

UNIVERSITY OF MUMBAI



Bachelor of Engineering

in

Production Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

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

Under

FACULTY OF SCIENCE & TECHNOLOGY

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

UNIVERSITY OF MUMBAI

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

Date

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

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

Preamble

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

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

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

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

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

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

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

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

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

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

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

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

Preface By BoS

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

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

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

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

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

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

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

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

Board of Studies (Adhoc) in Production Engineering

Dr. Hari Vasudevan: Chairman

Dr. Arun B. Rane: Member

Dr. Yogesh Padia: Member

Dr. K. H. Inamdar: Member

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total	
PEC401	Engineering Mathematics-IV.	3	--	1	3	--	1	4	
PEC402	Mould and Metal Forming Technology.	3	--	--	3	--	--	3	
PEC403	Theory of Machines.	3	--	--	3	--	--	3	
PEC404	Applied Electrical and Electronics.	3	--	--	3	--	--	3	
PEC405	Advanced Manufacturing Processes.	3	--	--	3	--	--	3	
PEL401	Mould and Metal Forming Technology Lab.	--	2	--	--	1	--	1	
PEL402	Theory of Machine Lab.	--	2	--	--	1	--	1	
PEL403	Applied Electrical and Electronics Lab.	--	2	--	--	1	--	1	
PEL404	Skill based Lab. Course-II	--	4	--	--	2	--	2	
PEM401	Mini Project – 1 B.	--	4 ^s	--	--	2	--	2	
Total		15	14	1	15	7	1	23	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
PEC401	Engineering Mathematics-IV.	20	20	20	80	3	25	--	125
PEC402	Mould and Metal Forming Technology.	20	20	20	80	3	--	--	100
PEC403	Theory of Machines.	20	20	20	80	3	--	--	100
PEC404	Applied Electrical and Electronics.	20	20	20	80	3	--	--	100
PEC405	Advanced Manufacturing Processes.	20	20	20	80	3	--	--	100
PEL401	Mould and Metal Forming Technology Lab.	--	--	--	--	--	25	25	50
PEL402	Theory of Machine Lab.	--	--	--	--	--	25	--	25
PEL403	Applied Electrical and Electronics Lab.	--	--	--	--	--	25	--	25
PEL404	Skill based Lab. Course-II	--	--	--	--	--	50	25	75
PEM401	Mini Project – 1 B	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	175	75	750

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

Mini Project 1B:

Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Credits
PEC401	Engineering Mathematics IV	03+01=04

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

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

Objectives:

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

Outcomes: Learner will be able to:

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

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

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

Term Work:

General Instructions:

- Students must be encouraged to write at least 6 class tutorials on entire syllabus.
- A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

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

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

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

End Semester Examination:

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

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

References:

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

Course Code	Course Name	Credits
PEC402	Mould and Metal Forming Technology	03

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

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

Objectives:

1. To study and analyze casting and forming processes like forging, rolling, extrusion and drawing for ferrous and nonferrous metals.
2. To study and design sand moulds, die casting dies, roll grooves and multi impression forging die etc.

Outcomes: Learner will be able to:

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

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

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

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

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

End Semester Examination:

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

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

Reference Books:

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

Course Code	Course Name	Credits
PEC403	Theory of Machines	03

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

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

Objectives:

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

Outcomes: learner will able to:

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

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

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

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

End Semester Examination:

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

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

Reference Books:

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

Course Code	Course Name	Credits
PEC404	Applied Electrical and Electronics	03

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

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

Objectives:

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

Outcomes: learner will be able to:

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

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

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

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

End Semester Examination:

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

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

Books Recommended:

Text Books:

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

Reference Books:

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

Course Code	Course Name	Credits
PEC405	Advanced Manufacturing Process	03

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

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

Objectives:

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

Outcomes: learner will be able to:

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

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

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

End Semester Examination:

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

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

Reference Books:

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

Course Code	Course Name	Credits
PEL 401	Mould & Metal Forming Lab.	01

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

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

Objectives

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

Outcomes: Learner will be able to:

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

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

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

Term Work:

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

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

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

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

Oral Examination:

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

Course Code	Course Name	Credits
PEL402	Theory of Machines Lab.	01

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

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

Objectives:

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

Outcomes: Learner will be able to:

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

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

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

Term Work

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

Experiments **10marks**

Exercises/Assignments**10marks**

Attendance:**05marks**

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
PEL403	Applied Electrical & Electronics Lab.	01

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

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

Objectives:

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

Outcomes: Learner will be able to:

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

Any Three from SIMULATION based (as below)

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

Any four from HARDWARE based circuits (as below)

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

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

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

Course Code	Course Name	Credits
PEL 404	Skill based Lab. Course-II Advanced Machining Process Lab.	02

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

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

Objectives:

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

Outcomes: Learner will be able to:

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

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

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

Term work

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

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

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

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

Practical Examination:

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

Course	Course Name	Credits
PEM401	Mini Project – 1B	02

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

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

Objectives

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

Outcome: Learner will be able to:

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

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.

- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

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

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

One-year project:

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

Half-year project:

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

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

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

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

Guidelines for Assessment of Mini Project Practical/Oral Examination:

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

Mini Project shall be assessed based on following points;

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