 and 2.
4. From module 4 and 5, suggested experiments (any three of the following).
   i. SCR characteristics.
   ii. Speed control of DC motor by SCR.
   iii. OP Amp used as differentiator and integrator.
   iv. Multiplexers.
5. Factory report: Preparation of equipment, process, quality control and failure analysis of engineering components reports after visit to important industrial plants.

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

- Laboratory work (assignments, Practicals and Factory report): 20 Marks.
- Attendance (practicals&theory): 05 Marks.

Reference Books:

1. *Electrical Technology,* 4th Edition by Cotton , Pitman (1939)
2. *Electric Machines,* 4th Edition by Kothari and I. J. Nagrath, McGraw Hill Publication.
3. *Electrical Machines and transformers,* 2nd Edition by Anderson Leonar and Jack Macneil, Prentice Hall (1988).
4. *Design with Operational Amplifiers and Analog Circuits,* 3rd Edition by Sergio Franco,Tata McGraw Hill (2002).
5. *Digital principles & Applications*, 4th Edition by Malvino& D Leach, McGraw Hill (1986).
6. *Modern digital electronics*, 4th Edition by R. P. Jain, Tata McGraw Hill (2010).
7. *SCR- General Electric Manual*, 5th Edition by D R Grafham (1972).
8. *Electronic Devices and Circuit Theory*, 9th Edition by Boylestad and Nashelsky, Pearson Publication (2006).
9. *Single phase commutator Motor,* by Frederick Creedy ,Ulan press.

Course Code	Course/Subject Name	Credits
PEC405	**Applied Thermodynamics**	**3**

Objectives:

1. To study the basic concepts and definitions used in engineering thermodynamics and applications of engineering thermodynamics in real life situations.
2. To broaden an understanding of Work, Heat, Energy, First Law & Second Law of Thermodynamics and their analysis in different applications.
3. To study the properties of pure substances.
4. To develop the students for a systematic approach to thermodynamic cycle analysis - Gas and Vapour power cycle.
5. To gain knowledge of application of mathematical skills to solve engineering thermodynamic problems.

Outcomes: Learner should be able to:-

1. Define heat, work, thermal efficiency and the difference between various forms of energy.
2. Identify and describe energy exchange processes (in terms of various forms of energy, heat and work).
4 Understand the steady-flow energy equation or the First Law of Thermodynamics to a system of thermodynamic components to estimate required balances of heat, work and energy flow.
5 Understand the importance of the second law of thermodynamics in the characterization of the processes and recognize the importance of entropy in the performance of the devices.
6 Characterize the different thermodynamic cycles of generating power, identifying the conditions of application of each.

Module	Details	Hrs.
01	1.1**Thermodynamic concepts**: Microscopic and Macroscopic viewpoints in thermodynamics, System, surrounding, state, path, property, Internal energy and Enthalpy, Reversible and irreversible process, thermodynamic work, heat, temperature, thermodynamic equilibrium and Zeroth law of thermodynamics. 1.2**First law of Thermodynamics:** Statement. First law applied to non-cyclic process, Application to non flow processes viz. Constant volume, constant Pressure, and constant temperature, adiabatic and polytrophic processes. Heat and work calculations.	08
02	**First law applied to open systems:** Flow work, Steady flow energy equation, Work done in steady flow processes in terms of pressure and volume. Throttling process. Joule's porous plug experiment. Joule-Thompson coefficient, SFEE applied to nozzle, turbine, compressor, boiler, condenser etc.	04
03	**Second law of thermodynamics**: Limitations of first law of Thermodynamics. 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 and Thermodynamic temperature scale.	06
04	**Entropy**: Entropy, temperature – entropy diagramClausius inequality, Entropy changes for an ideal gas during reversible process, Principle of increase of entropy. Introduction to availability and irreversibility	06

05	**Properties of steam**: Dryness fraction, enthalpy, internal energy and entropy. Steam table and Mollier chart and First law applied to steam processes.	05
06	6.1 **Power Cycles** (**Vapour power)**: Rankine cycle, Modified Rankine cycle, Reheat Rankine Cycle and Regenerative Rankine cycle. 6.2 **Gas power:** Thermodynamics of Otto, Diesel, Dual and Brayton cycle. Comparison and representation on P-V and T-S diagram.	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 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 course project.

Reference Books:

1. *Engineering Thermodynamics*,4th Edition *by* P. K. Nag, Tata Macgraw Hill (2008).
2. *Engineering Thermodynamics*, 4th Edition by R K. Rajput, Lakshmi Publication (2010).
3. *Applied Thermodynamics*, 5th Edition by T. D. Eastop and A. McConkey, Pearson (2009).
4. *Fundamentals of Compressible flow,* 3rd Edition by S. M. Yahya, New Age Publication
5. *Thermodynamics*, 2nd Edition by J. P. Holman, Macgraw Hill (1974).
6. *Thermodynamics for Engineers,* M. A. Saad, Prentice Hall publication.
7. *Fundamentals of Thermodynamics*, 8th Edition by Sonntag, Wiley India (2012).
8. *Thermodynamics,* 2nd Edition by W. C. Raynold, Macgraw Hill and NY (1977).
9. *Engineering Thermodynamics*, 4th Edition *by* Mayhew Y R and Rogers GFC, Pearson (1992).
10. *Engineering Thermodynamics,* 2nd Edition by M. Achutan, PHI (2009).
11. *Engineering Thermodynamics,* J. B. Jones and Dugan, PHI (1996).
12. *Thermal Engineering*, 20th Edition by P.L.Ballaney, Khanna Publication (1994).
13. *Thermodynamics and Engg. Approach*, 7th Edition by Yunus and Cengel, McGraw Hill (2012).
14. *Engineering Thermodynamics*, Lyndd Russell and George A Adebiyi ,Oxford Press (2007).

Course Code	Course/Subject Name	Credits
PEC406	**Materials Technology**	**4+1**

Objectives:

1. To understand basic engineering materials, their properties & selection and applications.
2. To understand types and causes of failure of components in various Engineering applications.

Outcomes: Learner should be able to:-

1. Distinguish different types of materials and composites used in Manufacturing.
2. Demonstrate a deeper understanding of materials in engineering applications.

Module	Details	Hrs.
01	1.1 **Solidification of metals:** Formation of solids from liquids of pure metals and alloys. Ingot defects and their remedies. Single crystal and polycrystalline structure. 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.	10
02	2.1**Fracture:**Definition and types of facture. Brittle fracture and Ductile fracture. Ductility transition. Definition and signification (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.	08
03	3.1 **Theory of Alloying:**Significance of alloying, Definition. Classification and properties of different types of alloys. 3.2 **Alloy Phase Diagrams:**Different types of alloy diagrams and their analysis. Tie bar and lever rules and their application. Dispersion hardening / age hardening 3.3**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.	10

04	4.1 **Principles of Heat treatment:** Technology of heat treatment. Classification heat treatment process. TTT Diagram. CT Diagram and Superimposition of cooling curves on Diagram. 4.2 **Heat treatment Process:** **Annealing**: Principle, process, and properties developed on Full Annealing; Spheroidizing; **Normalizing**: The process and its applications **Hardening:** Hardening media, Salt baths, Hardenabilitiy. 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.	10
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 Aluminium, Copper, Nickel, Tin, Zinc – Their alloys, properties and applications. 5.3 **Powder Metallurgy:** Powder manufacturing methods; Powder Metallurgy Process. Applications such as Oil Impregnated Bearings and Cemented Carbides. Limitations of Powder Metallurgy.	08
06	6.1 **Composites:** Definition; Classification; Particle-reinforced Composites and Fibre-**r**einforced Composites. Rule of Mixtures; Sandwich structures. Classification of Composites on basis of Matrix materials. 6.2**Nano-structured Materials:** Definition and Introduction to Nano-Technology. Unique features of Nano-structured Materials. Typical applications. **(Fundamental understanding only).** 6.3**Ceramics:** Definition, Comparative Study of Structure and Properties of Engineering Ceramics with reference to Metallic Materials. Toughening Mechanisms in Ceramics.Engineering application of Ceramics.	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 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 course project.

Term Work:

Term work shall consist of

1. Assignments: On topics drawn from syllabus.
2. Factory report: Preparation of equipment, process, quality control and failure analysis of engineering components reports after visit to important industrial plants.
3. All experiments below mentioned below have to be performed.

List of Experiments: (Term Work sr. no.3):

1. Preparation of specimen (minimum two metals/alloys) for microscopic examination.
2. Heat treatment process (Annealing, Normalizing and Hardening).
3. Jominy end Quench test for hardenability.
4. NDT (at least two).

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

• Laboratory work (assignments, Practicals/Factory report): 20 Marks.
• Attendance (practicals& theory): 05 Marks.

Reference Books:

1. *Materials Science and Engineering:AnItroduction*, 8th Edition by William D. Callister, Jr. – Adapted by R. Balasubramaniam. Wiley India (P) Ltd (2010).
2. *The Structure and Properties of Materials*, Vol I by M. G. Moffet, G. T. W. Pearsall & J. Wulff.
3. *Material Science and Metallurgy*, 12th Edition by V.D. Kodgire,Everest Publication (2002).
4. *Metallurgy for Engineer*s, 4th Edition by E.C. Rollason - ELBS SOC. And Edward Arnold, London (1973).
5. *Mechanical Behaviour of Materials*, 2nd Edition by Courtney, Waveland Press (2005).
6. *Introduction of Engineering Materials*, B.K. Agrawal, McGraw Hill Publishing Co. ltd.
7. *Mechanical Metallurgy*, 3rd Edition by G.E. Dieter, McGraw Hill International New Delhi (1988).
8. *Engineering Metallurgy Part I&II*, 6th Edition by R. A. Higgins &HodderStoughlon, London, Viva Books (P) Ltd. (1998).
9. *A text book of Metallurgy, 2nd*Edition by A.R.Bailey, Macmillan & Co. Ltd., London (1960).
10. *Introduction to solids*, L.V.Azaroff, McGraw Hill International New Delhi (1977).
11. *The Structure and Properties of Engineering Alloys*, 2nd Edition by W.F. Smith-McGraw hill International, New Delhi (1993).
12. *Strengthening of Metals*,Packner–ReinhildPuplishing Corporation, New Delhi.
13. *Engineering Physical Metallurgy*, Y. Lakhtin , University Press of the Pacific (2000).
14. *Physical Metallurgy for Engineer*s, Donald S. Clarke and Wibur R. Varney, D. Van Nostrand Co.INC (1962).
15. *Structure and Properties of Alloys*, Robert M, Brick, Robert B and Gordon , McGraw Hill International Book Co (1965).
16. *The Science and Engineering of Materials*, 6th Edition by Donald R. Askeland- PWS Publishing Co. (2011).
17. *Introduction to Physical Metallurgy*, 2ndEdition by S H Avner, Tata McGraw Hill (1997).
18. *Corrosion Engineering,* 3rd Edition by M.G. Fontana, McGraw-Hill (2005).

Course Code	Course/Subject Name	Credits
PEL407	**Workshop Practice-IV**	**2**

Objectives:

1. To practice machining of flat surfaces on shaping and grinding machines.
2. To practice milling, boring and thread cutting operations.

Outcomes: Learner should be able to:-

1. Understand the difference between metal machining and composite machining.
2. Understand different practical aspects involved in operation and applications of milling, shaping, grinding, boring etc.

Term Work:

1. One composite job consisting of minimum four parts, employing operations on lathe, precision turning, screw cutting, boring etc. and involving the use of shaping, milling and grinding operations.
2. Demo on machining of Glass Fiber 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).

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

- Laboratory work (workshop practicals): 40 Marks.
- Attendance (practicals): 10 Marks.

Practical Examination:

Practical examination will be held for 4 hours and shall consist of minimum 4 operations such as precision turning, boring, screw cutting, Drilling, milling, shaping, grinding etc.