

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				
		Examination Scheme								
		Theory								
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)	Term Work	Pract. /Oral	Total	
		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	

* **Theory for entire class to be conducted.**

** **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**

T.E. (Production) Sem.-V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned					
		Theory	Pract	Theory	Pract	Total			
PEC501	Design of Mold & Metal Forming Tools	04	--	04	--	04			
PEC502	Operations Research	03	--	03	--	03			
PEC503	Machine Design-I	04	--	04	--	04			
PEC504	CAD/CAM/CIM	04	--	04	--	04			
PEC505	Metrology & Quality Engineering	04	--	04	--	04			
PEDLO 501X	Department Level Optional Course I	03	--	03	--	03			
PEL501	Design of Mold & Metal Forming Tools Laboratory	--	02	--	01	01			
PEL502	Machine Design-I Laboratory	--	02	--	01	01			
PEL503	CAD/CAM/CIM Laboratory	--	02	--	01	01			
PEL504	Metrology & Quality Engg Laboratory	--	02	--	01	01			
PEL505	Business Communication & Ethics	--	02*+02	--	02	02			
	Total	22	12	22	06	28			
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.					
PEC501	Design of Molds & Metal Forming Tools	20	20	20	80	03	--	--	100
PEC502	Operations Research	20	20	20	80	03	--	--	100
PEC503	Machine Design-I	20	20	20	80	03	--	--	100
PEC504	CAD/CAM/CIM	20	20	20	80	03	--	--	100
PEC505	Metrology & Quality Engg.	20	20	20	80	03	--	--	100
PEDLO 501X	Department Level Optional Course I	20	20	20	80	03	--	--	100
PEL501	Design of Mold & Metal Forming Tools Laboratory	--	--	--	--	--	25	25	50
PEL502	Machine Design-I Laboratory	--	--	--	--	--	25	25	50
PEL503	CAD/CAM/CIM Laboratory	--	--	--	--	--	25	25	50
PEL504	Metrology & Quality Engg Laboratory.	--	--	--	--	--	25	25	50
PEL505	Business Communication & Ethics Laboratory						50	--	50
	Total			120	480		150	100	850

* Theory for entire class to be conducted.

Course Code	Department Level Optional Course I
PEDLO5011	Internal Combustion Engines
PEDLO5012	Finite Element Analysis
PEDLO5013	Plastic Engineering
PEDLO5014	Micro and Nano Manufacturing
PEDLO5015	Sustainable Manufacturing

T.E. (Production) Sem.-VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Total			
		Theory	Pract	Theory	Pract				
PEC601	Machining Science and Technology.	04	--	04	--	04			
PEC602	Process Engineering and Tooling.	04	--	04	--	04			
PEC603	Production Tooling.	04	--	04	--	04			
PEC604	Machine Design – II	04	--	04	--	04			
PEC605	Production and Operation Management	04	--	04	--	04			
PEDLO 601X	Department Level Optional Course II	03	--	03	--	03			
PEL601	Machining Science and Technology Laboratory	--	02	--	01	01			
PEL602	Process Engineering and Tooling Laboratory	--	02	--	01	01			
PEL603	Production Tooling Laboratory	--	02	--	01	01			
PEL604	Machine Design-II Laboratory	--	02	--	01	01			
	Total	23	08	23	04	27			
Examination Scheme									
Course Code	Course Name	Theory					Term Work	Pract. /Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg					
PEC601	Machining Science and Technology	20	20	20	80	03	--	--	100
PEC602	Process Engineering and Tooling	20	20	20	80	03	--	--	100
PEC603	Production Tooling	20	20	20	80	03	--	--	100
PEC604	Machine Design-II	20	20	20	80	03	--	--	100
PEC605	Production and Operation Management	20	20	20	80	03	--	--	100
PEDLO 601X	Department Level Optional Course II	20	20	20	80	03	--	--	100
PEL601	Machining Science and Technology Laboratory	--	--	--	--	--	25	--	25
PEL602	Process Engineering and Tooling Laboratory	--	--	--	--	--	25	25	50
PEL603	Production Tooling Laboratory	--	--	--	--	--	25	25	50
PEL604	Machine Design-II Laboratory	--	--	--	--	--	25	--	25
	Total			120	480		100	50	750

Course Code	Department Level Optional Course II
PEDLO6011	Manufacturing Planning and Control
PEDLO6012	Refrigeration and Air Conditioning
PEDLO6013	Reliability Engineering
PEDLO6014	Industrial Robotics
PEDLO6015	Rapid Prototyping and Manufacturing

B.E. (Production) Sem.-VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned						
		Theory	Pract	Theory	Pract	Total				
PEC701	Industrial Training & Project	--	5*8=40	--	20	20				
Course Code	Course Name	Examination Scheme								
		Theory				End Sem. Exam.	Exam. Duration (in Hrs)	Term Work	Pract. /Oral	Total
		Internal Assessment			Avg.					
		Presentation								
		Stage1	Stage2							
PEC701	Industrial Training & Project	50	50	50	--	--	100	50	200	
Total		--	--	50	--	--	100	50	200	

* Industrial Training and Project work should be of 24 weeks. (Learners load – 8 hours a day and 5days a week translates into 40 contact hours per week)

Workload of Teacher: Contact hours for project guidance – One hour per student per week

B.E. (Production) Sem.-VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Total				
		Theory	Pract	Theory	Pract					
PEC801	Fluid Power & Automation	04	--	04	--	04				
PEC802	Industrial Engineering and Human Resource Management	04	--	04	--	04				
PEC803	Economics, Finance, Accounting & Costing	04	--	04	--	04				
PEDLO 803X	Department Level Optional Course III	04	--	04	--	04				
ILO802X	Institute Level Optional courses	03	--	03	--	03				
PEL801	Fluid Power & Automation Laboratory	--	02	--	01	01				
PEL802	Industrial Engineering and Human Resource Management Laboratory	--	02	--	01	01				
PEL803	Economics, Finance, Accounting & Costing Tutorial	--	02	--	01	01				
	Total	19	06	19	03	22				
Examination Scheme										
Course Code	Course Name	Theory				End Sem. Exam.	Exam. Duration (in Hrs)	Term Work	Pract. /Oral	Total
		Internal Assessment								
		Test1	Test 2	Avg.						
PEC801	Fluid Power & Automation	20	20	20	80	03	--	--	100	
PEC802	Industrial Engineering and Human Resource Management	20	20	20	80	03	--	--	100	
PEC803	Economics, Finance, Accounting & Costing	20	20	20	80	03	--	--	100	
PEDLO 803X	Department Level Optional Course III	20	20	20	80	03	--	--	100	
ILO802X	Institute Level Optional courses	20	20	20	80	03	--	--	100	
PEL801	Fluid Power & Automation Laboratory	--	--	--	--	--	25	25	50	
PEL802	Industrial Engineering and Human Resource Management Laboratory	--	--	--	--	--	25	25	50	
PEL803	Economics, Finance, Accounting & Costing Tutorial	--	--	--	--	--	25	--	25	
	Total			100	400		75	50	625	

Course Code	Department Level Optional Course III	Course Code	Institute Level Elective Course II[#]
PEDLO8011	Product Design and Industrial Marketing	ILO8021	Project Management
PEDLO8012	World Class Manufacturing	ILO8022	Finance Management
PEDLO8013	Logistics and Supply Chain Management	ILO8023	Entrepreneurship Development and Management
PEDLO8014	Plant Engineering	ILO8024	Human Resource Management
PEDLO8015	Process Control and Instrumentation	ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

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

	$\int_0^{2\pi} f(\cos \theta, \sin \theta) d\theta, \quad \& \quad \int_{-\infty}^{\infty} f(x) dx$	
4	<p>Fourier Series:</p> <p>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 $2l$</p> <p>5.2 Dirichlet's theorem(only statement), even and odd functions, Half range sine and cosine series,Parseval's identities (without proof)</p> <p>5.3 Complex form of Fourier series</p>	10
5	<p>Partial Differential Equations:</p> <p>5.1.Numerical Solution of Partial differential equations using Bender-Schmidt Explicit Method, Implicit method (Crank- Nicolson method).</p> <p>5.2.Partial differential equations governing transverse vibrations of an elastic string its solution using Fourier series.</p> <p>5.3.Heat equation, steady-state configuration for heat flow</p> <p>5.4. Two and Three dimensional Laplace equations</p>	09
6	<p>Correlation and curve fitting</p> <p>6.1. Correlation-Karl Pearson's coefficient of correlation- problems, Spearman's Rank correlation problems, Regression analysis- lines of regression (without proof) –problems</p> <p>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 $y = ae^{bx}$</p>	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	<p>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.</p> <p>Vapour power cycle: Rankine cycle, Modified Rankine cycle, variables affecting the efficiency of Rankine cycle, Reheat cycle and Regenerative cycle.</p>	08
06	<p>Gas power cycle: Otto, Diesel, Dual and Brayton cycle. Comparison and representation on P-V and T-S diagram.</p>	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. Planing machines: types of planing machines, shaper vs. planer. Slotting machines types of slotting machines.	10

05	<p>Screw Threads: Thread production process – Machining (thread chasing, thread milling, thread whirling, and die threading & tapping), Thread rolling, Thread grinding. (Tool geometry omitted).</p> <p>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.</p>	08
06	<p>6.1 Grinding Machine: Grinding principle, Grinding machines types and operations, grinding wheels specification, balancing of grinding wheels, truing, dressing and shaping of grinding wheels.</p> <p>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.</p>	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. Raghuvanshi, 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	<p>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).</p> <p>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.</p> <p>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.</p>	07
02	<p>2.1 Fracture: Definition and types of fracture. Brittle fracture and Ductile fracture. Ductile-to-Brittle transition. Definition and significance (fundamental understanding only).</p> <p>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.</p> <p>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.</p>	07
03	<p>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.</p> <p>3.2 Theory of Alloying: Significance of alloying: definition, classification and properties of different types of alloys.</p>	08

	<p>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.</p> <p>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.</p>	
04	<p>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.</p> <p>4.2 Heat treatment Process: Annealing: Principle, process, and properties developed on Full Annealing; Spheroidizing; Process annealing, Stress relieve annealing. Normalizing: The process and its applications</p> <p>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.</p> <p>4.3 Heat treatment defects: Defect during heat treatment process. Typical design guidelines in Heat treatment.</p>	09
05	<p>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</p> <p>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.</p>	06
06	<p>Introduction to New Materials: (Fundamental understanding only)</p> <p>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.</p> <p>6.2 Nano-structured materials: Introduction, Concepts, synthesis of nano materials, examples, applications and nano composites.</p> <p>6.3 Biomaterials: Introduction, examples and applications.</p> <p>6.4 Smart materials: Introduction, examples and applications.</p>	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 eccentric loads, core of section. 4.2 Deflection of Beams: Deflection of cantilevers simple 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	<p>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.</p> <p>6.2 Strain energy: Strain energy due to axial loads gradually applied transverse loads and under impact load.</p>	06
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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 Russell 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	<p>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.</p> <p>1.2 Machine Elements: Preparation of 2-D drawings of standard machine elements (nuts, bolts, keys, cotter, screws, spring etc.).</p> <p>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.</p>	10
02	<p>Detailed and assembly drawings:</p> <p>2.1 Introduction to the unit assembly drawing, steps involved in preparing assembly drawing from details and vice-versa, Sequence in assembly.</p> <p>2.2 Preparation of details and assembly drawings of: Clapper block, Single tool post, square tool post, Lathe Tailstock.</p>	10
03	<p>Preparation of detailed and assembly drawings of Bearings:</p> <p>3.1 Simple, solid, Bushed bearing. I.S. conventional representation of ball & roller bearing.</p> <p>3.2 Pedestal bearing & footstep bearing.</p>	10
04	<p>Preparation of detailed and assembly drawings of pulleys, Pipe Joints. Limits, Fits & Tolerances -</p> <p>4.1 Classification of Pulleys, pipe joints</p> <p>4.2 Pulleys: Flat belt, V-belt, rope belt, Fast and loose pulleys.</p> <p>4.3 Pipe joints: Flanged joints, Socket and spigot joint, Gland and stuffing box, expansion joint.</p>	04
05	<p>Preparation of detailed and assembly drawings of Valves, I.C. Engine parts:</p> <p>5.1 Types of Valves, introduction to I.C. Engine</p>	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, aggregate 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, using 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 of Internal 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, Silberchatz, 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 (1 to 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	<p>Matrices:</p> <p>1.1 Brief revision of vectors over a real field, inner product, norm of a vector</p> <p>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</p>	08
2	<p>Matrices:</p> <p>2.1 Minimal polynomial and Derogatory matrix</p> <p>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</p> <p>Vector calculus</p> <p>2.3 Brief revision of Scalar and vector point functions. Gradient of a scalar function, Divergence and curl of a vector function</p> <p>2.4 Line integrals, circulation of a vector, condition for independence of the path in the line integral</p>	09
3	<p>Vector calculus:</p> <p>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)</p> <p>Linear Programming problems</p> <p>1.2 Types of solutions to linear programming problems, standard form of L.P.P. Simplex method to solve L.P.P</p>	09
4	<p>Linear Programming problems Probability Distributions:</p> <p>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.</p>	09

	<p>Probability Distributions</p> <p>4.2 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expected value, Variance.</p> <p>4.3 Probability Distributions: Binomial, Poisson and Normal Distributions</p>	
5	<p>Sampling theory:</p> <p>5.1. Sampling theory: 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</p> <p>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.</p> <p>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</p>	09
6	<p>Sampling theory and ANOVA</p> <p>6.1. Chi-square test, Test for the Goodness of fit, Association of attributes and Yate's correction</p> <p>6.2. Analysis of Variance(F-Test): One way classification, Two-way classification(short-cut method)</p>	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, Schaum 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	<p>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.</p> <p>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,</p> <p>Buoyancy and Flotation: Archimedes' Principle, Buoyancy, Centre of Buoyancy, Metacenter, Metacentric height, Stability of floating and submerged bodies. (Only Theory on Buoyancy and Flotation)</p>	10
02	<p>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,</p> <p>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)</p>	08
03	<p>Dynamics of Viscous Flow: Introduction to Laminar and Turbulent flow, Flow of viscous fluid in circular Pipes - Hagen Poiseuille flow.</p> <p>Flow Through Pipes: Major and Minor losses in pipes, Pipes in series, Pipes in parallel and Equivalent pipe.</p>	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	<p>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,</p> <p>Power Electronics Characteristics of SCR, Diac and Triac, Single Phase Half-Wave Circuit With R-L Load, Freewheeling Diode, Full Wave Controlled Rectifier.</p>	10
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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. Demonstrate the practical significance of interference and undercutting in gears.

Exp. No.	List of Experiments (Any 6)
01	Gyroscope
02	Longitudinal Vibrations of Helical Spring
03	Torsional Vibrations of Shaft
04	Torsional Vibrations of Single Rotor System
05	Torsional Vibrations of Two Rotors System
06	Compound Pendulum
07	Transverse Vibrations - Whirling Speed of Shaft
08	Cam Analysis
09	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.

Course Code	Course Name	Credits
PEC501	Design of Mould & Metal Forming Tools	04

Objectives

1. To prepare the students study and analyze casting and forming processes like forging, rolling, extrusion and drawing of ferrous and non-ferrous metals.
2. To familiarize the students with the design of sand molds, die casting dies, roll grooves and multi impression forging die etc.

Outcomes: Learner will be able to...

1. Demonstrate the concepts of metal casting and metal forming processes.
2. Identify the equipment, machinery and tooling used for sand casting/die casting.
3. Identify equipment, machinery and tooling used for forming processes (such as forging, rolling and extrusion).
4. Illustrate the basic theory pertaining to plastic deformation of metal.
5. Develop skills in designing tools, the set up for the processing techniques pertaining to various metal casting and metal forming operations.
6. Analyze various defects, their probable causes and remedial measures confronted with metal casting and forming processes.

Module	Contents	Hrs.
01	Design of Sand moulds: 1.1 Design and drawing of gating system: Pouring basin, Sprue, Runners and Ingates. 1.2 Design of feeding system: Caine's method, Modulus method, Chvorinov's mould constant, Use of chills, padding and risering.	10
02	2.1 Melting & Pouring: Melting practices: Cupola, Arc and Induction furnaces. 2.2 Defects in cast components and their remedies.	02
03	Special Casting Processes 2.1 Die design and manufacture for pressure die casting of non-ferrous metals, Principle of Hot chamber and Cold chamber die casting processes, Design and manufacture of die-casting dies for Cold chamber die casting process. 2.2 Casting process used for composites. 2.3 Defects in die cast components and their remedies. 2.4 Lost Wax Process Investment Casting : Use of wax as the moulding material; Process description; Features and advantages; Fields of application; 2.5 Shell Mould casting: Working principle and application.	10
04	Forging of metals 4.1 Forging hammers, high speed forging machines, Presses and Horizontal upset forging machines: Construction and principle of operation. 4.2 Single and multi-impression closed die forging process; 4.3 Design and drawing of multi-impression drop forging, die set using fuller, edger, bender, blocker and finisher, cavities with flash and gutter. 4.4 Defects in forged products and their remedies.	12
05	Rolling of metals 5.1 Design and drawing of Continuous Billet Mill Roll grooves using diamond, square, oval and round passes. Roll passes for rolling rails, beams, angles and channels.	12

	5.2 Production of seamless tubes by rolling. 5.3 Defects in rolled products and their remedies.	
06	Extrusion of Metals and Miscellaneous Metal Forming Processes 6.1 Introduction to metal extrusion and basic concepts of extrusion dies. 6.2 Drawing of metals: Principle of operation and applications.	02

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

Course Code	Course Name	Credits
PEC502	Operations Research	03

Objectives:

1. To familiarize the students with various tools of optimization for management of various resources.
2. To acquaint the students with various simulation tools for optimization for various resources.

Outcomes: Learner will be able to:

1. Utilize the resources in various industries optimally.
2. Apply the concept of linear programming for solving specialized problems on transportation, assignments & sequencing.
3. Apply principles of queuing, replacement & game theory models to solve real life problems.
4. Demonstrate the concept of dynamic programming in modelling and solving problems.
5. Illustrate different types of simulation models applicable to Inventory/queuing.
6. Acquire skills in identifying & applying cost effective strategies in managing of manufacturing projects.

Module	Contents	Hrs.
01	1.1 Linear Programming: Linear Programming Problem: Formulation, Graphical solution, Simplex method, Big-M method, Two-phase method, Principle of Duality, Dual Simplex, Sensitivity Analysis. 1.2 Transportation problem: Formulation - Optimal solution, Degeneracy. 1.3 Assignment problem: Formulation - Optimal solution, Traveling Salesman problem. 1.4 Sequencing: Introduction – Flow Shop sequence. Sequencing – n jobs through two machines - n jobs through three machines – Job shop sequencing - two jobs through ‘m’ machines.	15
02	2.1 Queuing Models: Introduction - Single Channel - Poisson arrivals - exponential service times - with infinite population and finite population models – Multichannel - Poisson arrivals – exponential service times with infinite population single channel Poisson arrivals. 2.2 Replacement: Introduction - Replacement of items that deteriorate with time - when money value is not counted and counted -Replacement of items that fail completely, group replacement	06
03	Game Theory: Introduction - Minimax (Maximin) - Criterion and optimal strategy - Solution of games with saddle points – Rectangular games without saddle points - 2 X 2 games - dominance principle – m X 2 & 2 X n games, Graphical method	05
04	Dynamic programming: Introduction – Bellman’s Principle of optimality - Applications of dynamic programming- capital budgeting problem - Shortest Path problem – Minimum Spanning Tree.	04
05	Simulation: Definition - Types of simulation models - phases of simulation - applications of simulation - Inventory and Queuing problems - Advantages and Disadvantages - Simulation Languages.	04
06	Project Management: Programme Evaluation and Review Technique, Critical Path Method, Network Updating, Crashing of Network and Resources levelling.	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. *Operations Research: Principle and Practices*, A. Ravindran, D. Phillips, Wiley India.
2. *Operations Research*, S. D. Sharma, Kedar Nath Ram Nath-Meerut.
3. *Operations Research*, R. Panneerselvam, PHI Publications.
4. *Operations Research*, Kanti Swarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.
5. *Operations Research*, A. M. Natarajan, P. Balasubramani, A. Tamilarasi, Pearson Education.
6. *Operations Research, An Introduction*, Hamdy A. Taha, Pearson Education
7. *Operations Research: Methods and Problems*, Maurice Saseini, Arthur Yaspan and Lawrence Friedman.
8. *Introduction to O.R.*, Hiller & Libermann (TMH).

Course Code	Course Name	Credits
PEC503	Machine Design – I	04

Objectives:

1. To prepare the students learn basic principles of engineering design.
2. To familiarise the students with the concepts of strength design related to various components.
3. To acquaint the students use design data books & various codes of practices.

Outcomes: Learner will be able to:

1. Apply basic principles of machine design.
2. Design joints such as knuckle joint/turn buckle.
3. Design machine elements such keys, shafts, couplings/springs.
4. Design pressure vessels.
5. Design weld joint.
6. Design rivet/bolt joints.

Module	Contents	Hrs.
01	1.1. Introduction - Steps involved in designing, types of designs, considerations in designing, Design–manufacturing interface, material selection, factor of safety and its implications. 1.2. Operational Joints - Introduction to cottered, pinned & threaded joints, & their applications. 1.3. Design of socket & spigot type 1.4. Design of Pinned Joints - Knuckle joint 1.5. Design of Turn Buckle	10
02	2.1 Determination of stresses in machine components with various cross sections. Circular, rectangular, triangular, trapezoidal, T & I sections subjected to direct & bending stresses. (Including stresses at critical sections) 2.1. Stresses in curved members- Design of crane hooks & C-clamps with various cross sections (Circular, triangular, square, rectangular, trapezoidal) (Circular & oval rings to be excluded).	06
03	3.1. Design of shafts 3.1.1. Design of shafts on the basis of strength. Shafts subjected to-bending alone, Torsion alone, combined action of torsion & bending, combined action of torsion & axial loads, combined action of torsion, bending & axial loads (Rankine’s and Guest’s equations) 3.1.2. Concepts about design of shafts based on rigidity (lateral & torsional rigidity)- only Implications 3.2. Design of keys 3.2.1. Different types of keys and applications. 3.2.2. Fitting of keys – types and effects of keyway on shaft 3.2.3. Stresses in keys and design of key dimensions. 3.3. Design of couplings: 3.3.1. Classification of couplings & application areas.	10

	3.3.2. Design of flanged couplings, muff couplings, bushed pin type flexible coupling.	
04	4.1. Design of welded joints - Types & classification of welded joints, applications. Familiarization of AWS code. Strength of welded joints- Transverse & parallel fillet welds. Welded joints subjected to torsion – circular fillet welds and adjacent fillet welds. 4.2. Design of welded joints subjected to eccentric loading.	06
05	5.1. Design of bolted joints - stresses in bolts, joints for leak proof fluid tight applications (like cylinder to cylinder cover fastening in an IC engine), bolts of uniform strength. 5.2. Design of riveted joints - Type of rivets and riveted joints. Failure modes of riveted joints & efficiency of riveted joints. Design of riveted joints for riveting longitudinal & circumferential seams of pressure vessels. Familiarization of Indian Boiler Regulation (IBR) 5.3. Design of bolted and riveted joints subjected to eccentric loading.	10
06	6.1. Design of Springs : Classification and applications, design of helical compression and tension springs (only circular cross-section), co-axial springs. Design of leaf springs–straight and semi elliptical laminated leaf springs. Strain energy of springs–design of buffer springs. 6.2. Design of Pressure Vessels : Design concepts of thick and compound cylinders, Stresses in thick & compound cylinders. Determination of wall thickness, hoop and radial stresses, nature of hoop and radial stress distribution on cylinder walls.	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**

NOTE:

Use of standard design data books like PSG Data Book or Design Data by Mahadevan is permitted at the examination and shall be supplied by the college.

Reference Books:

1. *Design of machine elements* -- V. B. Bhandari. Tara Mc-Graw Hill Pub.
2. *Design of machine elements* -- Sharma, Purohit. Prentice Hall India Pub.
3. *Machine Design - An Integrated Approach* -- Robert L. Norton – Pearson Education.
4. *Machine Design* - Pandya & Shah- Charotar Publishing.
5. *Mechanical Engineering Design* - J. E. Shigley - McGraw Hill
6. *Recommended Data Books* - PSG, K. Mahadevan
7. *Machine Design* - Reshetov - Mir Publication
8. *Machine Design* - Black Adams-Mcgraw Hill
9. *Fundamentals of Machine Elements* - Hawrock, Jacobson McGraw Hill
10. *Design of Machine Elements* - V.M. Faires
11. *Design of Machine Elements* - Spotts.

Course Code	Course Name	Credits
PEC504	CAD/CAM/CIM	04

Objectives:

1. To familiarize the concepts of computer aided engineering for design & manufacturing.
2. To impart the knowledge on computer graphics used in engineering.
3. To familiarize the students with the concepts of computer aided manufacturing and its significance.
4. To familiarize the students with interfacing of drive systems with the machines.

Outcomes: Learner will be able to...

1. Use computer graphics in design.
2. Identify proper modeling techniques for geometric modeling.
3. Develop expertise in computer-aided manufacturing.
4. Illustrate basic concepts of control systems.
5. Write the appropriate code for performing particular tasks in a CNC.
6. Solve real life engineering problems using FEA.

Module	Contents	Hrs.
01	<p>Computer Aided Design:</p> <p>1.1 Introduction : Need and Utility of CAD systems in industry, Product Cycle, Definition of CAD tools based on their Constituents and Implementation in a design environment.</p> <p>1.2 CAD Hardware : Types of systems, system considerations, I/O devices, Hardware Integration & Networking.</p>	04
02	<p>Computer Graphics :</p> <p>Pixel plotting, Scan conversions of lines & circuits, 2D & 3D transformation, 2D Viewing and clipping. Parallel Projection. Elementary treatment of Hidden lines and surfaces. Cubic spines Bezier curves & B- spines, Animation and Color models.</p>	10
03	<p>Solid Modeling :</p> <p>Types of representation of solid models, interactive tools available with solid modeling software's. Introduction to surface modeling.</p> <p>CAD DATA Exchange : File Structure and format of IGES,STEP and DXF</p>	05
04	<p>Introduction :</p> <p>Elements of CAM system, Computer Numerical control of Machine Tools, Fundamental elements of CNC, Benefits of CNC, Computer control concepts, Data processing units & Binary calculation.</p> <p>Basics of control systems:</p> <p>Motion controller, Interpolation-Linear & Circular, Positioning & contouring control loops, Incremental & Absolute system, DNC & CNC systems and Adaptive control system.</p> <p>CNC Hardware Basics:</p> <p>CNC drives, Spindle design, Actuation and Feedback devices</p>	10

05	<p>CNC Programming : Introduction to CNC Lathe & Milling, Touch probe system, Tool length, nose radius & Diameter compensation, Turning & Machining centre programming, CNC part programming using ISO controllers, Canned cycles, Looping Jumping Subroutines Macros, Parametric programming, Computer aided part programming using APT and Post processing.</p>	11
06	<p>CIM : Computer applications in manufacturing, Automation and Integrated Production management systems. Automated Material handling systems, Conveyors, AVG, AS/RS, GT, FMS, Automated inspection procedure, Distributed Numerical control & Benefits of CIM and implementation & computer aided shop floor control system. Concept of “Ghost” factory.</p> <p>FEA: Introduction, Stress and Equilibrium, Boundary Condition, Strain – Displacement Relations, Stress Strain Relation, Potential Energy. One Dimensional Problem: Finite Element Modelling, Coordinate Potential Energy Approach, Galerkin Approach, Assembly of Global Stiffness Matrix, Properties of Stiffness Matrix, Finite Element Equations. Trusses: Introduction, 2D Trusses, Assembly of Global Stiffness Matrix.</p>	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. *CAD/CAM* by Groover and Zimmers
2. *CAD Principles and Applications* by Barr, Krimger and Lazaer
3. William M Neumann and Robert F.Sproul “*Principles of Computer Graphics*”, Mc Graw Hill Book Co. Singapore, 1989.
4. Donald Hearn and M. Pauline Baker “*Computer Graphics*”, Prentice Hall, Inc., 1992.
5. Foley, Wan Dam, Feiner and Hughes – *Computer graphics principles & practices*, Pearson Education – 2003.
6. Reddy, J.N, “*An Introduction to the Finite element Method*”, McGraw – Hill, 1985.
7. Rao, “*Finite Element Method in Engineering*”, Pergammon Press, 1989.
8. CAD / CAM by P.N. Rao (Tata-Mcgraw- Hill) 2

9. *Mathematical and Procedural Elements for computer graphics* by Roger and Adams
10. *Computer Graphics* by Hearn and Baker (PHI)
11. *A first course in FEM* by daryl L.Logon(Cengage) 3
12. *Concepts and applications of FEA* by Cook, Malkus (Jhon-wiley)
13. *Mastering CAD – CAM* by Ibarahim Zeid (Tata-Mcgraw-Hill) 4

Course Code	Course Name	Credits
PEC505	METROLOGY AND QUALITY ENGINEERING	04

Objectives:

1. To acquaint with principles of precision measuring instruments & their significance.
2. To familiarize with the handling & use of precision measuring instruments/ equipment's.
3. To acquaint with key features and the basics of Total Quality Management philosophy.
4. To familiarize with various quality tools and their uses in solving problems.

Outcomes: Learner will be able to...

1. Handle & operate precision measuring instruments / equipment's.
2. Design Go and No Go gauges for a given assembly.
3. Analyze simple machined components for dimensional stability & functionality.
4. Identify and use proper quality tools in various manufacturing /service problems.
5. Integrate quality approaches for productivity improvement.
6. Comprehend and apply Quality standards in different situations.

Module	Contents	Hrs
01	1. Introduction to Metrology 1.1 Need for inspection, fundamental principles and definition, standards of measurement, Static characteristics of Measurements. 1.2 Limits, fits and Tolerances of interchangeable manufacture, Elements of Interchangeable System, hole based and shaft based systems IS 919 : 1963 tolerance grades, types of fits, General requirements of go & NO GO gauging, Taylor's principle, Design of go & no go gauges.	08
02	2.1 Comparators: Constructional features and operation of mechanical, optical, electrical/electronic and pneumatic comparators, advantages, limitations and field of Applications. 2.2 Principles of interference, concept of flatness, flatness testing, optical flats, optical Interferometer and laser interferometer. 2.3 Surface texture measurement: importance of surface conditions, roughness and waviness, surface roughness standards specifying surface roughness parameters- Ra, Ry, Rz, RMS value etc., surface roughness measuring instruments – Tomlinson and Taylor Hobson versions, surface roughness symbols	09
03	3.1 Screw Thread measurement: Two wire and three wire methods, fil carriage micrometer. 3.2 Gear measurement: Gear tooth comparator, Master gears, measurement using rollers and Parkinson's Tester. 3.3 Special measuring Equipment: Principles of measurement using Tool Maker's microscope, profile projector & 3D coordinate measuring machine.	07
04	Quality 1.1 Quality Control Evolution of Quality, Definition of Quality, Dimensions of Quality Planning, Principles of TQM, set up policy and objectives of quality control, quality of	08

	<p>design and quality of conformance, compromise between quality & cost, quality cost and planning for quality</p> <p>1.2 Cost of quality: prevention, appraisal & failure costs and Hidden cost of quality.</p> <p>1.2 Quality improvement</p> <p>Juran's trilogy, management of controllable defects, operator controllable defects, sporadic and chronic problems of quality. Bench Marking: Introduction, definition and its significance. Collection of data for bench marking and its use.</p>	
05	<p>SQC and SQC tools</p> <p>5.1 Process Data Collection & presentation – Bar Chart, Histogram and Run Charts.</p> <p>5.2 Process Variability – variables & Process Variation (Measures of accuracy & Centering, precision or spread, normal distribution and sampling averages).</p> <p>5.3 Process Control by Variable – using X bar and R Chart and control charts for standard deviation.</p> <p>5.4 Process Control by Attribute - for number of defectives or non-conforming units - np-charts, p-charts, c-charts and u-charts</p> <p>5.5 Process capability, OC curve, acceptance sampling AQL, LTPD, AOQL, producers and consumers risk (Single & Double sampling plan only). (Note: Emphasize the explanation with Numerical problems).</p>	08
06	<p>6.1 Sampling Techniques Sampling inspection and basic concepts, OC curves, consumer & Producer risk, single & double sampling plans and use of sampling tables.</p> <p>6.2 Quality standards</p> <p>a. The ISO9001:2000 Quality Management System Standard</p> <p>b. The ISO 14001:2004 Environmental Management System Standard</p> <p>c. ISO 27001:2005 Information Security Management System</p> <p>d. ISO/TS 16949:2002 for Automobile Industry</p> <p>e. Internal audit, surveillance audit, maintaining of certification</p>	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. *Engineering Metrology*, K. J. Hume, Kalyani publication
2. *Engineering. Metrology*, I.C. GUPTA, Dhanpat Rai Publications.
3. *Statistical quality control*, A.L. Grant, McGraw Hill International, New York.
4. *Engineering. Metrology*, R. K. Jain, Khanna Publisher.
5. *Engineering. Metrology*, Hume K.G., M C Donald, Technical &Scientific, London.
6. *Quality Control and Industrial Statistics*, Duncon A.J.,
D.B. Taraporevela & Co. Bombay.
7. *Statistical quality Control*, Mahajan M., DhanpatRai & Sons, Delhi.
8. *Introduction to Statistical Quality Control*, By Douglas C. Montgomery
wiley india publication
9. *Quality control* by D.H. Besterfield , Pearson education.
10. Juran's Quality Control Handbook.
11. *Metrology for Engineers* Charles Reginald Shotbolt, PublisherCassell,
12. *Understanding and Implementing ISO 9000 and ISO Standards* by David L. Goetsch,
Stanley Davis , Prentice Hall

Course Code	Course Name	Credits
PEDLO5011	Internal Combustion Engines	03

Objectives:

1. To familiarize with various types of internal combustion engines.
2. To impart knowledge about various systems/components of IC engines.
3. To impart knowledge about various engine performance characteristics and its testing.

Outcomes: Learner will be able to:-

1. Demonstrate working of different types of engines.
2. Analyze fuel supply systems and ignition systems of IC Engines.
3. Distinguish combustion process of SI and CI Engines.
4. Measure operating characteristics of IC Engines.
5. Analyze the impact of vehicular pollution and ways to reduce or control the pollution.
6. Illustrate various standard pollution norms like EURO, Bharat for I.C. engines.

Module	Contents	Hrs.
01	Introduction to IC Engines and cycle analysis: Basic of I.C. Engines, Details of two stroke and four stroke engines, Valve timing diagram, Air standard cycles, Fuel air cycle and actual cycle. Variation in specific heat, Dissociation and their effect on engine performance. Review of other losses in IC engines.	07
02	Spark Ignition Engines Fuel Supply System in S I Engines : Theory of Carburetion, Types of carburetors, Electronic fuel injection system (MPFI), Combustion in Spark Ignition Engines: Stages of combustion, ignition lag, flame propagation, factors affecting flame propagation, abnormal combustion, phenomenon of detonation in SI engines, effect of engine variables on detonation. Combustion chambers. Rating of fuels in SI engines.	07
03	Compression Ignition Engines Fuel supply system in CI Engine: Air injection systems, Airless/solid injection systems, individual pump, Common rail and distributor system, unit injector etc, types of fuel pump, injector and nozzles. Electronically controlled fuel injection system Combustion in compression ignition engines (CI): Stages of combustion, ignition delay, factors affecting delay period, phenomenon of knocking in CI engine, effect of engine variables on knocking, comparison of knocking in SI & CI engines, types of combustion chambers, rating of fuels in CI engines,	07
04	Engine systems and components Engine lubrication : Types of lubricants and their properties, SAE rating of lubricants, Types of lubrication systems	07

	<p>Engine Cooling: Necessity of engine cooling, disadvantages of overcooling, Cooling systems and their comparison: Air cooling, Liquid cooling.</p> <p>Supercharging/Turbo-charging: Objectives, Effects on power output and engine efficiency, Methods, Types and Limitations.</p>	
05	<p>Testing and Performance of engines: Measurement of indicated power, brake power, fuel consumption and emission, Measurement of friction power by Willan's Line Method* and Morse Test*, calculation of brake thermal efficiency, brake power and brake specific fuel consumption of I.C Engines, variable compression ratio engines, heat balance sheet of I.C Engines (Numerical on Performance and Heat balance sheet of I.C Engine)</p>	08
06	<p>Engine Emission and Control S.I. engine emission (HC, CO, NO_x) Control methods- Evaporative (ELCD), Thermal, Catalytic converters, C.I. Engines Emission (CO, NO_x, Smog, Particulate), Control methods- Chemical, EGR. Standard pollution norms like EURO, Bharat, Introduction to alternative fuels for I.C. engines,</p>	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. *Internal Combustion Engines*, by Willard W. Pulkrabek, Pearson Education.
2. *Internal Combustion Engines*, by Shyam Agrawal, New Age International
3. *Internal Combustion Engines*, by Mathur and Sharma
4. *Internal Combustion Engines*, by Mohanty, Standard Book House
5. *Internal Combustion Engines*, by Gills and Smith
6. *Internal Combustion Engines Fundamentals*, by John B. Heywood
7. *Internal Combustion Engines*, by Gupta H N, 2nd ed, PHI
9. *Internal Combustion Engines*, by Richard Stone - Palgrave Publication
10. *Internal Combustion Engines*, by Domkundwar
11. *Internal Combustion Engines*, by V. Ganeshan

Course Code	Course Name	Credits
PEDLO5012	Finite Element Analysis	03

Objectives

1. To introduce the concepts of Mathematical Modelling of Engineering Problems.
2. To familiarize with the applicability of FEM to a range of Engineering Problems.
3. To acquaint with the applications of numerical techniques for solving problems.

Outcomes: Learner will be able to...

1. Solve ordinary and partial differential equations using the Galerkin method.
2. Develop the finite element equations to model engineering problems governed by 2nd order partial differential equations.
3. Apply the basic finite element formulation techniques to solve engineering problems.
4. Use commercial FEA software, to solve problems related to engineering.
5. Prepare Solutions of 2 -D Problems using FE Software.
6. Find solution techniques to Dynamic problems, longitudinal vibration, frequencies and mode shapes.

Module	Contents	Hrs.
01	<p>Introduction</p> <p>1.1. Introductory Concepts: Introduction to FEM, Historical Background, General FEM procedure. Applications of FEM in various fields. Advantages and disadvantages of FEM.</p> <p>1.2. Mathematical Modeling of field problems in Engineering, Governing Equations, Differential Equations in different fields.</p> <p>1.3 Approximate solution of differential equations-- Weighted residual techniques, Galerkin methods.</p>	09
02	<p>FEA Procedure</p> <p>2.1 Discrete and continuous models, Weighted Residual Methods –Ritz Technique –Basic concepts of the Finite Element Method.</p> <p>2.2. Definitions of various terms used in FEM like element, order of the element, internal and external node/s, degree of freedom, primary and secondary variables, boundary conditions.</p> <p>2.3. Minimization of a functional. Principle of minimum total potential. Piecewise Rayleigh-Ritz method. Formulation of “stiffness matrix”; transformation and assembly concepts.</p>	05
03	<p>One-Dimensional Problems</p> <p>3.1. One Dimensional Second Order Equations Discretization–Element types-Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors.</p> <p>3.2. Assembly of Matrices -solution of problems in one dimensional structural analysis, heat transfer and fluid flow (Stepped and Taper Bars, Fluid Network, Spring-Cart systems)</p> <p>3.3. Analysis of Plane Trusses, Analysis of Beams.</p> <p>3.4. Solution of one Dimensional structural and thermal problems using FE Software, Selection of suitable Element Type, Modeling, Meshing,</p>	10

	Boundary Condition, Convergence of solution, Result analysis, Case studies.	
04	Two Dimensional Finite Element Formulations 4.1 Introduction, Three noded triangular element, four noded rectangular element, four noded quadrilateral element. 4.2 Natural coordinates and coordinates transformations: serendipity and Lagranges methods for deriving shape functions for triangular and quadrilateral element 4.3. Introduction to Sub parametric, Isoperimetric, super parametric elements. Compatibility, Patch Test, Convergence criterion, Sources of errors.	08
05	Two Dimensional Vector Variable Problems 5.1 Equations of elasticity –Plane stress, plane strain and axisymmetric problems. 5.2. Jacobian matrix, stress analysis of CST. 5.3. Solution of 2 -D Problems using FE Software (structural and Thermal), election of element type, meshing and convergence of solution. (Can be covered during practical hours).	05
06	Finite Element Formulation of Dynamics and Numerical Techniques: 6.1. Applications to free vibration problems of rod and beam. Lumped and consistent mass matrices. 6.2. Solutions Techniques to Dynamic problems, longitudinal vibration, frequencies and mode shapes. Fourth Order Beam Equation, Transverse deflections and Natural frequencies of beams. 6.3 Finding frequencies of beam using FE Software (Can be covered during practical hours).	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. Seshu. P. “*Textbook of Finite Element Analysis*” Prentice Hall of India, 2003.
2. J.N. Reddy, “*Finite Element Method*” Tata McGraw Hill, 2003.
3. Chandrupatla and Belegundu, “*Introduction to Finite Elements in Engineering*” PHI /Pearson Education, 2003.
4. Logan. D.L. “*A first course in Finite Element Method*”, Thomson Asia Pvt. Ltd., 2002.
5. Cook R.D., Malkus. D.S. Plesha, ME., “*Concepts and Applications of Finite Element Analysis*”, John – Wiley Sons 2003.
6. S.S. Rao, “*The Finite Element Method in Engineering*” Butter worth Heinemann, 2001.
7. M. Asghar Bhatti, “*FUNDAMENTAL Finite Element Analysis and Applications with Mathematica and MATLAB Computations*”, Wiley India Pvt. Ltd.

Course Code	Course Name	Credits
PEDLO5013	Plastics Engineering	03

Objectives

1. To familiarize with the vast potential of plastics materials in domestic engineering and specialty application areas.
2. To familiarize with the various processing techniques.
3. To familiarize with the design of moulds and dies.

Outcomes: Learner will be able to...

1. Illustrate the various applications of plastics.
2. Demonstrate applicability of plastics in place of conventional materials.
3. Design various tools for plastics processing.
4. Illustrate various plastic processing techniques.
5. Design different types of moulds with their application.
6. Demonstrate trouble shooting skills in manufacturing plastic parts.

Module	Contents	Hrs.
01	<p>Materials Brief introduction to plastics materials, their classifications, types important properties & fields of application. Introduction to plastics blends, alloys and composites. Principles of recycling of plastics and waste management</p>	04
	<p>Processing Techniques 2.1 Injection Moulding Moulding materials, moulding cycle-phases, and significance. Moulding Machinery: types, constructional and design features, plasticizing screw, injection and clamping units, Technical specifications and selection. Processing Techniques: Process parameters and their influence on product quality, trouble shooting. 2.2 Extrusion Process Constructional and design features of extrusion machinery plasticizing screw. Technical specification and selection. Extrusion lines for pipes, Films (monolayer and multilayer, blown and cast films), sheets, Extrusion coating, monofilaments, box strapping, cables/wires and profiles. [Coverage for the above should include materials, plant layouts, in line equipment, extrusion techniques, process parameter and their influence on extruded products and trouble shooting). 2.3 Blow Moulding Materials for blow moulding application, Types of Machinery, technical specifications and selection. (Extrusion Blow Moulding, Injection blow moulding and stretch Blow moulding). Processing Techniques: Process parameters and their influence on product quality, troubleshooting Comparison between types of Blow Moulding Processes.</p>	10

03	<p>Auxillary equipment for plastics processing Hopper dryers, Deccant dryers, Granulators, Mould temperature controllers, Proportionating devices, chilling units, automatic material conveying systems.</p> <p>Other Process: Brief coverage of the following processes with relevant details like machinery, materials, processing techniques and applications. Thermoset Mouldings, Thermoforming, Rotational Moulding, calendaring, fabrication and decorating with plastics.</p> <p>FRP Techniques: Raw materials and ancillaries used techniques like Hand lay-up, spray up and filament winding processes, applications.</p>	04
04	<p>Product designing with plastics Mechanical behaviour of plastics, creep data and its significance in designing. Product designing tips for designing articles to be manufactured by injection moulding, blow Moulding and Extrusion Processes.</p>	04
05	<p>Design of Moulds 5.1 Compression and transfer moulds: General arrangement of compression moulds-flash, semi positive and positive versions. General arrangement of transfer moulds-moulds for integral pot and auxillary transfer.</p> <p>5.2 Injection Moulds: General arrangement of two plate moulds. Design of mould components, design of feedings, cooling and ejection systems, three plate moulds, Designing for moulds for articles with undercuts-split moulds and moulds with side cores actuation techniques, moulds for internally threaded articles, fully automatic moulds, mould standardization and innovative mould components.</p> <p>5.3 Hot runner systems: General arrangement, design of manifold blocks, flow ways and nozzles, advantages and limitations.</p>	14
06	<p>Blow Moulds: General arrangement and mould components, design of neck and base pinch offs and flash pockets, Venting of moulds, selection of parting lines.</p> <p>Extrusion Dies: Design of extrusion dies for pipes, films, sheets, cables and profiles.</p> <p>Mould Materials of Construction: Characteristics, Tool steels and alloys, non-ferrous materials.</p>	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. *Moulding of Plastics*, Bickales.
2. *Design of Extrusion dies*, M. V. Joshi.
3. *Injection of Mould Design*, R. G. W. Pyre.
4. *Plastic Materials*, Brydson.
5. *Extrusion Technology* – Allen Griff.
6. *Practical guide to Blow Moulding*, Lee.
7. *Injection Moulding: Theory and Practice*, Rubin.
8. *Handbook of Composite fabrication*, Akovali.
9. *Plastic product materials and process selection Handbook*, Rosato.

Course Code	Course Name	Credits
PEDLO5014	Micro And Nano Manufacturing	03

Objectives:

1. To familiarize with the applications of various Micro and Nano manufacturing technologies.
2. To familiarize with traditional Micro and Nano machining.
3. To familiarize with Non-traditional Micro machining methods.
4. To familiarize with Micro Forming and Welding techniques.
5. To familiarize with various processes used for Nano finishing and carbon nano tube production.

Outcomes: Learner will be able to...

1. Demonstrate understanding of various traditional/non- traditional micro and nano machining methods.
2. Demonstrate understanding of various micro forming/welding techniques.
3. Demonstrate understanding of various nano finishing/carbon nano tube production methods.
4. Illustrate the details of various Micro Forming and Welding techniques.
5. Demonstrate various Nano Finishing Techniques used in industries.
6. Illustrate various Carbon Nanotube Production processes applicable in industries.

Module	Contents	Hrs.
01	Overview of Micro and Nano Manufacturing Introduction, Micro-Products And Design Considerations For Manufacturing, Material Factors, Considerations On Manufacturing Methods, Manufacturing Methods And Processes, Process Chains And Hybrid Processes, Transition from Nanotechnology to Nano manufacturing.	06
02	Traditional Micro and Nano Machining Mechanical micromachining: Introduction, Machining Effects at the Microscale, Shear Angle Prediction, Plastic Behavior at Large Strains, Langford and Cohen's Model, Walker and Shaw's Model, Usui's Model, Sawtooth Chip Formation in Hard Turning, Fluid-Like Flow in Chip Formation, Size Effects in Micromachining, Micromachining tool design, Nanomachining: Nanometric machining Theoretical basis of Nano machining Cutting force and energy, Cutting temperature, Chip formation and surface generation, Minimum undeformed chip thickness, Critical cutting edge radius, Properties of workpiece materials, Comparison of nanometric machining and conventional machining, Implementation of nanomachining - single point diamond turning.	12
03	Non-traditional Micro Machining Ultra Sonic Micro Machining, Chemical and Electro Chemical Micro Machining, Electric Discharge Micro Machining, Electron Beam Micro Machining, Laser Beam Micro Machining, Ion Beam Micro Machining.	06
04	Micro Forming and Welding	06

	Micro Blanking and Punching, Micro Embossing, Micro Extrusion, LASER Micro Welding, Electron Beam Micro Welding.	
05	Nano Finishing Techniques Abrasive Flow Machining (AFM), Magnetic Abrasive Finishing (MAF), Magneto rheological Finishing (MRF), Magneto rheological Abrasive Flow Finishing (MRAFF), Magnetic Float Polishing (MFP), Elastic Emission Machining (EEM), Chemical Mechanical Polishing (CMP).	06
06	Carbon Nanotube Production Chemical Vapour Deposition, Arc Discharge, Laser Ablation, Mechanisms of Growth, Purification of Carbon Nanotube.	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. Mark J. Jackson, *Micro and Nanomanufacturing*, Springer, 2007.
2. N. P. Mahalik, *Micromanufacturing and Nanotechnology*, Springer, 2006.
3. Yi Qin, *Micro-Manufacturing Engineering and Technology*, Elsevier, 2010.
4. Ming Wang Fu, Wai Lun Chan, *Micro-scaled Products Development via Microforming*, Springer, 2014.
5. Waqar Ahmed, Mark J. Jackson, *Emerging Nanotechnologies for Manufacturing*, 2nd Edition, Elsevier, 2015.
6. Joseph McGeough (Editor), *Micromachining of Engineering Materials*, Marcel Dekker, 2002.
7. V.K. Jain (Editor), *Micromanufacturing Processes*, Taylor and Francis, 2013.
8. Mark J. Jackson, *Microfabrication and Nanomanufacturing*, Taylor and Francis, 2006.

Course Code	Course Name	Credits
PEDLO5015	Sustainable Manufacturing	03

Objectives

1. To introduce basic concepts related to sustainability and sustainable development.
2. To get conversant with indigenous and global concerns about sustainability and its implications in manufacturing.
3. To familiarize with various technological innovations, approaches & environmental standards /legislations to promote sustainable development.

Outcomes: Learner will be able to...

1. Illustrate the agenda of indigenous and global sustainability to fulfil green expectations.
2. Demonstrate the knowledge about management of waste, pollution & energy conservation.
3. Demonstrate the knowledge of sustainability issues with its implementation in manufacturing.
4. Illustrate the relevance and implications of environment friendly materials.
5. Illustrate the implications of environment management in the context of modern industrial practices.
6. Develop the sustainability approach in environmental strategy and manufacturing.

Module	Contents	Hrs.
01	Sustainability: Basic concepts related to sustainability and sustainable development. Issues and challenges facing sustainable development. Global & indigenous sustainability agenda, green expectations & green movement.	04
02	Management of waste & pollution: Types, sources and nature of wastes, waste processing, green processing & engineering operations, Energy recovery, and 3 R principle. Types of pollution and management:-Anti pollution approaches & guide lines.	08
03	Management of Energy: Sources of energy, renewable energy, Innovations in generation, conservation, recycling and usage of energy. Energy audit and implications.	07
04	Environment friendly materials : Materials for sustainability , eco-friendly and new age energy efficient and smart materials , alternative manufacturing practices , materials and selection of manufacturing processes , control on use of renewable materials , Bio-degradable materials recycling of materials.	07
05	Environment Management : Innovations for reuse , bio-processing technology , sustainable loading on ecosystems , concept of eco-efficiency and its implementation , Environment analysis from raw materials to disposal (cradle to grave concept) sustainable design and materials for sustainable design , Environmental standards and legislations. ISO 14000, carbon foot print, anti-pollution boards, Environment management in business world, changing scenario in global perspective.	08

06	Integrating sustainability approach: Environmental issues in operating strategy, creating sustainable manufacturing, promoting sustainability awareness, sustainability rating schemes, eco-labelling programmes, human values and professional ethics in sustainable manufacturing. Encouraging innovations in sustainable manufacturing.	06
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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. *Strategic Management of Sustainable manufacturing operations* (Advances in logistics operations & Management) By. Rameshwar Dubey & Angappa Gunabekaran by Imuste Productivity press.
2. *Analysis for Smart energy management: Tools and applications for sustainable manufacturing.* By Seog-chanoh and Alfred .J.Hildreth , Springer Series.
3. *Advances in sustainable Manufacturing* By Gunther Seliger and Marwan M.K. khraishah, Springer Series
4. *Green Management* by M.Karpagam, Geetha Jaikumar, Ane Books Pvt.Ltd.
5. *Design for Environment: A guide to sustainable Product Development.*
6. *Sustainable Development* By M.K. Ghosh Roy Ane Books Pvt.Ltd,

Course Code	Course Name	Credits
PEL501	Design of Mould & Metal Forming Tools Laboratory	01

Objectives

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

Outcomes: Learner will be able to...

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

Sr.no	Design Exercise/Assignments
01	Assignment on Sand casting
02	Assignment on Special casting process.
03	Assignment on Extrusion process.
05	Design of sand casting moulds.
06	Design of Pressure die casting dies.
07	Design of Forging dies.
08	Design of Roll pass grooves.

Term Work

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

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

Assignments	: 07 marks
Industrial visit Report	: 03 marks
Design Exercises with Drawings (scaled model) on A4 size	: 15 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 syllabus content.
2. Examiners are expected to give a small task or ask questions either to evaluate understanding of basic fundamentals or to evaluate their capability of applying basic theory to practical applications.

Course Code	Course Name	Credits
PEL502	Machine Design – I Laboratory	01

Objectives

1. To familiarize with basic principles of engineering design and design various machine components.
2. To familiarize with the use of design data books & various codes of practice.
3. To familiarize with the preparation of working drawings based on designs.

Outcomes: Learner will be able to...

1. Demonstrate various design considerations.
2. Apply basic principles of machine design.
3. Design machine elements.
4. Use design data books and various standard codes of practices.
5. Prepare drawings pertaining to various designs.
6. Design various joints used in engineering applications.

Sr.no	Design Exercises/ Assignments
01	Design of Curved Beams
02	Design of Bolted, Welded and Riveted Joints
03	Design of Springs and Pressure Vessels
04	Design of Socket and Spigot type Cotter Joint, Knuckle Joint, Turnbuckle (Any Two)
05	Design of Shafts (Two Design Problems)
06	Design of Rigid Flange Coupling, Bush Pin Type of Flexible Coupling

Term Work

Term work shall consist of exercises listed in the above list

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

Assignments	: 10 marks
Design Exercises with Drawings on A4 size Paper	: 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 syllabus content.
2. Examiners are expected to give a small task or ask questions either to evaluate understanding of basic fundamentals or to evaluate their capability of applying basic theory to practical applications.

Course Code	Course Name	Credits
PEL503	CAD/CAM/CIM Laboratory	01

Objectives

1. To introduce new and exciting field of Intelligent CAD/CAM/CAE with particular focus on engineering product design and manufacturing.
2. To develop a holistic view of initial competency in engineering design by modern computational methods.
3. To develop New API for CAD

Outcomes: Learner will be able to...

1. Identify proper computer graphics techniques for geometric modelling.
2. Transform, manipulate objects as well as store and manage data.
3. Create CAM Toolpath and prepare NC- G code
4. Apply rapid prototyping and tooling concepts in any real life applications.
5. Identify the tools for Analysis of a complex engineering component.

List of Exercises

1. Programming for transformations,
2. API on Creating As built joints, Slider Joint Motion
3. Get the physical Properties API
4. Get the circle and arc data from the edge
5. Sketch spline through points creation : API
6. Solid modeling using any 3D modeling software
7. Part programming and part fabrication on CNC trainer (Turning / Milling)
8. Geometrical optimization of any mechanical component using computer aided engineering concepts. (Shape optimization)
9. Development of physical 3D mechanical structure using any one of the rapid prototyping processes.

Term Work

Term work shall consist of

- a. Any four exercises from 1 to 6 of above list
- b. Part programming and part fabrication on CNC trainer
- c. A course project in a group of not more than four students based on 8 and 9 of above list

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

- Exercises : 15 Marks
- Course Project : 05 Marks
- Attendance : 05 Marks

Assessment:

End Semester Practical/Oral Examination:

1. Each student will be given a small task of design based on syllabus, which will be assessed by pair of examiners during the oral examination.
2. Distribution of marks for practical-oral examination shall be as follows:

Design Task:	15 marks
Oral:	10 marks
3. Evaluation of practical/oral examination to be done based on the performance of design task
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
PEL504	Metrology And Quality Engineering Laboratory	01

Objectives

1. To acquaint with the principles of precision measuring instruments & their significance.
2. To familiarize with the handling & use of precision measuring instruments / equipments.
3. To acquaint with key features and basics of the Total Quality Management philosophy.
4. To familiarize with various quality tools and their uses in solving the problems.

Outcomes: Learner will be able to...

1. Handle & operate precision measuring instruments /equipment's.
2. Measure linear and angular measurements.
3. Measure thread and gear dimensions.
4. Design Go and Not Go gauge for given assembly.
5. Analyze simple machined components for dimensional stability & functionality.
6. Use proper quality tools in various manufacturing /service problems.
7. Use appropriate quality approaches for productivity improvement.
8. Comprehend and apply Quality standards in different situations.

Sr. No.	Experiments/Assignments
	Any Five experiments
01	Use of linear and angular measuring instruments
02	Use of Profile projector.
03	Use of comparator.
04	Measurement of surface roughness.
05	Measurement of flatness.
06	Thread measurement.
07	Gear measurement.
	Assignment on any Six assignments
01	Limits, Fits, Tolerance and Gauge Design.
02	Comparators and Interferometers
03	Surface Roughness Measurement.
04	Thread Measurement
05	Gear Measurement
06	Total Quality Management
07	Statistical Quality Control
08	Quality Standards

Term Work

Term work shall consist of at least 1 assignment on each module from syllabus and minimum 05 experiments as per above list to be conducted and presented with inferences.

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

Laboratory work (Experiment/ programs and journal):	10 Marks
Assignments:	10 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.

Practical / Oral Examination

1. Practical examination shall be conducted based on the list of experiments. Examination shall be based on actual handling of instruments and accurate measurement of given parameters.
2. Examiners are expected to evaluate learners' skill of handling the instruments and accurate measurement of asked parameters and conduct oral based on the syllabus.
3. The distribution of marks for practical/oral examination shall be as follows:
 - a. Practical performance 15 marks
 - b. Oral 10 marks
4. Students work along with evaluation report to be preserved till the next examination.

Subject Code	Subject Name	Credits
PEL505	Business Communication & Ethics	02

Objectives:

1. To inculcate professional and ethical attitude at the workplace
2. To enhance effective communication and interpersonal skills
3. To build multidisciplinary approach towards all life tasks
4. To hone analytical and logical skills for problem-solving

Outcomes: Learner will be able to...

1. Design a technical document using precise language, suitable vocabulary and apt style.
2. Develop the life skills/ interpersonal skills to progress professionally by building stronger relationships.
3. Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities.
4. Apply the traits of a suitable candidate for a job/higher education, upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP.
5. Deliver formal presentations effectively implementing the verbal and non-verbal skills

Modules	Detailed Content	Hours
01	Report Writing 1.1 Objectives of Report Writing 1.2 Language and Style in a report 1.3 Types : Informative and Interpretative (Analytical, Survey and Feasibility)and Formats of reports (Memo, Letter, Short and Long Report)	05
02	Technical Writing 2.1 Technical Paper Writing (IEEE Format) 2.2 Proposal Writing	03
03	Introduction to Interpersonal Skills 3.1 Emotional Intelligence 3.2 Leadership and Motivation 3.3 Team Building 3.4 Assertiveness 3.5 Conflict Resolution and Negotiation Skills 3.6 Time Management 3.7 Decision Making	09
04	Meetings and Documentation 4.1 Strategies for conducting effective meetings 4.2 Notice, Agenda and Minutes of a meeting 4.3 Business meeting etiquettes	02
05	Introduction to Corporate Ethics 5.1 Professional and work ethics (responsible use of social media - Facebook, WA, Twitter etc. 5.2 Introduction to Intellectual Property Rights 5.3 Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response and making ethical decisions)	02

06	Employment Skills 6.1 Group Discussion 6.2 Resume Writing 6.3 Interview Skills 6.4 Presentation Skills 6.5 Statement of Purpose	07
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Assessment:

List of Assignments

1. Report Writing (Theory)
2. Technical Proposal
3. Technical Paper Writing (Paraphrasing a published IEEE Technical Paper)
4. Interpersonal Skills (Group activities and Role plays)
5. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
6. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
7. Corporate ethics (Case studies, Role plays)
8. Writing Resume and Statement of Purpose

Term Work

Term work shall consist of all assignments from the list.

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

Book Report	10 marks
Assignments:	10 marks
Project Report Presentation:	15 marks
Group Discussion:	10 marks
Attendance:	05 marks

References:

1. Fred Luthans, "Organizational Behavior", Mc Graw Hill,
2. Lesiker and Petit, "Report Writing for Business", Mc Graw Hill
3. R.Subramaniam, "Professional Ethics" Oxford University Press
4. Huckin and Olsen, "Technical Writing and Professional Communication", McGraw
5. Raman and Sharma, Fundamentals of Technical Communication, Oxford University Press
6. Hill Wallace and Masters, "Personal Development for Life and Work", Thomson Learning, 12th Edition
7. Heta Murphy, "*Effective Business Communication*", Mc Graw Hill, edition
8. R.C Sharma and Krishna Mohan, "*Business Correspondence and Report Writing*",
9. Raman Sharma, *Communication Skills*, Oxford University Press
10. B N Ghosh, "*Managing Soft Skills for Personality Development*", Tata McGraw Hill Lehman,
11. Dufrene, Sinha, "*BCOM*", Cengage Learning, 2nd edition
12. Bell . Smith, "Management Communication" Wiley India Edition, 3rd edition.
13. Dr. K. Alex , "Soft Skills", S Chand and Company
14. Robbins Stephens P., "Organizational Behavior", Pearson Education
15. <https://grad.ucla.edu/asis/agep/advsoystem.pdf>

Course Code	Course Name	Credits
PEC601	Machining Science and Technology	04

Objectives:

1. To familiarize with the basic concepts of machining science like mechanics of machining, tool wear, tool life and surface roughness.
2. To familiarize with various single and multipoint cutting tools designing processes
3. To prepare for understanding the economics of machining process.

Outcomes: Learner will be able to...

1. Calculate the values of various forces involved in the machining operations.
2. Analyse the effect of temperature and cutting fluids in metal cutting.
3. Analyse the surface integrity after post machining.
4. Design various single/multipoint cutting tools.
5. Select an appropriate tool material for particular machining application.
6. Demonstrate the interrelationship between cutting parameters and machining performance measures.

Module	Contents	Hrs.
01	<p>Metal Cutting Theory: Orthogonal and oblique cutting, various types of chips ,Mechanics of orthogonal steady state metal cutting ,shear plane and shear plane angle, Merchant's force circle, stresses, shear strain, velocity relations, rate of strain, energy considerations ,Concept of specific power consumption in machining, Ernst and Merchant's model& modified model for orthogonal cutting, Lee and Shaffer model. Analytical modelling of machining operations, mechanistic modelling of machining, slip line field analysis, finite element analysis, modelling of material properties.</p> <p>Dynamometry: Dynamometer requirements, force measurement, electric transducers, strain gage lathe dynamometer, strain rings, milling dynamometer, drilling dynamometer, surface grinding dynamometer, piezoelectric dynamometry.</p>	10
02	<p>Temperatures in metal cutting and cutting fluids: Heat generation in metal cutting, heat transfer in a moving material, temperature distribution in metal cutting, temperature in primary deformation zone, temperature in secondary deformation zone, effect of cutting speed on temperature, prediction of temperature distribution in machining, measurement of cutting temperature, work-tool thermocouple, direct thermocouple measurement, radiation methods, hardness and microstructure changes in steel tools.</p> <p>Cutting fluid types, the action of coolants, the action of lubricants, characteristics of an efficient lubricant in metal cutting, application methods of cutting fluid, cutting fluid maintenance and environmental considerations, disposal of cutting fluids, dry cutting and minimum quantity lubrication, cryogenic cooling.</p>	06
03	<p>Cutting tool materials and machining induced Surface Integrity Properties of cutting tool materials. Major tool material types. Plain carbon steel, high speed steel, cast alloys, cemented tungsten carbide, titanium</p>	06

	carbides, ceramic and cermet tools, synthetic diamond, polycrystalline diamond (PCD), cubic boron nitride (CBN), coated tools. Measurement and specification of surface finish, primary cutting edge finish, fracture roughness, BUE formation and its influence on finish, secondary cutting edge finish, geometrical contribution to roughness, edge finishing, residual stress and microhardness.	
04	Tool life and machining economics: Definition, flank wear and crater wear, criteria for tool failure, effect of cutting parameters and tool geometry on tool life. Taylor's tool life equation. Experimental methods to find Taylor exponents. Components of product cost, Optimum cutting velocity for minimum cost of production and maximum production rate.	06
05	Design of single point cutting tools : Different systems of tool nomenclature like MRS, ORS and NRS. Interrelationship among different systems of nomenclature for tool angles. Constructional features of solid tool, tipped tools, mechanically held regrind able insert type tools and throw away tip type tools. Design of shanks, cutting tip and chip breakers for HSS and Carbide tools. ISO coding system for tipped tools and tool holders.	08
06	Design of Multi point cutting tools: Various types such as flat form tool, tangential form tool, circular form tool, constructional details and fields of application. Profile design of flat and circular form tools. Broach nomenclature, design steps for circular pull type, key way and spline broaches. Design of face and peripheral milling cutters.	12

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. *Fundamentals of Metal Machining and Machine Tools, Third Edition* by Winston A. Knight, Geoffrey Boothroyd, CRC press Taylor and Francis group (2006).
2. *Metal Cutting Principles (2nd Edition)*, by Milton Clayton Shaw, Oxford University Press (2005).
3. *Cutting Tools*, by P. H. Joshi, A. H. Wheeler Publishing Co. Ltd. (1991).
4. *ASM Handbook, Vol. 16: Machining (9th Edition)*, by Joseph R. Davis, ASM International(1989).

5. *Fundamentals of Metal Cutting and Machine Tools (2nd Edition)*, by B. L. Juneja, G. S. Sekhon and Nitin Seth, New Age International Pvt. Ltd. (2003).
6. *Metal Cutting Theory and Cutting Tool Design*, by V. Arshinov and G. Alekseev, Mir publishers, Moscow (1976).
8. *Typical Examples and Problems in Metal Cutting and Tool Design*, by N. Nefedov and K. Osipov, Mir publishers, Moscow (1986).

Course Code	Course Name	Credits
PEC602	Process Engineering and Tooling	04

Objectives

1. To familiarize with the significance of process engineering with its relevance to manufacturing operations.
2. To prepare a skills in preparing machining sequence and estimate manufacturing time.
3. To acquaint with the significance and control of tolerance in design & manufacturing.
4. To appraise with basics of process and operation planning.

Outcomes: Learner will be able to...

1. Determine machine sequences to cater to the manufacturing requirements.
2. Analyse part prints.
3. Prepare tolerance control charts with its balancing.
4. Design work holding devices for consistent positioning of work piece in relation to the tool.
5. Prepare process picture, process routing/process sheets.
6. Design cams for part production on single spindle automats.

Module	Contents	Hrs.
01	Process Engineering Differentiation between Product Engg and Process Engg. Role of process engineering in a manufacturing setup, organization chart, functions of process engineering. Determining machining sequences - criteria and manufacturing sequence.	04
02	2.1 Preliminary Part Print Analysis General characteristics, determining the principal processes, alternate processes, functional surfaces of the work piece, areas for processing, nature of work to be performed, finishing and identifying operations, case study for understanding preliminary part print analysis. 2.2 Work piece control Causes of work-piece variations, variables influencing work-piece control, work piece control techniques - Equilibrium theories, concept of location, geometric control, dimensional control, mechanical control, alternate location theory.	08
03	Tolerance Design Dimensional Analysis: Types of dimensions, concept of baseline dimension, basic geometric dimensioning and tolerance (GD & T). Tolerance Analysis: Rules for adding and subtracting tolerance, tolerance stacks, design and process tolerance stacks, tolerance chart, purpose and use of tolerance chart, definitions and symbols, determining lay-out of tolerance chart, stock removal, constructing and balancing of tolerance chart.	08
04	Process planning 4.1 Classifying operations (Study of Basic Processes Operations, Principal Processes and Auxiliary Processes, identification of major, critical, qualifying, re-qualifying and supporting operations), product and process critical area, selection of equipment and Tooling. 4.2 Computer Aided Process Planning (CAPP): CAPP -variant approach and generative approach.(Detail)	06

05	<p>5.1 Operation Planning Process plan sheet design for complete manufacturing part with details of sequence of operations, machine or equipment used, Process pictures, machining parameters i.e. cutting speed, feed, depth of cut, tooling and gauge details, cutting tools specifications and gauge details machining time calculations. Tool layout for turning on production lathe.</p> <p>5.2 Other aspects of Process Engineering Introduction to high speed machines, SPM, transfer line and other mass production machines-Elementary treatment only, in-process gauging and multiple gauging. ERP SOFTWARE (PPC module -only introduction).</p>	12
06	<p>Cam Design for Automat Automats major classification& types, tools and tool holders, magazines, and hoppers for feeding. Single spindle automats and its tooling, tool layout and cam design for part production on Single spindle automat.</p>	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. Process Engineering for Manufacturing, Donald F. Eary and Gerald E. Johnson, Prentice-Hall, Inc.
2. Production Technology, HMT.
3. Manufacturing Engineering, V. Danilevsky, Mir publication.
7. Tolerance Design and Analysis, Wade.
8. Fundamentals of Manufacturing Engineering, V.M. Kovan et al, Mir Publications.
9. HSS and Carbide Tool Catalogues for Turning, Drilling, Milling, Boring etc. from Tool manufactures.
10. Westerman Tables for the Metal Trade, Wiley, Eastern Limited.
11. PMT Catalogue Traub Automat

Course Code	Course Name	Credits
PEC603	Production Tooling	04

Objectives:

1. To acquaint with the concepts pertaining to planning and sequencing of operations.
2. To familiarize with the capabilities of designing a simple productive and cost effective jigs and fixtures
3. To acquaint with the various press working operations for mass production of sheet metal components.
4. To familiarize with the sheet metal working techniques for design of press tools.

Outcomes: Learner will be able to...

1. Select location and clamping faces/points on jobs.
2. Design and develop simple productive and cost effective jigs.
3. Design and develop simple productive and cost effective fixtures.
4. Identify press tool requirements to build concepts pertaining to design of press tools.
5. Prepare working drawings and setup for economic production of sheet metal components.
6. Demonstrate the principles of blank development in bent & drawn components.

Module	Contents	Hrs
01	<p>Introduction to Jigs and Fixture: 1.1Introduction to Jigs and Fixtures, their difference and Significance. Material used for different elements of jigs/fixtures and recommended hardness where necessary. 1.2Location & Locating Devices: Locating principles, Degrees of freedom, Redundant location, Fool proofing, nesting, Locators: location from Flat and cylindrical surfaces, conical locators, centralizers. 1.3Clamping & clamping Devices: Clamping Principle, Examples of typical clamps such as multiple clamping and equalizing devices, quick acting clamping mechanisms such as link, toggle, cam, eccentric, pneumatic &hydraulic devices.</p>	08
02	<p>Construction of Drill Jig 2.1 Introduction, Selection of location, supporting and clamping faces/points. 2.2 Various types of Jig Bushes. 2.3 Commonly used Drill jigs. Case Study on Drill Jig Design.</p>	08
03	<p>Construction of Milling fixture 3.1 Introduction, Selection of location, supporting and clamping faces/points. 3.2 Tool setting &cutter guiding (Tennons & Setting block). 3.3 Case Study on Milling Fixture Design.</p>	08

04	<p>Introduction to Press Working</p> <p>4.1 Classification of common Press working operations, Benefits and limitations of using Press tools. Applications of pressed parts/components.</p> <p>4.2 Theory of Shearing in Press Working. Optimum Cutting clearance Construction of Basic shearing die. Functions of different elements of a press tool. Methods of feeding the strip/coil material.</p>	06
05	<p>Design and Calculations for Piercing & Blanking Die</p> <p>5.1 Different types of Dies, Die sets and its selection.</p> <p>5.2 Calculations for Economic Strip Layout, Calculations of Cutting force and Stripping force. Recommending minimum tonnage of a press. Centre of Pressure (its importance and calculation).</p> <p>5.3 Design aspects of Press tool elements viz. Punches & methods of retaining punches, Die block, Stripper, Pilot, etc. Methods of reducing cutting loads on press tools.</p> <p>5.4 Selection of materials and its hardness for different elements of Press tools.</p>	10
06	<p>Bending & Drawing Dies</p> <p>6.1 Theory of Bending. Spring back and measures to control it. Calculations for bending force & Blank development of Simple Bent components. Types of Bending dies. Minimum bend radius.</p> <p>6.2 Theory of Drawing. Metal flow in Drawing & forming operations; reduction ratio and redrawing limits, draw clearance, drawing and blank holding forces for cylindrical draws only. Blank development of Cup.</p> <p>6.3 Defects in drawn as well as bent parts. Presses selection for drawing/bending operations.</p> <p>6.4 Basic construction and working of Bending and Drawing dies.</p>	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. *Production Engineering* – P. C. Sharma
2. *Jig and Fixture Design Manual*, Erik K. Henrikson, Industrail Press.
3. *Jigs and Fixture*, P.H. Joshi, THM. .
4. *Non- Standards Calming Devices*, Hiran E. Grant TMH, New Delhi.
5. *Die Design Fundamentals* – J. R. Paquin
6. *Techniques of Press Working Sheet Metal* – D. F. Eary& E. A. Reed
7. *Press Tools Design and Construction* – P. H. Joshi
8. *Tool Design* – C.Donaldson

Course Code	Course Name	Credits
PEC604	Machine Design - II	04

Objectives:

1. To familiarize with the constructional & design features of machine tool structures like bed, columns, slide ways/guideways and mechanical drives.
2. To prepare for a skills in designing feed gear boxes, bearings, power screws, clutches etc. used in machine tools.
3. To acquaint with the usage of standards & hand books and retrieve relevant data from these for designing/selection of machine tool components.
4. To appraise about safety and safety standards pertaining to machine tools.
5. To acquaint with the recommended procedure of carrying out acceptance tests on machine tools & their significance.

Outcomes: Learner will be able to...

1. Design machine tool structures, drive elements/drives.
2. Design feed gear boxes.
3. Design power screws and clutches.
4. Design bearings.
5. Demonstrate the requirements like maintaining of expected accuracy levels, parametric optimization, managing wear and tear problems.
6. Illustrate the safety aspects/ acceptance tests in machining tools.

Module	Contents	Hrs.
01	<p>ELEMENTS OF MACHINE TOOLS</p> <p>1.1 Types and capabilities of various machine tools. General purpose, and special purpose machine tools.</p> <p>1.2. Design of machine tool structures :-</p> <p>1.2.1 Design of bed & columns- Materials of construction, Profiles, Static and dynamic stiffness. Designing for strength and rigidity. Methods of enhancing rigidity. Design of machine tool bed cross-section like lathe bed. Design of simple machine tool columns like pillar drill column etc. on the basis of strength and rigidity.</p> <p>1.2.2 Machine tool guideways - Materials of construction, Classification of guideways, Types of slideways, Clearance adjustment and wear compensation techniques, Fundamentals of hydrostatic guideways. Design of guideways for wear and stiffness.</p> <p>1.3 Design of mechanical drives:</p> <p>1.3.1 Design of belt drives - Design of belts, belt materials, belt types:- specification and selection, types of pulleys and design of pulleys.</p> <p>1.3.2 Design of gear drives - Types of gears, materials, application, and selection. Design of spur gears - Design on the basis of beam strength (W. Lewis equation), Design on the basis of wear and fatigue (Buckingham's Equation) Design of chain drives- Types of chains and sprockets. Principles of designing sprockets and roller chains. Design of chain drives- Types of chains and sprockets. Principles of designing sprockets and roller chains.</p>	12

02	<p>DESIGN OF SPEED AND FEED BOXES</p> <p>2.1 Stepped and Stepless speed outputs, selection of spindle speed ranges, construction of structural, speed, gearing & deviation diagrams, layout of speeds on arithmetic and geometric progression, kinematic advantages of geometric progression series, selection of values of common ratio.</p> <p>2.2 Stepless drives : Mechanical stepless drives – single disc, double disc and cone disc transmissions, speed regulation by epicyclic gear train, positive infinitely variable drives (PIV drives) – Kopp’s , Meander and Svetozarav’s drives.</p> <p>2.3 Feed boxes: Quadrant change gear mechanism, speed boxes with gear cone and sliding key, Norton gear drive, Meander gear drives, gear boxes with clutched drive, Schopke drive and Ruppert drive.</p> <p>2.4 Design of gear boxes for feed and speeds having 2–3 stages and 4–12 speeds.</p>	16
03	<p>DESIGN OF POWER SCREWS</p> <p>3.1 Design of power screws: Materials of construction. Power screw profiles and selection, design of machine tool power screws based on strength, buckling and stiffness, power requirements and efficiency, mounting of power screws, Elementary treatment on ball recirculating power screws.</p>	04
04	<p>DESIGN OF CLUTCHES</p> <p>4.1 Design considerations, materials of clutch plates & linings. Running conditions- wet & dry.</p> <p>4.2 Design of plate clutches. Single and multiplate clutches involving design of clutch plates, springs & operating lever.</p>	04
05	<p>DESIGN OF MACHINE TOOL BEARINGS</p> <p>Bearing materials & their characteristics. Types of bearings- selection & application.</p> <p>5.1 Design of ball & roller bearings – Bearing designation (ISI, ISO, SAE, and SKF). Calculation of equivalent load, cubic mean load, static & dynamic load bearing capacities. Selection of ball & roller bearing from handbook. Mounting & maintenance of bearings.</p> <p>5.2 Design of journal bearings – Terminology. Theory of lubrication, bearing characteristic Number, Sommerfeld Number, calculations involving bearing dimensions, clearance, coefficient of friction, heat generated, heat dissipated and power lost in friction. Mounting & maintenance of bearings.</p>	07
06	<p>SAFETY OF MACHINE TOOLS & ACCEPTANCE TESTS</p> <p>6.1 Safety concepts, various safety devices incorporated in machine tools to safeguard safety of man, tools and equipment. Interlocked, fool proof safety systems. Introduction to safety standards.</p> <p>6.2 Acceptance tests on machine tools : Significance, performance and geometrical tests on lathe, milling, drilling and shaping machines.</p> <p>6.3 Vibrations in machine tools:- Elementary concepts about factors contributing to vibrations, vibration detection and measurement, remedial approaches</p>	05

NOTE:

Use of standard design data books like PSG data book is permitted at the examination and shall be supplied by the college.

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. *Principles of machine tools*, Sen and Bhattacharya, New Central Book Agency.
2. *Machine tool design and Numerical Control*, N.K.Mehta, Tata MGH
3. *Machine tool Engineering*, G R Nagpal, Khanna Publishers.
4. *Design of Machine tool*, S.K. Basu and D.K.Pal, Oxford and IBH publishing Co.
5. *The design and construction of machine tools*, H.C.Town.
6. *Machine tool design hand book: Central Machine Tool Research Institute*, Bangalore. Tata MGH
7. *PSG Design Data book*: PSG College of engineering and technology, Coimbatore.
8. *Machine Tool Design (Volume 3)*, (English, Paperback, V. Vermakov, N. Acherkan, Nicholas Weinstein)
9. *Machine Tool Structures*: v. 1, by F. Koenigsberger (Author), J. Tlustý (Author)

Course Code	Course Name	Credits
PEC605	Production and Operations Management	04

Objectives:

1. To prepare for understanding of the role of production and operations management in the overall business strategy of the firm.
2. To prepare for understanding of the interdependence of the operating system with other key functional areas of the firm.
3. To familiarize with the key factors and interdependence of these factors in the design of effective operating systems.
4. To prepare for identification and evaluation of tools appropriate for analysis of operating systems of the firm.
5. To familiarize with the application of production and operations management policies and techniques to the service sector as well as manufacturing firms.

Outcomes: Learner will be able to...

1. Analyze implications of Production and Operations Management in industries.
2. Demonstrate the role of Production Management in creating competitive advantage for business organizations.
3. Analyze various constituents of production operations in manufacturing and service.
4. Plan and control various production related activities.
5. Illustrate various inventory management procedures with the tools employed there in.
6. Demonstrate role of JIT, MRP, and ERP with their contribution towards production and operations management.

Module	Contents	Hrs.
01	Introduction An overview of Production and Operations Management (POM), Managing a Production System, Types of Production Systems, Significance of Productivity, Decision making in POM, Problems in POM, Sub functional areas of POM, Recent trends in POM.	06
02	Product Planning and Development (PPD) What is a Product?, Need, Objectives and Challenges of PPD, characteristics of Successful Product Development, New Product development Strategy and Process, Factors to be considered in Product Development, The Product Life Cycle Concept, Factors affecting Product Design and Product Development, Stages in Product Design and Product Development.	06
03	3.1 Facility Location The need for location decision, Procedure for making location decisions, Factors affecting location decisions, Methods of evaluating location decisions (numerical on this topic)	08

	<p>3.2 Facility Layout / Plant Layout Types of Layout, Significance and Factors influencing layout choices, Principles of Plant layout, Computerised Layout Techniques.</p> <p>3.3 Materials Handling Function, Importance and Objectives of Material Handling, Material handling Principles, Types of Material Handling Systems, Selection of Material Handling Equipments, Evaluation of Material handling Performance Relationship with Plant layout (numerical on this topic).</p>	
04	<p>Production Planning and Control Classification of PPC functions, Factors determining PPC, procedure Role of PPC in POM, Principles of PPC, PPC in different Production System, Organisation of PPC department.</p>	06
05	<p>Inventory Management Nature, Importance, Classification and Functions of Inventory, Inventory Costs, Importance of Inventory Management, Inventory Control System for Dependent Demand and Independent Demand, Inventory Ordering Systems. Inventory Control subject to Known Demand. The EOQ Model, Extension to Finite Production Rate, Quantity Discount Model (numerical on this topic). Inventory Control subject to Uncertain Demand, The Newsboy Model, Service Levels in Q and R Systems, (numerical on this topic)</p>	12
06	<p>Advance Topics in POM Material Requirement Planning (MRP) (numerical on this topic), Manufacturing Resource Planning (MRP II), Enterprise Resource Planning (ERP), Just in Time Manufacturing, Lean Production, Agile Manufacturing, Line Balancing (numerical on this topic), Line of Balance (numerical on this topic), Sustainable Production and Green Manufacturing.</p>	12

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. *Production and Operations analysis* by Steven Nahmias , McGraw-Hill/Irwin publication
2. *Facilities Planning* 4th Edition by James A. Tompkins, John Wiley and Sons Inc.
3. *Elements Of Production Planning And Control* by Eilon, Samuel, New York: Macmillan
4. *Production Planning and Control* by Prof. Jhamb L.C. by Everest Publishing House
5. *Production (Operations) Management* by Prof. Jhamb L.C. by Everest Publishing House
6. *Inventory Management* Prof. Jhamb L.C. by Everest Publishing House
7. *Operations Management- an Integrated Approach* 5th Edition by R. Dan Reid , Wiley
8. *Production and Operations Management* by R. Panneerselvam, Prentice-Hall Of India
9. *Operations Management for Competitive Advantage* by Richard B. Chase, MGH
10. *Orlicky's Material Requirements Planning*, by Carol Ptak , MGH
11. *Enterprise resource planning: concepts and practice* by Vinodkumar Garg PHI Learning
12. *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, by James P. Womack, Free Press
13. *Toyota Production System: An Integrated Approach to Just-In-Time*, by Yasuhiro Monden ,CRC PRESS

Course Code	Course Name	Credits
PEDLO6011	Manufacturing Planning and Control	03

Objectives

1. To provide a profound insights into how to coordinate the supply, production and distribution functions.
2. To provide an insight in knowhow to balance a conflicting objectives to minimize the total costs involved and maximize customer service.
3. To prepare for analytical abilities to formulate, solve and analyze problems arising in modern production and inventory systems.

Outcomes: Learner will be able to...

1. Analyze all aspects of a successful manufacturing planning and control infrastructure.
2. Design demand management scheme.
3. Illustrate the significance of sales and operations planning.
4. Design and oversee an effective master production schedule.
5. Design materials requirements planning.
6. Analyze capacity planning and management.

Module	Contents	Hrs.
01	MPC concept and Significance Typical MPC support activities. An MPC system framework matching, MPC system with the needs of the firm, Evaluation of the MPC system.	06
02	2.1 Demand Management in MPC system Demand management and the MPC environment, Sales and Operations planning, Information Use in Demand management. 2.2 Forecasting The time Horizon in Forecasting, characteristics of Forecast, Subjective Forecasting Methods, Objective Forecasting Mehods, Methods for Forecasting Stationery Series, Trend Based Mthods, Method for Seasonal Series, Evaluating Forecasts, Practical Considerations.	10
03	3.1 Aggregate Planning Overview of the Aggregate Planning Problem, Costs in Aggregate Planning, Evaluation of various strategy, Modelling Management behaviour, Disaggregating Aggregate Plans, Practical Considerations 3.2 Master Production Scheduling The MPS activity, The MPS techniques, Bill of Materials Structuring for the MPS, The final assembly schedule, MPS stability.	06
04	4.1 Capacity Planning and Utilisation The role of Capacity Planning in MPC, Capacity Planning and control Techniques, Rough-cut Capacity Planning, Scheduling Capacity and Materials, Management and Capacity Planning Utilisation. 4.2 Production Activity and Control (PAC) A framework for PAC, PAC Techniques.	08

05	Strategy and MPC System Design MPC Design options, Choosing the Options, Integrating MRP and JIT, Extending MPC integration to customers.	06
06	Advanced concepts in MRP, ERP, JIT and Scheduling, MPC implementation.	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. *Manufacturing planning and control systems* by Thomas E. Vollmann, MGH.
2. *Master production scheduling: principles and practice*, William L. Berry, MGH.
3. *Operations management: a systems model-building approach*, Thomas E. Vollmann, Addison-Wesley Pub. Co.
4. *Manufacturing Planning and Control: Beyond MRP II*, P. Higgins, P. Le Roy, Springer Science & Business Media.
5. *Manufacturing Planning Systems*, Bill Scott McGraw-Hill.
6. *Supply Chain Focused Manufacturing Planning and Control* By W. C. Benton Cengage Learning.
7. *Dynamic Analysis of Agile Manufacturing Planning and Control (MPC) Systems Using Control Theory* by Ahmed Mahmoud Deif, University of Windsor (Canada).
8. *Planning and Control of Manufacturing Operations* by By John Kenworthy, Woodhead Publishing.
9. *Production Planning and Inventory Control*, Seetharama L. Narasimhan, Prentice Hall.
10. *Distribution Planning and Control: Managing in the Era of Supply Chain management* By David Frederick Ross, Kluwer Academic Publisher.

Course Code	Course Name	Credits
PEDLO6012	Refrigeration and Air Conditioning	03

Objectives:

1. To familiarize with the working and operating principles of Vapour Compression and Vapour Absorption systems.
2. To familiarize with the components of refrigeration and air conditioning systems.
3. To familiarize with the design air conditioning systems using cooling load calculations.

Outcomes: Learner will able to...

1. Demonstrate fundamental principles of refrigeration and air conditioning.
2. Locate various important components of the refrigeration and air conditioning system.
3. Illustrate the properties of refrigerants.
4. Use psychometric chart.
5. Design and analyse complete air conditioning systems.
6. Design ducts for conditioning system.

Module	Contents	Hrs.
01	Introduction to Refrigeration: Methods of refrigeration, First and Second Law applied to refrigerating machines, Carnot refrigerator, Carnot heat pump, unit of refrigeration, Coefficient of Performance, Energy Efficiency Ratio (EER), BEE star rating	04
02	Vapour Compression Refrigeration System: Simple vapour compression cycle, Effect of liquid sub cooling & superheating, effect of evaporator and condenser pressures, methods of sub cooling, use of P-h charts, Actual VCR cycle. Types of condensers, evaporators, expansion devices and Compressors. Use of enhanced surface tubes in Heat Exchangers. Cooling tower: Types of cooling towers, tower approach, tower range, tower efficiency, tower losses, tower maintenance. Refrigerants- Desirable properties of refrigerants, ASHRAE numbering system for refrigerants. Thermodynamic, Chemical and Physical properties. Secondary refrigerants, ODP and GWP, Montreal protocol and India's commitment, Recent substitutes for refrigerants.	08
03	Vapour Absorption Refrigeration: Importance of VAR system, COP of ideal VAR system, Ammonia-water VAR system, Lithium Bromide – Water VAR system, Single and double effect, Electrolux refrigeration system. Solar VAR system. Nonconventional Refrigeration Systems : Thermoelectric Refrigeration, Thermoacoustic Refrigeration, Vortex Tube Refrigeration	06

04	Psychrometry Need for air conditioning, Principle of psychromerty, Psychrometric properties, chart and processes, air washers, requirements of comfort air conditioning, summer and Winter Air conditioning.	06
05	Design of air conditioning systems: Different Heat sources,- Adiabatic mixing of two air streams, Bypass factor, sensible heat factor, RSHF, GS HF, ERS HF, Room apparatus dew point and coil apparatus dew point, Ventilation and infiltration, Inside and Outside Design condition, Cooling Load estimation , Introduction to Unitary Products viz. Room/Split and Packaged Air Conditioners, Introduction to recent developments viz. Variable Refrigerant Flow systems, VAV control systems, Inverter Units. Human Comfort, Thermal exchange of body with environment, Effective temperature, Comfort chart, Comfort zone.	10
06	Duct Design and Applications: Friction chart for circular ducts. Equivalent diameter of a circular duct for rectangular ducts, Static pressure regain and equal pressure drop methods of duct design, Factors considered in air distribution system, Air distribution systems for cooling & heating. Controls – LP/HP cutoff, Thermostats, Humidistats, Interlocking control, Electronic Controllers. Applications Refrigeration & A/C Ice plant – food storage plants – dairy and food processing plants, Food preservation ,Freeze Drying, A/c in textile ,printing pharmaceutical industry and Hospitals	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. *Refrigeration and air-conditioning* – C P Arora, TMH
2. *Principles of refrigeration* – R J Dossat, Willey Eastern Publication
3. *Refrigeration and air-conditioning* – W F Stoker and J W Jones, TMH
4. *Modern Air-conditioning practice* – C P Arora, TMH
5. *Refrigeration and air-conditioning*- Manohar Prasad, New Age Int (P) Ltd.
6. *Basic Refrigeration and air-conditioning*- P.Ananthanarayana, TMH
7. *Refrigeration and air-conditioning*- V. M. Domkundwar

Course Code	Course Name	Credits
PEDLO6013	Reliability Engineering	03

Objective:

1. To introduce the basic concepts of Reliability Engineering for ensuring sustainable product management.
2. To familiarize with the application of engineering knowledge and statistical techniques to prevent or to reduce the likelihood of frequency of failure.
3. To familiarize with the reliability of new designs and its analysis based on data.
4. To familiarize the concept of reliability testing and simple calculations.

Outcomes: Learner will be able to...

1. Analyze different modes of failure with its interpretations.
2. Demonstrate an integrated approach for achieving optimum product reliability.
3. Select appropriate reliability testing method/report failure.
4. Demonstrate the concept of reliability predication and analysis techniques.
5. Illustrate the concept of maintainability and availability related to reliability.
6. Illustrate the different corporate strategies for product reliability management.

Module	Contents	Hrs.
01	Reliability and Failure Concept: Definition, Role of reliability functions in the organization, Quality and reliability, Significance and importance of reliability. Concept of Failure, Causes of failures, Failure and hazard rate, Reliability expressions for constant, increasing and decreasing hazard rates, Component Reliability, Mean Time To Failure (MTTF), Mean Time Between Failure (MTBF), Time dependent and Stress dependent hazard models, Numerical based on calculations of failure rate and hazard rate.	08
02	System Reliability: Basic Probability concept, Introduction to independence, mutually exclusive, conditional probability, Discrete and continuous probability distributions, Data analysis based on Probability distributions (Exponential, Wei-bull, Normal, Gamma, Poisson, Lognormal and extreme value), Conditional Probability. Analysis of Series, parallel, series-parallel, standby and k-out of-m modelling. System reliability evaluation technique including methods of bounds, decomposition and transformation techniques. Single and Multiple variable inversion techniques for minimizing system reliability expression. Tie-set and cut- set method.	08
03	Reliability Design : Functional Designs, Designing for reliability, Design process, Optimal reliability and redundancy techniques, Failure and repair rate allocation, Various design problems and their relevant solution techniques, Reliability improvements.	04
04	Reliability Predication and Analysis: Reliability predication methodology, System reliability analysis techniques – Failure Mode Effects Analysis (FMEA), Failure Mode effects and critically analysis (FMECA)-Case studies, Basic symbols, Fault tree construction and	10

	analysis, Failure Mechanism- Types, Introduction to computer aided reliability.	
05	Maintainability and Availability: Maintainability: Concepts, Allocation, Predication and Design aids. Availability: Function and Analysis. Trade-off between reliability, Maintainability and Availability, Planning for safety.	04
06	Reliability Testing and Management Introduction to Reliability Testing, Stress strength interaction, Testing for reliability and Durability-Accelerated Life Testing and Highly Accelerated Life Testing (HALT), Highly accelerated stress screening (HASS). Objective of reliability management, Typical reliability control organization, Integrated reliability programs, Costs and productivity, Reliability audit, Customer involvement, Reliability considerations in production, Reliability specifications and contracts, Reliability data system and data bank.	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. *"An Introduction to Reliability and Maintainability Engineering"*, Ebeling Charles E, Tata McGraw-Hill.
2. *"Reliability in Engineering Design"* Kapur K.C., and Lamberson L.R., John Wiley and Sons.
3. *"Quality and Reliability in Engineering"* Chandrupatla, Cambridge University Press, India.
4. *"Reliability Based Designs"* S. S. Rao, Tata McGraw-Hill.
5. *"Concept in Reliability with an introduction to Maintainability and Availability"*, L. S. Srinath East-West Press Pvt. Ltd.
6. *"Accelerated Testing—Statistical Models, Test Plans, and Data Analysis"*, Nelson, Wayne , John Wiley & Sons.
7. *"Reliability Engineering Handbook Vol. I and II"*, Kececioglu Dmitri, Prentice-Hall, Englewood Cliffs, New Jersey.
8. *"Reliability Engineering and Life Testing"*, V.N.A. Naiken, PHI Learning.
9. *"Reliability Engineering"* E. Balagurusamy, Tata McGraw-Hill.

10. *“Maintenance Theory of Reliability”* Toshio Makagawa, Springer Series.
11. *“Practical Reliability Engineering and Analysis for System Designs a Life Cycle Sustainment”* William Wessels , C R C Press.
12. *“Recent Advances in Reliability and Quality”*, Hoang Pham, World Scientific Technology.

Course Code	Course/Subject Name	Credits
PEDLO6014	Industrial Robotics	03

Objectives

1. To acquaint with the significance of robotic system in agile and automated manufacturing processes.
2. To familiarize with the robotic elements/ peripherals, their selection and interface.
3. To familiarize with the basics of robot kinematics.

Outcomes: Learner will be able to...

1. Illustrate the importance of robot in automation.
2. Acquire skills in robot language and programming.
3. Acquire skill in robot task planning for problem solving.
4. Demonstrate the concepts of kinetics and dynamics of robot.
5. Select various sensors/robot peripherals for deployment in a manufacturing system.
6. Identify an application of robots in manufacturing.

Module	Contents	Hrs.
01	Introduction Automation, robotics, Robotic system & Anatomy, Classification and Future Prospects.	02
02	2.1 Drives Control Loops, Basic Control System Concepts & Models, Control System Analysis, Robot Activation & Feedback Components, Position & Velocity Sensors, Actuators and Power Transmission system. 2.2 Robot & its Peripherals 2.3 End Effecters: Type mechanical and other grippers, Tool as endeffector. Sensors: Sensors in Robotics, Tactile Sensors, Proximity & Range Sensors, Sensor Based Systems, Vision systems and Equipment. Introduction to the Microcontroller (Arduino) and interfacing with a sensor	10
03	3.1 Machine vision Introduction, Low level & High level Vision, Sensing & Digitizing, Image Processing & analysis, Segmentation, Edge detection, Object Description & recognition, interpretation and Applications. 3.2 Programming for Robots Method, Robot Programme as a path in space, Motion interpolation, motion & task level Languages, Robot languages, Programming in suitable languages and characteristics of robot.	10
04	4.1 Robot Kinematics Forward, reverse & Homogeneous Transformations, Manipulator Path control and Robot Dynamics.	08

05	5.1 Root Intelligence & Task Planning Introduction, State space search, Problem reduction, use of predictive Logic, Means. Ends Analysis, Problem solving, Robot learning and Robot task planning.	07
06	6.1 Robot application in manufacturing Material transfer, machine loading & un loading, processing operation, Assembly & inspectors, robotic Cell design & control, Social issues & Economics of Robotics.	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. *Industrial Robotics, Technology, Programming & Applications*, Grover, Weiss, Nagel, Ordey, Mc Graw Hill.
2. *Robotics: Control, Sensing, Vision & Intelligence*, Fu, Gonzalez, Lee, Mc Graw Hill.
3. *Robotic technology & Flexible Automation*, S R Deb. TMH.
4. *Robotics for Engineers*, Yoram Koren , Mc Graw hill.
5. *Fundamentals of Robotics*, Larry Health.
6. *Robot Analysis & Control*, H Asada, JJE Slotine.
7. *Robot Technology*, Ed. A Pugh, Peter Peregrinus Ltd. IEE, UK.
8. *Handbook of Industrial Robotics*, Ed. Shimon. John Wiley.

Course Code	Course Name	Credits
PEDLO6015	Rapid Prototyping and Digital Manufacturing	03

Objectives:

1. To acquaint with various rapid prototyping and additive manufacturing technologies.
2. To familiarize with the concept of Direct Digital Manufacturing.
3. To familiarize with the various Rapid tooling and Reverse engineering techniques.
4. To introduce the concept of Digital Manufacturing.

Outcomes: Learner will be able to...

1. Demonstrate an importance of rapid prototyping/additive manufacturing techniques.
2. Design and develop of products using rapid manufacturing technology.
3. Design and develop of products using additive manufacturing technology.
4. Illustrate the concept of Direct Digital Manufacturing.
5. Select appropriate Reverse engineering techniques for a particular case.
6. Select appropriate Rapid tooling techniques for a particular case.

Module	Contents	Hrs.
01	<p>Introduction to Rapid Prototyping (RP) and Additive Manufacturing (AM) Prototype Fundamentals, Historical Development, Fundamentals of Rapid Prototyping, Advantages of Rapid Prototyping, Commonly Used Terms, Additive Manufacturing (AM) Definition, Applications of AM parts, The Generic AM process, Why use the term Additive Manufacturing, The Benefits of AM, Distinction Between AM and CNC Machining Other Related Technologies: Reverse Engineering, CAE, Haptic based CAD. Classifications of AM / RP System: Liquid polymer Systems, Discrete Particle Systems, Molten Material Systems, Solid Sheet Systems New AM Classification Schemes as per ASTM F42 and ISO TC 261: Vat photo polymerization, Powder bed fusion, Material extrusion, Material jetting, Binder jetting, Sheet lamination and Directed energy deposition.</p>	06
02	<p>Additive Manufacturing / Rapid Prototyping Systems Vat Photo Polymerization based AM / RP Systems: Principle of operation, Process, materials advantages, disadvantages, and applications of 3D Systems' stereo lithography (SLA), CMET'S Solid Object Ultraviolet-Laser Printer (SOUP). 2.1 Powder Bed Fusion based AM / RP Systems: Principle of operation, Process, materials, advantages, disadvantages, and applications of 3D Systems' Selective Laser Sintering (SLS), EOS's EOSINT Systems, ARCAM's Electron Beam Melting (EBM). 2.2 Material Extrusion based AM / RP Systems: Principle of operation, Process, advantages, disadvantages and applications of STRATASYS' Fused Deposition Modeling (FDM).</p>	10

	<p>2.3 Material Jetting based AM / RP Systems: Principle of operation, Process, advantages, disadvantages and applications of 3D Systems' Multi-jet Modeling System (MJM).</p> <p>2.4 Binder Jetting based AM / RP Systems: Binder jetting principle, materials, Z Corporation's Three Dimensional Printing (3DP) machine, process benefits and drawbacks.</p> <p>2.5 Sheet lamination based AM / RP Systems: Principle of operation, Process, materials, advantages, disadvantages, and applications of CUBIC Technologies Laminated Object Manufacturing (LOM), CAM-LEM's (Computer Aided Manufacturing of Laminated Engineering Materials) CL 100.</p> <p>2.6 Directed Energy Deposition based AM / RP Systems: Principle of operation, Process, materials, advantages, disadvantages, and applications of OPTOMECH's Laser Engineered Net Shaping (LENS).</p>	
03	<p>Direct Digital Manufacturing Concept of Direct Digital Manufacturing (DDM), Application Case Studies, DDM Drivers</p> <p>3.3 Manufacturing Versus Prototyping</p> <p>3.4 Cost Estimation: Cost Model, Build Time Model</p> <p>3.5 Life-Cycle Costing</p> <p>3.6 Future of DDM</p>	05
04	<p>Design for Additive Manufacturing</p> <p>4.1 AM Unique Capabilities: Shape Complexity, Hierarchical Complexity, Functional Complexity, Material Complexity.</p> <p>4.2 Core DFAM Concepts and Objectives: Complex Geometry, Integrated Assemblies, Customized Geometry, Multifunctional Designs, Elimination of Conventional DFM Constraints</p>	05
05	<p>Rapid Tooling and Reverse Engineering</p> <p>5.1 Introduction to Rapid Tooling, Indirect Rapid Tooling Processes, Direct Rapid Tooling Processes, Emerging Trends in Rapid Tooling</p> <p>5.2 Reverse Engineering (RE): Introduction, RE generic process, RE hardware and software, Integration of RE and RP for Layer-based Model Generation, Applications and case studies of RE in automotive, aerospace and medical device industry, Barriers for adopting RE.</p>	07
06	<p>Digital Manufacturing</p> <p>6.1 Definition of digital manufacturing, Digital manufacturing idea taking control for center, Digital manufacturing idea taking design for center, Digital manufacturing idea taking management as its center, The 10 disruptive principles of digital manufacturing processes.</p> <p>6.2 Key Technologies of Digital Manufacturing: Various Digital Technologies in Product Life Cycle, Resource and Environment, Management, Control and Product Recognition.</p>	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. *Fundamentals of Digital Manufacturing Science*, Zude Zhou, Shane (Shengquan) Xie, Dejun Chen, Springer, 2012.
2. *Rapid Manufacturing: An Industrial Revolution for the Digital Age*, N. Hopkinson, R.J.M. Hague and P.M. Dickens (Eds.), John Wiley & Sons, 2006.
3. *Rapid Tooling: Technologies and Industrial Applications*, Peter D. Hilton and Paul F. Jacobs (Eds.), Marcel Dekker, 2000.
4. *Collaborative Design and Planning for Digital Manufacturing* Lihui Wang, Andrew Y.C. Nee. (Eds.), Springer, 2009.
5. *Rapid Prototyping Principles and Applications*, Chua C.K., Leong K.F., and Lim C.S 2nd Edition, World Scientific, 2003.
6. *Additive Manufacturing Technologies*, Ian Gibson, D.W. Rosen, and B. Stucker, 2nd Edition, Springer, 2015.
7. *Rapid Prototyping Theory and Practice*, Ali Kamrani, and Emad Abouel Nasr (Eds.), Springer, 2006.
8. *Understanding Additive Manufacturing*, Andreas Gebhardt, Hanser, 2011.
9. *Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling*, D. T. Pham and S.S. Dimov, Springer, 2001.
10. *Rapid Prototyping Technology Selection and Application*, Kenneth G. Cooper, Marcel Dekker Inc, 2001.
11. *Reverse Engineering: An Industrial Perspective*, Vinesh Raja and Kiran J. Fernandes (Eds.), Springer, 2008.

Course Code	Course Name	Credits
PEL601	Machining Science and Technology Laboratory	01

Objectives

1. To familiarize with the methods of force measurement during machining.
2. To familiarize with the methods of temperature measurement during machining.
3. To familiarize with the Taguchi's Design of Experiments and ANOVA.
4. To familiarize with the design procedures for various cutting tools.

Outcomes:-The learner will be able to...

1. Select a proper force measurement method for the required machining operation.
2. Select a proper temperature measurement method for the required machining operation.
3. Distinguish surface integrity after parametrical changes in machining operation.
4. Apply Taguchi's Design of Experiments and ANOVA for various machining operations.
5. Design multi point cutting tool like Broach.
6. Design of Flat Form Tool and Circular Form Tool.

Sr. No.	Design Exercise/Assignment
01	Assignment on Dynamometry and Metal Cutting Theory
02	Assignment on Temperature Measurement in metal cutting and cutting fluids
03	Assignment Introduction to Taguchi Design of Experiments and ANOVA. – Two Case Studies on applications in machining.
04	Design of Circular Broach.
05	Design of Flat Form Tool.
06	Design of Circular Form Tool.

Term Work

Term work shall consist of exercises listed in the above list

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

Assignments	: 10 marks
Design Exercises with Drawings on A4 size Paper	: 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 Code	Course Name	Credits
PEL602	Process Engineering and Tooling Laboratory	01

Objectives.

1. To familiarize with the significance of process engineering and its relevance to manufacturing operations.
2. To prepare for developing a skills in preparing machining sequence and estimating manufacturing time.
3. To acquaint with the significance and control of tolerance in design & manufacturing.
4. To appraise a basics of process and operation planning.

Outcomes: Learner will be able to...

1. Develop capability to prepare part prints.
2. Develop workpiece control system.
3. Develop tolerance control charts and process sheets.
4. Develop tool layout for production Lathe.
5. Develop process picture, process routing, process sheets.
6. Design cams for part production on single spindle automats.

Sr no	Design Exercise /Assignment.
01	Assignment on introduction to process engineering.
02	Assignment on Part print analysis.
03	Assignment on Work piece control.
04	Prepare Tolerance Chart Design for one component.
05	Design of Tool Layout for production lathe.
06	Design process planning sheet with process picture.
07	Design of Cams for Traub Automat.

Term Work

Term work shall consist of assignments based on the syllabus and exercises as mentioned in the table above as well as a detailed report, based on an Industrial visit to a manufacturing firm, covering few of the essential concepts mentioned in subject of Process Engineering and Tooling. The report should cover the importance of optimisation of various resources like Time, Material etc. in today's manufacturing firms.

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

Design Exercise	: 12 marks
Assignments	: 05 marks
Industrial Visit Report	: 03 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.

Practical/Oral Examination

Each student will be given a small exercise based on syllabus, which will be assessed/verified by examiners during the oral examination.

The distribution of marks for oral-practical examination shall be as follows:

Exercise : 15 marks

Oral : 10 marks

1. Evaluation of practical/oral examination to be done, based on the performance of design task.
2. Student's work along with evaluation report to be preserved till the next examination.

Course Code	Course Name	Credits
PEL603	Production Tooling Laboratory	01

Objectives:

1. To acquaint with the concepts pertaining to planning and sequencing of operations.
2. To prepare for designing of simple productive and cost effective jigs and fixtures
3. To acquaint with the various press working operations for mass production of sheet metal components.
4. To familiarize with the sheet metal working techniques for design of press tools.

Outcomes: The students will be able to...

1. Identify and select location and clamping faces/points on jobs.
2. Design and develop simple productive and cost effective jigs.
3. Design and develop simple productive and cost effective fixtures.
4. Identify press tool requirements to build concepts pertaining to design of press tools.
5. Prepare working drawings and setup for economic production of sheet metal components.
6. Prepare bill of materials..

Term Work

Term work shall consist of:

A : Design of

1. Simple Progressive Die with minimum three stages.
(Assembly & BOM)
2. Drill Jig (Assembly & BOM).
3. Milling fixture (Assembly & BOM).

B : A detailed report based on an Industrial visit to a manufacturing firm, covering the topics mentioned in subject of Production Tooling.

Assignments on topics drawn from the syllabus are as follows-

One assignment/module on module nos. 1, 2, 3 and 1 physical model/prototype (by a group of 4 students) on module 4, 5 or 6. OR

One assignment/module on module nos. 4, 5, 6 and 1 physical model/prototype (by a group of 4 students) on module 1, 2 or 3.

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

Part A: Design task	: 12 marks
Part B: Assignments	: 05 marks
Industrial Visit Report	: 03 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.

Practical/Oral Examination

Each student will be given a small task of design based on syllabus, which will be assessed/verified by examiners during the oral examination.

The distribution of marks for oral-practical examination shall be as follows:

Design Task	...	15
Oral	...	10

1. Evaluation of practical/oral examination to be done based on the performance of design task.
2. Student's work along with evaluation report to be preserved till the next examination.

Course Code	Course Name	Credits
PEL604	Machine Design – II Laboratory	01

Objectives:

1. To familiarize with the concept of design features of machine tool structures.
2. To acquaint with design principles of feed gear boxes, bearings, power screws, clutches etc. used in machine tools.
3. To acquaint with the standards & hand books to retrieve relevant data for designing/selection of machine tool components.
4. To acquaint with the acceptance tests on machine tools & their significance.

Outcomes: Learner will be able to...

1. Use codes and hand books to retrieve relevant data for design and selection.
2. Design machine tool structures.
3. Select drive elements and drives for machine tools.
4. Design feed gear boxes for a machine tool.
5. Design bearings and clutches for a machine tool.
6. Design power screws for a machine tool.

Sr.no	Design Exercise/ Assignment
01	Design of mechanical drives (At least one design and drawing)
02	Design and drawing of machine tool guideways, slideway profiles, wear compensation techniques.
03	Design and drawing of machine tool structure profiles.
04	Demonstration of acceptance test on at least one machine tool.
04	Assignment on power screws.
05	Assignment on clutches.
06	Assignment each on antifriction bearing & journal bearing.

Term Work:

Term work shall consist of design exercises and assignments as per the list given above

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

Laboratory work (Experiments/ design and drawings):	15 marks
Assignments:	05 marks
Interest & involvement	05 marks
TOTAL:	25 Marks.

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

Course Code	Course Name	Credits
PEC701	Industrial Training and Project	20

Objectives:

1. To correlate with the lessons learnt in theory and actual practices followed in the industries.
2. To give exposure to an industrial environment/discipline.
3. To familiarize with the need for a coordinated effort of various persons at different levels in different departments for achieving the set goals and targets.

Outcomes: Learner will be able to...

1. Demonstrate managerial skills.
2. Identify the size and scale of operations in Industry.
4. Apply the knowledge in problem solving.
5. Demonstrate an understanding of various constraints in industry.
6. Demonstrate the scope, functions and job responsibilities in various departments of an organization.
7. Develop a positive attitude while dealing in professional manner.

Guidelines for Evaluation/Assessment

The total duration for each presentation shall be maximum 30 minutes, inclusive of 20 minutes for presentation and 10 minutes for discussion. 50 marks each for stage I and stage II to be awarded based on the points furnished below and as per the discretion of the internal project guide.

1. Contents of the presentation.
2. Presentation skills.
3. Interest taken, personal involvement and contribution.
4. Headway/progress made in the project execution.

Evaluation/Assessment of the Term Work

1. Introduction, Acknowledgements, references.	}	10
2. Company background/ activities.		
3. Training areas / Training details.		
4. Synopsis / Abstract of the Project.		10
5. General presentation, neatness and accuracy of the data furnished.		15
6. Technical contents of the report with data / observations, graphs, drawings, etc.		25
7. Quality of work carried out and details furnished based on personal Observations/involvement.		30
8. Results/ Conclusion.		10

Total - 100

Note: Report shall be prepared using University of Mumbai approved Guidelines, as applicable.

Course Code	Course Name	Credits
PEC801	Fluid Power Automation	04

Objectives:

1. To familiarize with the basic concepts of industrial automation.
2. To acquaint with the concept of low cost automation with pneumatic and hydraulic systems.
3. To familiarize with the elements of electrical control systems.
4. To acquaint with the concepts related to fluid power.

Outcomes: Learner will be able to...

1. Apply automation techniques in small manufacturing set-ups.
2. Illustrate the working principles of fluid power accessories like pumps, motors.
3. Analyse pneumatic and hydraulic circuits of medium complexity.
4. Illustrate the working of control and regulation elements used in pneumatic and hydraulic circuits.
5. Demonstrate the use of electrical and electronics control in pneumatic and hydraulic circuits.
6. Analyse the benefits and challenges of Digital Hydraulics.

Module	Contents	Hrs.
01	Introduction to Fluid Power Automation: Definition; Automation in production systems; Automation principles and strategies; Levels of automation; Types of automation; Benefits and Impact of Automation on Manufacturing and Process Industries. Hydraulic & Pneumatic Comparison – ISO symbols for fluid power elements, Hydraulic, pneumatics – Selection criteria.	08
02	Fluid Power Generating/Utilizing Elements Hydraulic pumps and motor, gears, vane, piston. Pumps & motors-selection and specification-Drive characteristics – Linear actuator – Types, mounting details, cushioning – power packs – construction. Reservoir capacity, heat dissipation, accumulators and their types. Applications of Accumulator circuits. Standard circuit symbols, circuit (flow) analysis. Different types of compressors and Actuators in Pneumatics, their applications and use of their ISO symbols.	06
03	Control And Regulation Elements Hydraulic and pneumatic direction, flow and pressure control valves. Methods of actuation, types, sizing of ports – pressure and temperature compensation, overlapped and under lapped spool valves – operating characteristics-electro hydraulic and electro-pneumatic servo valves-different types-characteristics and performance. Difference between Servo and Proportional hydraulic valve.	06
04	Circuit Design Basic Hydraulic Circuits: Meter in, meter out and Bleed off circuits; Intensifier circuits, Regenerative Circuit, Counter balance valve circuit and sequencing circuits. Pneumatic Circuit Designing: Design of Pneumatic sequencing circuits using Cascade method and Shift register method (up to 3 cylinders).	12

05	<p>Sensors and Transducers: Performance Terminology; Displacement, position and Proximity Sensors; Velocity and Motion Sensors; Force and Fluid Pressure Sensors; Liquid level and Flow sensors; Temperature and light Sensors; Control of stepper motors.</p>	04
06	<p>Electro Pneumatics & Electronic Control Of Hydraulic and Pneumatic Circuits: Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves; with and without grouping; Design of Pneumatic circuits using PLC Control (ladder programming only) up to 2 cylinders, with applications of Timers and Counters and concept of Flag and latching. Digital Hydraulics: Definition & Introduction, Digital vs. analog hydraulic control, different ways to realize motion control with on/off valves, Benefits and challenges of digital Hydraulics, Application case studies.</p>	12

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. Mikell P. Groover, *Automation, Production Systems, and Computer-integrated Manufacturing (3rd Edition)*, PHI Learning Private Limited, New Delhi, 2008.
2. Joji P., *Pneumatic Controls*, Wiley India Pvt. Ltd., 2008.
3. Peter Croser, Frank Ebel, *Pneumatics Basic Level*, Festo Didactic GmbH & Co. Germany.
4. Prede G., Scholz D., *Electropneumatics Basic Level*, Festo Didactic GmbH & Co. Germany.
5. Bliesener R., Ebel F., Löffler C., Plagemann B., Regber H., Terzi E. V., Winter A., *Programmable logic controllers Basic Level* Festo Didactic GmbH & Co. Germany.
6. S.Ilango and V. Soundararajan, *Introduction to Hydraulics and Pneumatics*, PHI Learning Pvt. Ltd. New Delhi.
7. *Industrial Hydraulics Manual*, Sperry & Vickers Co.
8. Shanmuga Sundaram.K, *Hydraulic and Pneumatic controls*, Chand& Co. 2006.

Course Code	Course Name	Credits
PEC802	Industrial Engineering and Human Resource Management	04

Objectives

1. To familiarize with the practices of industrial engineering and human resource management.
2. To familiarize with the concepts of strategic objectives, optimization of human resource potential and enhancing of human effectiveness.

Outcomes learner will be able to...

1. Apply different industrial engineering principles for productivity enhancement.
2. Design integrated systems in industrial engineering.
3. Develop a concept in identifying, planning, and deployment of man power.
4. Develop an inter personal and soft skills.
5. Identify the training needs of employs at different levels.
6. Analyze legal aspects of employment

Module	Contents	Hrs
01	<p>1.1 Introduction to Industrial Engineering (IE) : Definition, History and Development of IE, Present Scenario of IE, Contributions to IE, Activities and approaches of IE, Objectives and Functions of IE.</p> <p>Productivity: Definition, Productivity in Enterprise, Task of Management, Productivity of Materials, Land, Building, Machine and Power. Measurement of Productivity, Factors affecting productivity, Productivity Improvement likes 5s, Poka-Yoke, Kaizen, Kanban, Quality Improvement Techniques like QFD, FMEA, Ishikawa diagram, SMED</p> <p>1.2 Method Study: Objectives and procedure for methods analysis, Recording techniques, Micro motion and macro-motion study: Principles of motion economy, Normal work areas and work place design.</p> <p>1.3 Work Measurement: Objectives, Work measurement techniques - time study, work sampling, pre-determined motion time standards (PMTS) Determination of time standards. Observed time, basic time, normal time, rating factors, allowances, and standard time, Maynard's Operation Sequence Technique (MOST).</p> <p>1.4 Job Evaluation and Wage Plan: Objective, Methods of job evaluation, job evaluation procedure, merit rating (performance appraisal), method of merit rating, wage and wage incentive plans.</p>	14
02	<p>2.1 Value Analysis : An Overview Of Value Analysis -Concepts and approaches of value analysis and engineering - importance of value, Function - identity, clarify – analysis Evaluation of VE-Evaluation of function, Problem setting system, problem solving system, value analysis case studies, Effective organization for value work, function analysis system techniques- FAST diagram, Case studies.</p> <p>2.2 Ergonomics :</p>	10

	<p>Introduction: Inter disciplinary nature of ergonomics modern ergonomics human performance – information processing – factors affecting human performance – physical workload and energy expenditure.</p> <p>Workspace Design - Anthropometry – workspace design for standing and seated workers – Arrangements of components within a physical space – Interpersonal aspect of workplace design.</p> <p>Recent Advances and Trends - Legislative trends – Trends in work system design – occupational diseases – Application of Ergonomics’ in automobiles.</p>	
03	<p>3.1 Human Resource Management : Introduction to HRM and Management Thought, Historical Developments of HRD, HRD core functions and activities, Virtual HR –E-Recruiting, HRIS- Human Resource Information System, E-Training, Human Resource Planning, Job Analysis, Recruitment and selection, Steps and types of Training and Development, Promotion, Safety and OSHA standards for HR, Differences of HR with Personnel Management, Careers with HR.</p>	06
04	<p>4.1 Human Behaviour : Definition, Factors affecting human behaviour – Genetics, social norms, creativity, attitude, faith and culture, Group and Group behaviour.</p> <p>4.2 Motivation : Definition, Types of theories and models of motivation, Practical Applications of motivation – Employee morale, Employee recognition programs, Drug abuse, Education, Business and work engagement.</p>	06
05	<p>5.1 Decision Making : Introduction, Problem Analysis through Decision making tools, Characteristics of decision making, Steps in Rational decision making.</p> <p>5.2 Communication: Definition, Types, Historical Developments in communication, Barriers to communication, Introduction to Bio-communications, Noise and its types,</p> <p>5.3Leadership: Definition, Leadership Theories, Leadership styles, Self – Leadership.</p>	06
06	<p>Industrial Relations : Introduction, Historic perspective, Industrial Relations today, Collective Bargaining, Trade Unions and Managing Conflicts, Labour Laws and Legislations, Importance of Industrial Relations, Objectives of Industrial Relations, Introduction to Factories Act, Industries Disputes Act, Salary and Wage Fixation and Workman Compensation Act, Employee Grievances, Redressal.</p>	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. *Industrial Engineering and Production Management* -By M. Mahajan, Dhanpat Rai and Co.
2. *Human Resource Management*, Aswathapa. K, TMH,
3. Miles, L.D., "*Techniques of Value Engineering and Analysis*", McGraw Hill Book Company.
4. "*Industrial Engineering and Management*", Khanna, O.P., Dhanpat Rai and Sons.
5. *Personnel Management and Human Resources*, C.S. Venkataraman, B.K. Srivastava.
6. *Principles of Management*, P.C. Tripathi, P.N. Reddy.
7. *Organizational Behaviour*, Text and cases, Uma Sekaran.
8. *Factory Administration and Management*, A.S. Deshpande.
9. Bridger, R.S. "*Introduction to Ergonomics*", McGraw Hill.
10. Micormic, J. "*Human factors in Engineering and Design*", McGraw Hill,
11. *Work Study*, ILO, Geneva.

Course	Course Name	Credits
PEC803	Economics, Finance, Accounting and Costing	04

Objectives:

1. To acquaint with the concept of Micro and Macro Economics.
2. To familiarize with the concepts like comprehend the need, definition, functions and economic significance of financial institutions and markets.
3. To familiarize with the concept of Fiscal and Monetary Policy.
4. To acquaint with financial statements and Annual Reports of industries.
5. To familiarize with the concept of cost records / statements.

Outcomes: Learner will be able to...

1. Correlate various micro and macro-economic variables.
2. Analyze various market/business strategies.
3. Illustrate concept of Economic policies and their implications.
4. Demonstrate the roles played by various financial institutions/banks.
5. Analyze various accounting and costing practices.
6. Select best investment method.

Module	Contents	Hrs.
01	Introduction Definition of Economy, Central problems of an economy: what, how and for whom to produce; concepts of production possibility frontier and opportunity Cost. Economics, its scope and importance. Introduction to Micro and Macro Economics and their comparison.	04
02	Micro Economics Consumer's Behavior: meaning of utility, marginal utility and law of Diminishing Marginal Utility. Conditions of consumer's equilibrium using marginal utility analysis utility, law of demand and relation between law of demand & law of diminishing marginal utility. Producer's Behavior: law of supply, variation in supply, Types of elasticity of supply. Types of Market: perfect competition, pure competition, Monopoly.	04
03	Macro Economics Concept of National Income: Circular flow of income, Distinction between Gross and Net National Income. Different Methods of Measuring National Income, Definition of Money, Functions of Money, Value of Money and Different concepts of Money. Economic Policy: Monetary, Income and Fiscal Policies. Functions of Central Bank, Functions of Commercial Banks credit Creation, Credit Control Methods, Theory of Inflation, Concepts of Inflation, Effects of Inflation and Anti-inflationary policies.	04

04	<p>Financial Environment of Business: Financial Management-Sources of finance-long term and short term finance</p> <p>Working Capital Management:- Concept of working capital management, Cash Conversion Cycle, Management of stock ,overtrading</p> <p>Capital Markets</p> <p>Primary Market: Basics of capital market mechanism and instruments.</p> <p>Secondary Market: Basics of stock exchange and their role, Role of SEBI, Role of FIIs, MFs and Investment Bankers .Money Markets: Basics of Mon Mechanism, instruments, and institutions.</p> <p>An Overview of investment Appraisal Methods: NPV method, Payback method, discounted payback period method, IRR, Annual worth method.</p>	10
05	<p>Accounting Mechanics, Process and system: Introducing Book Keeping and Record Maintenance, The concept of Double entry and fundamental principles, Journal, Ledger, Trial Balance and Final accounts. Financial Analysis, Ratio Analysis and comparative balance sheet.</p> <p>Management Accounting: Understanding of Financial Statements (Overview), Interpreting Financial statements (overview).</p>	12
06	<p>Cost and Management Accounting Introduction to cost, Types of cost, Treatment of Overheads, Unit Costing (Cost Sheet), Joint Product Costing, Process Costing, Marginal Costing, Cost Volume Profit Analysis and Decision Making. Budgetary Controls, Standard Costing, concept and Importance of Depreciation and Methods of Depreciation.</p>	16

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. *Managerial and Cost Accounting*, Larry M. Walther, Christopher J. Skousen.
2. *Corporate Finance Principles and Practices*, Denzil Watson & Tong Heads, Financial Time Pitman Publisher.
3. *Strategic Financial Management*, Robert Alan Hill.
4. *Basics of Accounting & Information Processing The Accounting Cycle*, Larry M. Walther, Christopher J. Skousen.
5. *Introduction to Managerial Accounting*, Larry M. Walther, Christopher J. Skousen.
6. *Essentials of Microeconomics*, Krister Ahlersten.
7. *Essentials of Macroeconomics*, Peter Jochumzen.
8. *Banking: An Introduction*, Dr. AP Faure, Rhodes University.
9. *Financial System: An Introduction*, Dr AP Faure, Rhodes University.
10. *Central Banking & Monetary Policy: An Introduction*, Dr. AP Faure, Rhodes University.

Course Code	Course Name	Credits
PEDLO8011	Product Design and Industrial Marketing	04

Objectives

1. To acquaint with various approaches in designing and developing new products.
2. To familiarize with various software solutions for designing and developing products.
3. To familiarize with modern approaches like concurrent engineering, product life cycle management, robust design, rapid prototyping / rapid tooling, etc.
4. To familiarize with characteristics of business markets, buying situations, trends in industrial marketing and relevant industrial strategies.

Outcomes: Learner will be able to...

1. Design and develop products right from the conceptual level.
2. Demonstrate concept of computer aided product design approach.
3. Illustrate various modern approaches like concurrent engineering, product life cycle management, robust design, rapid prototyping / rapid tooling.
4. Analyze products based on ergonomics and aesthetic aspects.
5. Apply appropriate strategies in industrial marketing.
6. Demonstrate various aspects related to Industrial Marketing Communication, Advertising, Sales promotion, Publicity Media Plan.

Module	Contents	Hrs.
01	<p>1.1. Introduction: Definition of product design, Classification of products, Design by evolution, Design by innovation, Product Mix, Various phases in product development and Design, Morphology of Design, Considerations in product design, Product specifications.</p> <p>1.2. Conceptual Design: Market research, Generation , Selection and Embodiment of concept, Product Architecture, Customer centric product designing</p> <p>1.3. Creativity: Role of creativity in problem solving, Vertical and lateral thinking, Brain storming, Synectics, Group working dynamics, Adaptation to changing scenarios in economics, social, cultural and technological fronts, Anticipation of new needs and aspirations.</p> <p>1.4. Materials: Overview of materials including new generation materials, Tailor made material concepts, Material selection process.</p>	06
02	<p>2.1. Design for manufacturing (DFM): Guidelines and Methodology, Producibility requirements, Accuracy and Precision requirements, Strength considerations in Design: Criteria and objectives, Designing for uniform strength, Designing for stiffness and rigidity, Practical ideas for material saving in design - ribs, corrugations, rim shapes, bosses, laminates, etc.</p> <p>2.2. Design for forged and Cast components, Design for Sheet Metal processed components, powder metallurgical components, Expanded metals and wire forms</p>	12

	<p>2.3. Designing with plastics: Mechanical behavior, special characteristics and considerations, Design concepts for product features to be manufactured by various production process technologies, Special considerations for designing of components for load bearing applications,</p> <p>2.4. Other DFX Principles : Designs for Maintainability, Safety, Reliability, Sustainable Design</p> <p>2.5. Design for Assembly (DFA): DFA Index, Analysis of assembly requirements, Standardization, Ease of Assembly and disassembly, Design for bolted, welded and riveted components, Design for hinge and snap fit assemblies, maintenance, consideration of handling and safety, Modular concepts.</p>	
03	<p>3.1. Product Ergonomics: Anthropometry, Environmental conditions, thermal, noise, vibration, displays, illusions, Psycho and psychological aspects in design, Man-machine information exchange.</p> <p>3.2. Product Aesthetics: Visual awareness, Form elements in context of product design, Concepts of size, shape and texture, Introduction to colour and colour as an element in design, Colour classifications and dimensions of colour, Colour combinations and colour dynamics, Interaction / communication of colours, Psychological aspects of colours, generation of products forms with analogies from nature.</p> <p>3.3. Product Graphics: Graphics composition and layout, Use of grids in graphics composition, Study of product graphics and textures.</p>	06
04	<p>4.1. Value Engineering: Product value and its importance, Value analysis job plan, Steps to problem solving and value analysis, Value analysis tests, Value Engineering idea generation check list, Material and process selection in value engineering, Cost reduction, case studies and exercises.</p> <p>4.2. Software solutions: Software for drafting, modeling, assembly, detailing, CAM interfacing, Rapid tooling/rapid prototyping, etc.</p> <p>4.3. Modern Applications: Concurrent Engineering, Robust Design, Additive Manufacturing/Rapid Prototyping, Product Life Cycle Management techniques and application areas.</p>	08
05	<p>Introduction to Industrial Marketing, Understanding Industrial Markets, Nature of Industrial Buying, Industrial Market Segmentation, New Products and Established product strategies, Resource based and Value based strategy, Industrial Pricing: Price Determinants, Pricing Policies, Pricing Decisions, Pricing - Value based and Competition based.</p>	08
06	<p>6.1. Industrial Marketing Channels: Channel participants, Channel effectiveness, Marketing logistics, Physical Distribution and Marketing Strategy, Value added market channels</p> <p>6.2. Industrial Marketing Communication, Advertising, Sales promotion, Publicity Media Plan, Integrated Promotion Plan, Industrial Sales force Management, Technical Support for Marketing – customer technical services and feedback.</p>	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 Books:

1. *Product Design & Development*, Karl Ulrich, Steven Eppinger,
2. *Design Fundamentals*, R. G. Scott.
3. *Design methods inter science*, Jomes.
4. *Creative Engineering Design*, Buhl H. R.
5. *The Science of Engineering Design*, Holt, Hill Percy H.
6. *Ergonomics*, Merilyn Joyce, Ulrika Waller Steiner.
7. *Human Factors in Engineering & Design*, 4th edition
8. *Human Engineering Guide & Equipment Design*, Morgon C. T. & Others
9. *Barron D.ed, Creativity*, New York, Art Directors
10. *Design for Production*, Baldwin E. W. & Niebel B. W. Edwin, Homewood Illinois.
11. *Industrial design of plastic products*, Gordon, 2003
12. *Plastics Engineered Product Design*, Rosato, 2001
13. *Industrial Marketing Analysis, Planning and control* , Robert R Reeder, Edward G Brierty, Betty H Reeder, Prentice Hall India
14. *Industrial Marketing*, Havalder, Krishna K, Tata McGraw Hill, New Delhi.
15. *Industrial Marketing*, P.K.Ghosh, Oxford University Press, New Delhi.

Course Code	Course Name	Credits
PEDLO8012	World Class Manufacturing	04

Objectives

1. To familiarize with the concepts of Business excellence and competitiveness.
2. To acquaint with the business challenges and the future manufacturing competition.
3. To acquaint with the current trends of manufacturing scenario at domestic and global level.

Outcomes: Learner will be able to ...

1. Illustrate relevance and basics of World Class Manufacturing.
2. Co-relate factors of competitiveness and performance measures with respect to benchmarking.
3. Apply productivity tools for world class manufacturing.
4. Demonstrate Human Resource Managerial approaches for value addition.
5. Analyze the current Status of Indian Manufacturing scenario.
6. Design and develop a roadmap to achieve world class manufacturing status for industries.

Module	Contents	Hrs.
01	Historical Perspective World class Excellent organizations–Models for manufacturing excellence: Schonberger, Halls, Gunn and Maskell models, Business Excellence.	06
02	Benchmark, Bottlenecks and Best Practices Concepts of benchmarking, Bottleneck and best practices, Best performers – Gaining. Competitive edge through world class manufacturing – Value added manufacturing – Value. Stream mapping - Eliminating waste –Toyota Production System – Example.	08
03	System and Tools for World Class Manufacturing [8hrs] Improving Product & Process Design – Lean Production – SQC, FMS, Rapid Prototyping, PokaYoke, 5-S, 3M, JIT, Product Mix, Optimizing, Procurement & stores practices, Total Productive maintenance, Visual Control.	08
04	Human Resource Management in WCM Adding value to the organization– Organizational learning – techniques of removing Root cause of problems–People as problem solvers–New organizational structures. Associates–Facilitators–Teams manship– Motivation and reward in the age of continuous improvement.	06
05	Typical Characteristics of WCM Companies Performance indicators like POP, TOPP and AMBITE systems– what is world class Performance –six Sigma philosophies	08
06	Indian Scenario Case studies on leading Indian companies towards world class manufacturing –Task Ahead. Green Manufacturing, Clean manufacturing, Agile manufacturing with applications of Timers and Counters and concept of Flag and latching.	12

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. Sahay B.S., Saxena KBC. and Ashish Kumar, “*World Class Manufacturing – Strategic Perspective*”, Mac Milan Publications, New Delhi.
2. Korgaonkar M.G., “*Just In Time Manufacturing*”, MacMilan Publications.
3. Narayanan V.K., “*Managing Technology and Innovation for Competitive Advantage*”, Prentice Hall, 2000.
4. Adam and Ebert, “*Production and Operational Management*”, 5th Edition, Prentice Hall learning pvt. Ltd., New Delhi.
5. Ron Moore, “*Making Common Sense Common Practice – Models for Manufacturing excellence*”, Butter worth Heinmann.
6. Jeffrey K.Liker, “*The Toyota Way – 14 Management Principles*”, Mc-Graw Hill, 2003.
7. Chase Richard B., Jacob Robert., “*Operations Management for Competitive Advantage*”, 11th Edition, McGraw Hill Publications, 2005.
8. Moore Ron, “*Making Common Sense Common Practice*”, Butterworth-Heinemann, 2002.
9. Womack J.P., Jones D.T., “*Machine That Changed The World: The Story of Lean Production*”, Harper Perennial, 1991.

Course Code	Course Name	Credits
PEDLO8013	Logistics and Supply Chain Management	04

Objectives:

1. To acquaint with the concept of key drivers of supply chain performance and their inter-relationships with strategy.
2. To impart analytical and problem solving skills necessary to develop solutions for a variety of supply chain management.
3. To acquaint with the design problems and develop an understanding of information technology in supply chain optimization.
4. To acquaint with the complexity of inter-firm and intra-firm coordination in implementing programs such as e-collaboration, quick response, jointly managed inventories and strategic alliances.

Outcomes: Learner will be able to:-

1. Demonstrate the functional strategy map of supply chain management.
2. Design supply chain strategy of a firm.
3. Demonstrate concepts and ideas related to Materials management.
4. Illustrate various aspects pertaining to logistics for any organization.
5. Demonstrate activities of business logistics.
6. Use technology to change logistics and supply chain management.

Module	Contents	Hours
01	<p>Building a Strategic Framework to Analyse Supply Chains Building a Strategic Framework to Analyse Supply Chains Understanding the Supply Chain: What Is a Supply Chain?, The Objective of a Supply Chain, The Importance of Supply Chain Decisions, Decision Phases in a Supply Chain, Process Views of a Supply Chain, Examples of Supply Chains. Supply Chain Performance- Achieving Strategic Fit and Scope: Competitive and Supply Chain Strategies, Achieving Strategic Fit, Expanding Strategic Scope, Obstacles to Achieving Strategic Fit Supply Chain Drivers and Metrics: Drivers of Supply Chain Performance, Framework for Structuring Drivers, Facilities, Inventory, Transportation, Information, Sourcing, Pricing</p>	10
02	<p>Designing the Supply Chain Network Designing the Supply Chain Network, Designing Distribution Networks and Applications to e-business: The Role of Distribution in the Supply Chain, Factors Influencing Distribution Network Design, Design Options for a Distribution Network, E-Business and the Distribution Network, Distribution Networks in Practice.</p>	06
03	<p>Designing and Planning Transportation Networks Transportation in a Supply Chain: The Role of Transportation in a Supply Chain, Modes of Transportation and Their Performance Characteristics, Transportation Infrastructure and Policies, Design Options for a Transportation Network, Trade-Offs in Transportation Design, Tailored Transportation, The Role of IT in Transportation, Risk Management in Transportation, Making Transportation Decisions in Practice.</p>	08

04	<p>4.1 Designing Global Supply Chain Networks Designing Global Supply Chain Networks, The Impact of Globalization on Supply Chain Networks: The Offshoring Decision: Total Cost, Risk Management in Global Supply Chains, The Basic Aspects of Evaluating Global Supply Chain Design, Evaluating Network Design Decisions Using Decision Trees, Evaluation of Global Supply Chain Design, Decisions Under Uncertainty, Making Global Supply Chain Design, Decisions Under Uncertainty in Practice.</p> <p>4.2 Managing Cross-Functional Drivers in a Supply Chain Sourcing Decisions in a Supply Chain: The Role of Sourcing in a Supply Chain, In-House or Outsource, Third and Fourth-Party Logistics Providers, Supplier Scoring and Assessment, Supplier Selection-Auctions and Negotiations, Contracts, Risk Sharing, and Supply Chain Performance, Design Collaboration, The Procurement Process, Sourcing Planning and Analysis, The Role of IT in Sourcing, Risk Management in Sourcing, Making Sourcing Decisions in Practice.</p>	08
05	<p>IT in a Supply Chain Information Technology in a Supply Chain: The Role of IT in a Supply Chain, The Supply Chain IT Framework, Customer Relationship Management, Internal Supply Chain Management, Supplier Relationship Management, The Transaction Management Foundation, The Future of IT in the Supply Chain, Risk Management in IT, Supply Chain IT in Practice</p>	06
06	<p>Coordination in a Supply Chain Coordination in a Supply Chain: Lack of Supply Chain Coordination and the Bullwhip Effect, The Effect on Performance of Lack of Coordination, Obstacles to Coordination in a Supply Chain, Managerial Levers to Achieve Coordination, Building Strategic Partnerships and Trust Within a Supply Chain, Continuous Replenishment and Vendor-Managed Inventories, Collaborative Planning, Forecasting, and Replenishment (CPFR), The Role of IT in Coordination, Achieving Coordination in Practice. Reverse logistics: Reasons, Role, Activities; RFID systems: Components, Applications, Implementation; Lean supply chain, Implementation of Six Sigma in supply chain, Basics of Green supply chain management.</p>	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. *Supply Chain Management–Strategy, Planning & Operation*. Sunil Chopra & Peter Meindl, Pearson Education Asia, 2001, ISBN: 81-7808-272-1.
2. *Supply Chain Redesign–Transforming Supply Chains into Integrated Value Systems*. Robert B Handfield, Ernest L Nichols, Jr., Pearson Education Inc, 3rd Edition (3rd Impression), 2007, ISBN: 81-317- 0401-7
3. *Modelling the Supply Chain -Jeremy F Shapiro, Duxbury, Thomson Learning, 2002, ISBN 0-534-37363* 3. *Designing & Managing the Supply Chain*. David Simchi Levi, Philip Kaminsky & Edith Simchi Levi; Mc Graw Hill
4. *Supply Chain Redesign: Transforming Supply Chains into Integrated Value Systems*, Robert B Handfield, Ernest L Nicholas.
5. *The Management of Business Logistics: A Supply Chain Perspective*, Coyle, Bardi, Langley

Course Code	Course Name	Credits
PEDLO8014	Plant Engineering	04

Objectives:

1. To acquaint with various plant organizing functions.
2. To familiarize with various type of maintenance work and systems in a plant.
3. To acquaint with various methods of pollution control, noise control and vibration control.
4. To acquaint with concept of energy conservation programs.

Outcomes:-Learner will be able to...

1. Illustrate various organization of plant engineering.
2. Apply of heating, ventilating and air conditioning system.
3. Demonstrate process of material handling systems in plant engineering
4. Demonstrate various operational and safety aspects.
5. Illustrate concepts of pollution control, noise control, vibration control and fire control methods.
6. Apply energy conservation programs.

Module	Contents	Hours
01	Organization of the plant engineering function, the role of first line supervisor, design of plant engineering organization-Classification of maintenance work, computer based maintenance, predictive maintenance, reliability centered maintenance, integrated system. Standalone system. Ventilation and air-conditioning, Sanitation control and housekeeping. Electric system management, Reliability, power quality, utility rate structures.	10
02	Producer Gas Plants-operation and safety aspects in P.G. Compressor and Oxygen plants.	04
03	Applications of heating, ventilating and air conditioning system- General considerations, occupancies, exhaust systems. Communication and computer networks- The network, hardware, backing up data. peripherals, environment, security	04
04	Material handling Planning Solving material handling problems, justification of material handling projects. Material handling containerization -AS and RS (Automatic Storage and Retrieval System)-AGV and robotics- piping system design and components- Pollution control Regulatory requirement, emission safety, emission control methods and plant safety Lighting Determining lighting criteria, determining light source requirement, utilize multiple designs	10
05	Noise control – Occupational noise control limits, occupational hearing conservation requirement, Human response to noise, control of plant noise, computer modelling, measurement and instrumentation. Vibration control-	10

	<p>Characterization of vibrations, causes of vibrations, effects of vibration, the need for vibration control, vibration control strategy.</p> <p>Fire control The nature of fire, The plant fire problem: causes and prevention, plant fire hazards, fire hazards of materials, design and construction for fire safety, fire detection and alarm system, special agent suppression systems, portable fire extinguishers, codes and standards.</p>	
06	<p>Energy Conservation- Energy conservation program preparation. Determining energy conservation potential, refining the problem, implementation, savings maintenance.</p> <p>Lubrication and corrosion- Synthetic and solid lubricants -lubrication systems - causes and control deterioration - paints and protective coatings</p>	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. *1.Lindley and Higgins, "Maintenance Engineers Hand Book", 7th Edition, McGraw Hill Professional, 2008.*
2. *2. Rosaler, R.C. "Standard HandBook of Plant Engineering", 3rd Edition, McGraw Hill, 2002.*

Course Code	Course Name	Credits
PEDLO8015	Process Control and Instrumentation	04

Objectives:

1. To familiarize with various measuring instruments and methods of measurements of important process parameters.
2. To acquaint with the principles of automation and automatic process control techniques.
3. To familiarize with concepts of measurement and automatic process control related to specific industrial applications.

Outcomes: Learner will be able to...

1. Illustrate basic principles of working and error estimation of measuring instruments.
2. Select various measuring instruments.
3. Illustrate basics of automatics control and control modes.
4. Measure process parameters.
5. Apply automatic process control approaches to various industrial application areas.
6. Identify Industrial applications of process control techniques.

Module	Contents	Hrs
01	Basics of instruments: Types of measurements, classification, types of measuring instruments, constructional and design features, performance characteristic. Generalised configuration of a measurement systems.	05
02	Measurements of process parameters (Temperature and pressure): 2.1 Temperature measurement: sensors for temperature measurement – Thermistor, Thermocouple and Resistance Temperature Detectors. Solid and liquid expansion thermometers, Radiation and optical pyrometers. 2.2 Pressure measurement: pressure sensors, Elastic Electrical and Inductance type pressure transducers, Barometer, Manometers – Types and comparisons, Differential pressure measurement, vacuum measurement, Pressure gauges – Types.	10
03	Measurements of Process Parameters (Level, Flow, and Humidity) 3.1 Level and density Measurement: Direct Level measurement – Point contact, Gauge glass and buoyancy methods. Indirect Level measurement – Hydrostatic, capacitance, radiation and ultrasonic methods. Density measurement techniques. 3.2 Flow measurement: Flow measuring methods, head flow measurements – Orifice plate, Venturi-tube flow nozzle and pitot tubes- applications and sources of errors. Variable area flow measurement – Rotameter and valve type area meter, Electromagnetic flow meter, Flow integrators, Positive displacement flow meters – types, Velocity Flow meter and turbine flow meters. 3.3 Humidity measurement: measurement of humidity using psychrometer and hygrometer (Mechanical and Electrical types), Moisture measurement in solids.	10

04	Automatic process control: Fundamentals of automatic process control, Process dynamics – process response, process time tags, types of lags- capacitance, resistance, transportation and inertia lag, Process classification – first order and second order systems.	06
05	Automatic control and control modes: 5.1 Automatic control: block diagram, feedback and feedback forward control, servo and regulator operations, Controlling of batch and continuous process. 5.2 Control modes: classification of controllers, ON-OFF control; Proportional (P) control; Integral (I) control; Differential (D) control; P & I control; P & D control; P, I & D control, Selection of control modes. ISA (instrumentation society of America) codes and flow-plan symbols; Typical instrumentation symbols.	10
06	Industrial Application of process control: Examples of control systems used for measurement and control of – Temperature, Pressure, Level and Flow. Ratio Control and Cascade control. Alarm systems and indications, Basic concepts of telemetry and telecontrol of operations.	07

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. *Fundamentals of industrial instrumentation and process control*, William C. Dunn, TMH.
2. *Process/ industrial instruments and controls handbook*, Gregory Mc-Millian, TMH.
3. *Instrumentation and process control*, Anandan Prasad M.; N. Jayaswal; Vishnu Priye; I. K. international publisher.
4. *Instrumentation for process measurement and control*, Anderson, Taylor and Francis Publisher.
5. *Process control*, Peter Harriott, TMH.
6. *Trends in process instrumentation and control*, Agashe, Ceneage publication.
7. *Process control and instrumentation technology*, Curtis D. Johnson, Pearson publication.

Course Code	Course Name	Credits
ILO 8021	Project Management	03

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to...

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	Project Management Foundation: Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI)	5
02	Initiating Projects: How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	Project Planning and Scheduling: Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	8
04	Planning Projects: Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	5.1 Executing Projects: Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings 5.2 Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit 5.3 Project Contracting Project procurement management, contracting and outsourcing,	8

06	<p>6.1 Project Leadership and Ethics: Introduction to project leadership, ethics in projects, Multicultural and virtual projects</p> <p>6.2 Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.</p>	6
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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. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK[®] Guide), 5th Ed, Project Management Institute PA, USA
3. Project Management, Gido Clements, Cengage Learning
4. Project Management, Gopalan, Wiley India
5. Project Management, Dennis Lock, 9th Edition, Gower Publishing England

Course Code	Course Name	Credits
ILO 8022	Finance Management	03

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to...

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	<p>Overview of Indian Financial System: Characteristics, Components and Functions of Financial System.</p> <p>Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.</p> <p>Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market</p> <p>Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges</p>	06
02	<p>Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.</p> <p>Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.</p>	06
03	<p>Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.</p> <p>Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.</p>	09
04	<p>Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)</p> <p>Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.</p>	10
05	<p>Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.</p> <p>Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure</p>	05

06	Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03
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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. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8023	Entrepreneurship Development and Management	03

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to...

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	Overview Of Entrepreneurship: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	Business Plans And Importance Of Capital To Entrepreneurship: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	Indian Environment for Entrepreneurship: key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	Effective Management of Business: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	Achieving Success In The Small Business: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	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. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations
3. To familiarize the students about the latest developments, trends & different aspects of HRM
4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Outcomes: Learner will be able to...

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	<p>Introduction to HR</p> <ul style="list-style-type: none"> • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues 	5
02	<p>Organizational Behaviour (OB)</p> <ul style="list-style-type: none"> • Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour • Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor); • Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study 	7
03	<p>Organizational Structure & Design</p> <ul style="list-style-type: none"> • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies. 	6

04	<p>Human resource Planning</p> <ul style="list-style-type: none"> • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale • Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning • Training & Development: Identification of Training Needs, Training Methods 	5
05	<p>Emerging Trends in HR</p> <ul style="list-style-type: none"> • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation 	6
06	<p>HR & MIS: Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries)</p> <p>Strategic HRM: Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals</p> <p>Labor Laws & Industrial Relations: Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act</p>	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**
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4. Only **Four questions need to be solved.**

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	Professional Ethics and Corporate Social Responsibility (CSR)	03

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to...

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	Professional Ethics and Business: The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	Professional Ethics in the Marketplace: Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	Professional Ethics of Consumer Protection: Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	Introduction to Corporate Social Responsibility: Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	Corporate Social Responsibility: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	Corporate Social Responsibility in Globalizing India: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal Assessment for 20 marks:

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End Semester Examination:

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4. Only **Four questions need to be solved.**

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. **Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.**

Course Code	Course Name	Credits
ILO8026	Research Methodology	03

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to...

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	Introduction and Basic Research Concepts 1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology 1.2 Need of Research in Business and Social Sciences 1.3 Objectives of Research 1.4 Issues and Problems in Research 1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
02	Types of Research 2.1. Basic Research 2.2. Applied Research 2.3. Descriptive Research 2.4. Analytical Research 2.5. Empirical Research 2.6 Qualitative and Quantitative Approaches	07
03	Research Design and Sample Design 3.1 Research Design – Meaning, Types and Significance 3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07
04	Research Methodology 4.1 Meaning of Research Methodology 4.2. Stages in Scientific Research Process: a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	08
05	Formulating Research Problem 5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
06	Outcome of Research 6.1 Preparation of the report on conclusion reached	04

	6.2 Validity Testing & Ethical Issues	
	6.3 Suggestions and Recommendation	

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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End Semester Examination:

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4. Only **Four questions need to be solved.**

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	IPR and Patenting	03

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to...

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	Enforcement of Intellectual Property Rights: Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	Emerging Issues in IPR: Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	Basics of Patents: Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	Patent Rules: Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	Procedure for Filing a Patent (National and International): Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement Patent databases: Important websites, Searching international databases	07

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. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
ILO 8028	Digital Business Management	03

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	Introduction to Digital Business- Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	Overview of E-Commerce E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	Digital Business Support services: ERP as e –business backbone, knowledge Tope Apps, Information and referral system Application Development: Building Digital business Applications and Infrastructure	06
4	Managing E-Business- Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	E-Business Strategy- E-business Strategic formulation- Analysis of Company’s Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	Materializing e-business: From Idea to Realization- Business plan preparation Case Studies and presentations	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. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO8029	Environmental Management	03

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to...

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

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. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management, **T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Course Code	Course Name	Credits
PEL801	Fluid Power Automation Laboratory	01

Objectives:

1. To familiarize with software based pneumatics, electro-pneumatics and PLC circuits' simulation.
2. To familiarize with setup and execution of pneumatics, electro-pneumatics and PLC circuits on an experimental kit.

Outcomes: The learner will be able to...

1. Design & Simulate Pneumatic, Electro-Pneumatic and PLC based circuits on any compatible software.
2. Setup and execute Pneumatic, Electro-Pneumatic and PLC based circuits on an experimental kit.
3. Design & Simulate PLC based circuits (Ladder Diagram) on any compatible software.
4. Set up and execute Pneumatic circuits on an experimental kit.
5. Set up and execute electro-pneumatic circuits on an experimental kit.
6. Set up and execute PLC based circuit on an experimental kit.

Sr no	Circuit Design/Assignment
01	Designing & Simulation of two pneumatic circuits on any compatible software.
02	Designing & Simulation of two electro-pneumatic circuits on any compatible software.
03	Designing & Simulation of two PLC based circuits (Ladder Diagram) on any compatible software.
04	Two Pneumatic circuits Setup and execution on experimental kit.
05	Two Electro-Pneumatic circuits Setup and execution on experimental kit.
06	Two PLC based circuits Setup and execution on experimental kit.

Term Work:

Term work shall consist of exercises listed in the above list

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

Circuit Simulation : **10** marks

Circuit Setup and Execution : **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.

Practical/Oral Exam:

The practical/Oral exam shall consists of the following;

Circuit Simulation: one problem : **15** marks

Circuit Setup and Execution: one problem : **10** marks

Course Code	Course Name	Credits
PEL802	Industrial Engineering and Human Resource Management Laboratory	01

Objectives

1. To familiarize with the concepts like Design, develop, implement, and improve integrated systems.
2. To acquaint with basic philosophy of enhancing effectiveness of the human resource potential of their organization.

Outcomes learner will be able to...

1. Apply different industrial engineering principles for productivity enhancement.
2. Develop an integrated systems.
3. Develop skills in identifying, planning, and deploying of man power.
4. Develop inter personal and soft skills.
5. Develop skills in identifying training needs of employs at different levels.
6. Apply legal aspects of employment.

Sr. No.	List of Assignments (any Five assignments)
1	Exercise on Decision Making process in solving a chosen problem.
2	Exercise on a Case analysis of Human Behavior at work place.
3	Exercise on any one of the Time Measurement techniques.
4	Exercise on Assessment of Leadership Quality.
5	Exercise on a case study on Value Analysis.
6	Exercise on Ergonomic Design of a part / product.
7	Presentation on current scenario of Industrial Relations.

Term Work

Term work shall consist of at least 5 assignments from above list.

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

Assignments : 20 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. Examiners are expected to evaluate learner's practical understanding of fundamental skills involved in the field of Industrial Engineering as well his/her grasp of the knowledge of Human Resources, being a very crucial and critical resource in modern firms. The oral examination should be conducted broadly based on the practical significance of the syllabus.
2. The distribution of marks for oral examination shall be as follows:
3. Oral25 marks

Course Code	Course Name	Credits
PEL803	Economics, Finance, Accounting and Costing Tutorial	01

Objectives:

1. To acquaint the students with the concepts of Micro and Macro Economics.
2. To enable the students to comprehend the need, definition, functions and economic significance of financial institutions and markets.
3. To familiarize the students with the concept of Fiscal and Monetary Policy.
4. To acquaint the students with financial statements and Annual Reports of industries.
5. To familiarize the students with cost records / statements.

Outcomes: Learner should be able to...

1. Correlate various micro and macro-economic variables.
2. Illustrate economic policies and their implications.
3. Get familiarized with the roles played by various financial institutions/banks.
4. Get exposure to various business strategies.
5. Get familiarized with accounting and costing practices.
6. Get an exposure to wider intricacies of financial management.

List of Assignments

Sr. No.	List of Assignments
01	An assignment on Micro and Macro Economics.
02	An assignment on Financial Management.
03	An assignment on Job Costing
04	Assignment on Marginal Costing.
05	Assignment on Standard Costing.
06	Assignment on Process Costing.

One assignment each on the above mentioned list of assignments and a Mini Project based on the syllabus in the subject of Economics, Finance, Accounting and Costing. Students have to present the mini project in a group of 3-4. Some areas suggested are as follows:-

- a. Study of annual report and final accounts of a company (currently active) and comment upon the financial aspects of the firm.
- b. Making of a profit & loss statement and Balance sheet of any firm using hypothetical data /actual data and presentation of same.
- c. Any other mini project based on the subject syllabus.

Assignments	: 10 Marks
Mini Project	: 10 Marks
Attendance	: 05 Marks
Total	: 25 Marks