Savitribai Phule Pune University

Faculty of Science & Technology

Curriculum for

Third Year

Production (Sandwich) Engineering

(2019 Course)

(with effect from June 2021)

Savitribai Phule Pune University, Pune TE (Production Sandwich Engineering) 2019 Course (With effect from Academic Year 2021-22)														
Semester-V														
Course Code	**Course Name**	**Teaching Scheme (Hours/Week)**			**Examination Scheme and Marks**						**Credit**			
		Theory	**Practical**	**Seminar**	**IN-Sem**	**End-Sem**	**TW**	**PR**	**OR**	**Total**	**TH**	**PR**	**Seminar**	**Total**
311121	Industrial In-plant Training for 6 months (2 contact hrs. Per student per week) @	-	-	-	-	-	150*	-	100#	250	-	15	-	15
311122 (A)	Manufacturing Technology (Self Study) $	-	-	-	30	70	-	-	-	100	3	-	-	3
311122 (B)	Manufacturing Technology Practices	-	-	-	-	-	50	-	-	50	-	1	-	1
311123	Seminar@	-	-	-	-	-	50	-	50	100	-	-	2	2
311087	Mandatory Audit Course 5	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		**-**	**-**	**-**	**30**	**70**	**250**		**150**	**500**	**3**	**16**	**2**	**21**

Abbreviations:

TW: Term Work
TH: Theory
OR: Oral
TUT: Tutorial
PR: Practical
- Oral based on TW by one internal guide & one external examiner from industry
* - Exams to be conducted in End of Semester after successful completion of Industrial Training and student had procured completion of 6 months Industrial Inplant Training completion certificate from concerned industry.
$ - Students should study this subject during training & contact college guide for guidance.
@- The contact hours are provided for supervision of students under training and for providing guidance regarding the seminar/theory subject to be studied during the training.

Mandatory Audit Course 5 :
Students should choose one the following courses as audit course-

I. Disaster Management
II. Industrial Waste Management

Savitribai Phule Pune University, Pune

TE (Production Sandwich Engineering)
2019 Course
(With effect from Academic Year 2021-22)

Semester-VI

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit			
		Theory	Practical	Seminar	IN-Sem	End-Sem	TW	PR	OR	Total	TH	PR	Seminar	Total
311084(A)	Kinematics and Design of Machines	3	-	-	30	70	-	-	-	100	3	-	-	3
311124(A)	Material forming and Mould Design	3	-	-	30	70	-	-	-	100	3	-	-	3
311125 (A)	Metrology & Quality Control	3	-	-	30	70	-	-	-	100	3	-	-	3
311088(A)	Statistics and Numerical Optimization methods	3	-	-	30	70	-	-	-	100	3	-	-	3
311126 (A)	Elective- I	3	-	-	30	70	-	-	-	100	3	-	-	3
311084(B)	Kinematics and Design of Machines- Lab	-	2	-	-	-	-	-	25	25	-	1	-	1
311124(B)	Material forming and Mould design- Lab	-	2	-	-	-	-	-	25	25	-	1	-	1
311088(B)	Statistics and Numerical Optimization methods-Lab	-	2	-	-	-	-	50	-	50	-	1	-	1
311125 (B)	Metrology & Quality Control- Lab	-	2	-	-	-	-	-	25	25	-	1	-	1
311126 (B)	Elective- I – Lab	-	2	-	-	-	25	-	-	25	-	1	-	1
311130	Entrepreneurship Development	-	2	-	-	-	50	-	-	50	-	1	-	1
311094	Mandatory Audit Course 6	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		**15**	**12**	**-**	**150**	**350**	**75**	**50**	**75**	**700**	**15**	**6**	**-**	**21**

Abbreviations:

TW: Term Work
TH: Theory
OR: Oral
TUT: Tutorial
PR: Practical

Course Code for Elective –I Subjects	
Elective-1	**Elective- 1 Lab**
311126 (A) -I :Advanced Materials	311126 (B)-I: Advanced Materials
311126 (A) -II :Costing and Cost Control	311126 (B)-II: Costing and Cost Control
311126 (A) -III :Advanced Joining Technology	311126 (B) –III: Advanced Joining Technology
311126 (A) –IV: World Class Manufacturing	311126 (B) –IV: World Class Manufacturing

Mandatory Audit Course 6:

Students should choose one of the following course as an audit course-

I. Technical writing and communication skill
II. Energy Auditing and Management in Industries

Industrial In-plant Training

311121

Teaching Scheme	**Credit Scheme**	**Examination Scheme**
2 hrs/week/student	Pr/OR: 15	TW: 150 Marks
		Oral: 100 Marks

Duration of Training in industry: 6 Months

Course Objectives:

1. Learning the environment of Industry and organization chart.

2. Exposed to different departments of plant which gives them to conceptualize design, detail design, manufacturing, quality inspection etc.

3. Learning about process of supply chain management, vendor development, product design as well as concept of value engineering in new product design etc.

4. Understanding of manufacturing machine tools

5. Comprehensive report writing skills based on his/her observations, training received and assignments completed.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Figure out the organizational structure, scale and type of production

2. Understand basic manufacturing technology in terms of scale of production.

3. Understand the functioning of the various departments in the manufacturing environment.

4. Understand the advanced manufacturing and finishing process.

5. Able to handle manufacturing and inspection machines.

6. Understand International Standards on Quality and Reliability

7. Understand various Production Planning and Control functions. Process and Operation Planning

8. Understand material handling methods and equipment.

9. Design manufacturing jigs and fixtures and other accessories

10. Understand different types of tooling system and their role in precision manufacturing.

11. Read and interpret the industrial drawing and process plans

General guidelines to the institutions running Production - Sandwich degree course and to the students opting for sandwich course:

Students are expected to learn following things during the Industrial In-plant Training of 6 months:

He/ She shall be given training in large or medium size manufacturing unit in various departments.

1. Orientation/Rotational Training: Organizational structure of the company, scale and type of production, types of products, functional departments like manufacturing, process planning and control, quality assurance, assembly, testing, maintenance, stores, purchase, marketing, human resources department, design and drawing department, general administration, packing and dispatching, tool engineering, materials and material handling.

2. Industrial Design and Drawing Practice: Design and Drawing standards, study of Mechanical components and introduction to machine design element design such as gears, gear boxes, chain and belt drives, electric motor selection, couplings, shafts, keys, bearings, brackets, bolted and welded connections, sub-assembly and assembly design and drawings, various ISO/BIS/TS standards for design, simple assignments based on the above items, selection of materials, material specifications, heat treatment, and properties of materials.

3. Study of Manufacturing Processes: Study of Processes such as casting, forging, sheet metal working, plastic moulding, extrusion, rolling and machining operations on various machines, study of finishing processes like grinding, lapping, honing, burnishing, buffing, etc. Chipless Manufacturing Processes.

4. Study of Various Manufacturing Machine Tools: Lathe, Capstan and Turret Lathe, Planer, Shaper and Milling, Mechanical and Hydraulic Presses, Gear Hobbing, Shaping and Grinding Machines.

5. Study of special purpose machines, jig boring machines, NC/CNC machines, work centers, transfer lines and automatic machines.

6. Study of single point cutting tools and multipoint tools, form tools, jig and fixtures, special purpose machine tools and press tools, Tool Material and Tool Selection, Study of Cutting Parameters.
7. Study of Material Handling Methods and Equipment.

8. Introduction to Quality and Quality Policy, Need for quality control, National and International Standards on Quality and Reliability, Introduction to Total Quality Management (TQM), Kaizen Practice, 5' S, Study of various inspection gauges, selection of gauges, comparators, calibration of gauges, standards room etc. Product Performance Test Procedures.

7. 9. Study of various Production Planning and Control functions. Process and Operations planning, yearly and Monthly Planning, Forecasting, Machine Loading, Exposure to Interdepartmental coordination planning.

10. Study of various Industrial Engineering Functions, Work Study (Motion Study and Time Analysis), Economic considerations, Plant Layout, Safety aspects of working, safety gadgets used on machines and personal safety, Students shall be asked to do simple assignments in various departments where he is undergoing training.

Industries shall be instructed to prepare training program before hand, covering as much

as possible from above mentioned topics depending upon the type of industry. Students shall be encouraged to give monthly reports and presentation (preferably power point presentation) to the college of his/her works in the industry.

Students are also should be encouraged for paper presentation at National/International Level based upon the applied knowledge gained during the In plant Training.

Term Work

Term work will consist of a comprehensive report based on his observation, training received and assignments completed during 6 months of training. The report shall also include good drawing figure, process sheets, machine and product specifications.

Examination

Oral Examination shall be conducted after training by appointing one internal examiner and one external examiner from industry.
A Six Months Industrial In-plant Training successful completion certificate is essential for granting the term of student.

Instructions regarding In Plant Training report:

1. Paper: The Project report should be typed. Printed on the white paper of A-4 size.
2. Typing: The typing shall be with single spacing and on one side of the paper.
3. Binding: The Industrial In plant Report should be submitted with front and back cover in black bound, with golden embossing.
4. Margins: Left - 1.25", Right - 1". Top & Bottom 1"
5. Font size: Main Heading: 14pt, Sub Heading & Contents: 12pt
6. Font: Times New Roman
7. Paragraph:- Justified.
8. Paragraph Indent:- Nil.
9. Page numbers: - Right bottom, starting from 'Contents' page
10. Number of Copies of the In Plant Training Report: - Three

Sequence of Pages:

1. Title page
2. Certificate form Institute
3. Completion Certificate form Industry
4. Acknowledgement
5. Abstract
6. Index (Contents, List of figures, List of tables, Abbreviations)
7. Nomenclature & Symbols
8. Actual Content (Company Profile-not more than 2-3 pages, Min. 3 Assignments done during In Plant Training)
9. Conclusion
10. References

Manufacturing Technology (Self Study)
311122 (A)

Teaching Scheme	Credit Scheme	Examination Scheme
Self Study	Theory: 03	In-Sem: 30 Marks End-Sem : 70 Marks

Prerequisites:
Manufacturing Processes, Basic knowledge of maintenance activities, Production & Industrial Management.

Course objectives:
1. To impart students with the knowledge about MEMS and microsystems.
2. To make students aware of application of Nanomaterials and their synthesis processes.
3. To facilitate students to understand and apply knowledge of different Maintenance Management Practices
4. To facilitate students to understand the Production Planning and Material Management.

Course Outcomes:
After studying the subjects students will be able to
1. Understand MEMS technology and their applications in industry.
2. Learn properties and synthesis mechanism of different nanomaterials.
3. Understand various aspects of maintenance in practical situations.
4. Explain various aspects of Production Planning and Material Management
5. Demonstrate Commitment to quality, timeliness, and continuous improvement in production rate in manufacturing sector.
6. Understand fundamentals of Mechanical Estimation and Costing.

Unit I:

MEMS and Microsystems

Over view of MEMS and Microsystems: Definition – historical development – properties, design and fabrication micro-system, microelectronics, working principle ,applications and advantages of micro system. Substrates and wafers, silicon as substrate material, mechanical properties of Si, Silicon Compounds - silicon piezo resistors, Galium arsenide, quartz, polymers for MEMS, conductive polymers.

Unit II:

Nanotechnology
Science and synthesis of nano materials: Classification of nano structures – Effects of nano scale dimensions on various properties – structural, thermal, chemical, magnetic, optical and electronic properties fluid dynamics –Effect of nano scale dimensions on mechanical properties - vibration, bending, fracture.
Nanoparticles, Sol-Gel Synthesis, Inert Gas Condensation, High energy Ball Milling, Plasma Synthesis, Electro deposition and other techniques. Synthesis of Carbon nano tubes – Solid

carbon source based production techniques – Gaseous carbon source based production techniques – Diamond like carbon coating. Top down and bottom up processes.

Unit III:

Maintenance Management Practices
Maintenance Management Practice –Various types of maintenance, breakdown, preventive, periodic or predictive, condition based maintenance as predictive preventive maintenance.
Condition based maintenance using Vibration Signature, SOAP, ferrography, hot ferrography, Infra Red Camera, fluorescent dye, Quantum Debris Analysis using Particle Analysers and other diagnostic techniques.
Reliability, Availability and Maintainability of equipment.

Unit IV:

World Class Manufacturing
Deming's and Juran's Approach, Deming's PDCA, PDSA cycle, 7 QC Tools, 5'S, TPM, Kaizen, Quality Circle, Concurrent Engineering, JIT, Kanban, Quality Function Deployment, House of Quality, Six Sigma, Poka Yoke.

Unit V:

Production Planning: Material Resource Planning, Selection of material, methods, machines & manpower. Routing, Scheduling and Dispatching. Types of charts and form used. Computer Aided Process Planning.
Basic economics concepts: Law of demand and supply, Law of diminishing marginal utility, Forms and functions of money. Money market and Capital Market.
Materials Management: Objective, functions of materials management, material planning analysis (MRP I and MRP II).

Unit VI:

Mechanical Estimating and Costing
Fundamentals of Estimating: Objectives and functions of cost estimating, organization of estimating departments, principle factors in estimating, estimating procedure, time estimation for machining.
Estimation of Weights and materials
Introduction, need for scrap, provision for scrap, minimizing manufacturing time, estimation of volume and weight of material, volume and surface area of solids, densities of metals Depreciation: Concept, need and classification, methods of depreciation. Replacement Techniques, Time Value of Money.

Text Books:
1. Sharma P.C., "A Text Book of Production Technology- Manufacturing Processes", S. Chand & Co., 2008, ISBN 81-219-111-4-1.
2. Amitabh Ghosh & Ashok Kumar Mallik, "Manufacturing Science", Affiliated East-West Press Pvt. Ltd., ISBN 81-85095-85-X.

3. A. K. S. Jardine, “Maintenance, Replacement & Reliability”, HMSO, London.
4. A. K. Gupta, “Terotechnology & Reliability Engineering”, McMillan Co.

Reference Books:

1.Kannappan D. and Augustine A. G., "Mechanical Estimating and Costing", Tata McGraw Hill Publishing Company Ltd.
2. T. R. Banga and S.C. Sharma, "Mechanical Estimating and Costing (including contracting)", Khanna Publisher, 2001.
3. Hajara Choudhary, "Workshop Technology", Media Promoters & Publishers Pvt Ltd
4. Mukherjee & Kachwala, "Operations Management & Productivity Tech", Prentice Hall of India.
5. M. Mahajan, "Industrial Engineering & Production Management", Dhanpat Rai & Co.
6. P. Rama Murthy, "Production & Operation Management", New Age International (P) Ltd.
7. R K Jain, Production Technology, 11th edition, Khanna Publication.

Manufacturing Technology Practical (Self Study)
311122 (B)

Teaching Scheme	Credit Scheme	Examination Scheme
Self Study	Pr/OR: 01	Term Work: 50 Marks

Term Work:

1. Assignment based on Unit No. I
2. Assignment based on Unit No. II
3. Assignment based on Unit No. III
4. Assignment based on Unit No. IV
5. Assignment based on Unit No. V
6. Assignment based on Unit No. VI

Seminar

311123

Teaching Scheme	Credit Scheme	Examination Scheme
Self Study	Pr/OR: 02	Term Work: 50 Marks Oral: 50 Marks

Course Objectives:

1. Understanding of seminar topic and its importance
2. Excellent presentation & communication skill
3. Interest towards research oriented fields with ability to search the literature and brief report preparation.
4. Technical writing skill.

Course Outcomes:

1. Students will demonstrate the ability to perform close and critical readings.
2. Students will demonstrate the ability to evaluate, credit and synthesize sources.
3. Students will use multiple thinking strategies to examine real world issues, explore creative avenues, solve problems and make consequential decisions.
4. Students will acquire, articulate, create and convey intended meaning using verbal and non verbal method of communication that demonstrates understanding of student.

Syllabus Contents:

Seminar shall strictly based on deep study of any topic practically studied during Industrial In-plant Training related to any process, production machines, manufacturing related software.

The seminar topic along with Index of report to be finalized by a college guide within first month of commencement of semester and students must be guided to make this seminar to the level of research article that can be published as review article, technical notes in reputed peer reviewed National/International Journal.

The last part of seminar report should necessarily include the relevant research work reported from peer reviewed research articles published in national and international journals.

The report is expected to be about 15 A4 size pages, including figures and tables, in addition to certificate, synopsis and reference pages. The presentation is expected to be in front of the audience which must include at least two internal examiners one of them being a guide and both being university approved teachers and one external examiner. The marks distribution is equally divided between the report and presentation/oral examination.

Instructions regarding Seminar Report:-

1. Page size :- A4
2. Page Format :- Left-1.25", Right-1", Top & Bottom 1" – No Border / Frame
3. Font :- Times New Roman
4. Font Size and Colour:- 12, Black.
5. Line Spacing :- 1.5
6. Printing / Typing :- On one side of the paper only. (No blank sheet be left any where in the report.)
7. Paragraph :- Justified.
8. Paragraph Indent :- Nil.
9. Page numbers :- Right bottom, starting from 'Contents' page
10. Binding :- Spiral with front and back cover of card paper neatly cut to size
11. Number of Copies of the Seminar Report: - Two

Sequence of Pages:

Seminar shall be based on deep study of any topic related to production engineering; contents of the report shall be as follows:

1. Title Page
2. Certificate
3. Acknowledgements:- There should not be any mistake in name and initials.
4. Abstract:- A page explaining the Seminar topic in maximum 150 words.
5. Content / Index
6. List of Tables/Figures or Nomenclature and Symbols:- List of Tables, Figures, Graphs etc. with respective page numbers.
7. Introduction: - 2-3 pages.
8. Seminar Report: - Description of topic about 13-15 pages.
9. Conclusion
10. References

Audit Course 5:

Disaster Management

311087

The course is intended to provide a general concept in the dimensions of disasters caused by nature beyond the human control as well as the disasters and environmental hazards induced by human activities with emphasis on disaster preparedness, response and recovery.

Course Contents:

1. Different Types of Disaster: Natural and man made
2. Risk and Vulnerability Analysis
3. Disaster Preparedness
4. Disaster Response
5. Reconstruction and Rehabilitation as a Means of Development.
6. Damage Assessment
7. Post Disaster effects and Remedial Measures.
8. Long-term Counter Disaster Planning

Audit Course 5:

Industrial Waste management

311087

Introduction: Characteristics of industrial wastes, Types of industries and industrial pollution, Population equivalent, Bioassay studies, effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health, Environmental legislations related to prevention and control of industrial effluents and hazardous wastes.

Waste management Approaches: Waste Audit, Volume and strength reduction, Material and process modifications, Recycle, reuse and byproduct recovery – Applications.

Treatment technologies: Equalization, Neutralization, Removal of suspended and dissolved organic solids, Chemical oxidation, Adsorption, Removal of dissolved inorganics, combined treatment of industrial and municipal wastes, Residue management, Dewatering, Disposal

References:

1. Zander Elis,, Industrial Waste Management, Larsen and Keller Education, 2017, ISBN: 9781635491494
2. John P. Samuelson, Industrial Waste: Environmental Impact, Disposal and Treatment, Nova Science Publishers, 2009, ISBN: 9781606927205

Kinematics and Design of Machines

311084(A)

Teaching Scheme Scheme	Credit Scheme	Examination
Lectures: 3 Hrs / week	Theory: 3	In-Sem: 30 Marks End-Sem: 70 Marks

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Prerequisites: Engineering Mechanics, Mechanics of Materials, Theory of Machines, Design of Machine Elements.

Course Outcomes:

After studying the subjects students will be able to

- Perform kinematic synthesis, analysis of mechanisms.
- Apply fundamentals of kinematics of machines this includes analysis of kinematics of gears, gear trains, cams, flywheel etc.
- Design mechanical system for fluctuating loads.
- Demonstrate optimum design principles and statistical considerations and apply it to mechanical components.

Unit I **(7)**

Synthesis and Analysis of mechanisms:

Computer Aided Analysis and coupler curves for four bar mechanism and slider crank mechanism, dimensional synthesis of mechanisms, three position synthesis of slider crank mechanism and four bar mechanism, Over lay method, Bloch Synthesis

Unit II **(7)**

Theory of spur gear and Gear Train:

Classification, Spur gear: definition, terminology, fundamental law of toothed gearing, involute and cycloidal profile, path of contact, arc of contact, conjugate action, contact ratio, interference and under cutting – Methods to avoid interference.

Gear Trains Simple, compound, epicyclic gear trains, Computation of velocity ratios and torque transmitted in epicyclic gear trains.

Unit III **(7)**

Cams and Flywheels

Cams: Types of cams and followers, terms used in radial cams, analysis of motion of follower, displacement, velocity, acceleration, and jerk diagrams, and determination of cam profile for various types of follower motions: uniform velocity, SHM, uniform acceleration and retardation, cycloidal

Flywheels: Introduction, Turning Moment Diagram ,Fluctuation of speed, Fluctuation of energy, Coefficient of fluctuation of speed, Maximum fluctuation of energy, Energy stored in flywheel, flywheel in punching presses.

Unit IV **(7)**

Design for Fluctuating Load:

Stress concentration-causes & remedies, fluctuating stresses, fatigue failures, S-N curve, endurance limit, notch sensitivity, endurance strength modifying factors, design for finite and infinite life, cumulative damage in fatigue failure, Soderberg's line, Gerber curve, Goodman equation, Modified Goodman diagrams, Fatigue design of components under combined stresses.

Unit V **(7)**

Statistical considerations in design

Frequency distribution- Histogram and frequency polygon, normal distribution - units of of central tendency and dispersion- standard deviation - population combinations - design for natural tolerances - design for assembly - statistical analysis of tolerances, mechanical reliability and factor of safety.

Unit VI **(7)**

Optimum Design and DFMA

Optimum Design:

Objectives of optimum design, adequate and optimum design, Johnson's Method of optimum design, primary design equations, subsidiary design equations and limit equations, optimum design with normal specifications of simple machine elements- tension bar, transmission shaft and helical spring, Pressure vessel.

Design for manufacturing and assembly:

General principles of design for manufacture and assembly (DFM and DMFA), principles of design of castings and forgings, design for machining, design for safety.

Text Book

1. S.S.Ratan , ―Theory of Machines, Tata McGraw Hill [ISBN0070591202]
2. Ghosh Amitabh and Malik Ashok Kumar, "Theory of mechanisms and Machines", 3ed, Affiliated East West press, 2000, ISBN 81-85938-93-8.
3. P.L.Ballaney, ―Theory of Machine, Khanna Publisher.
4. Bhandari V.B. ―Design of Machine Elements, Tata McGraw Hill Pub. Co. Ltd.
5. Juvinal R.C, Fundamentals of Machine Components Design, Wiley, India

Reference Books

1. J. E. Shigley and J.J.Uicker Jr., ―Theory of Machines and Mechanism‖, McGraw Hill
2. Thomas Bevan, "Theory of machines", CBS publishers and Distributors, 1984. ISBN: 8131729656
3. Shigley J. E. and Mischke C.R., ―Mechanical Engineering Design, McGraw Hill Pub.
4. M. F. Spotts, ―Mechanical Design Analysis‖, Prentice Hall Inc.

Material forming and Mould Design
311124(A)

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 Hrs / week	Theory: 3	In-Sem: 30 Marks
		End-Sem: 70 Marks

Prerequisites:

Basic knowledge of Engineering Metallurgy and Strength of materials

Course objectives:

1. Students will understand and analyze the mechanism of forming
2. Students will learn to overcome the difficulties in the process

Course outcomes:

After studying the subject,
1. Students will be able to classify various forming processes
2. Students will learn roll pass design for rolling process
3. Students will learn to design die for forging process
4. Students will learn to design mould for injection moulding

Unit I: **(7)**
Fundamental of Material Forming
Introduction of forming process, Deformation under complex stresses, Maximum shear stress, Principle stresses and principle planes, Theory of plasticity, Mohr's circle diagram, Slip line theory, Upper and lower bound theory, Yield criteria for ductile material – Von Mises criteria, Tresca criteria. Effect of temperature, strain rate, chemical composition and mechanical properties. Friction and lubrication in metal working, concept of flow stress and flow stress determination. Classification of material forming process on forces and material movement, Concept of formability, formability limit and formability diagram, Concept of redundant work and its impact on metal working operations.

Unit II: **(7)**
Extrusion: - Introduction, Dies for Extrusion, stock penetration, Extrusion ratio, Force requirement, metal flow in extrusion, defects. Role of friction and lubrication, Extrusion plant layout and accessories, Manufacture of seam-less tubes.
Wire Drawing:-Introduction, Rod and Wire drawing machines- construction and working. Preparation for stock for wire drawing, wire drawing dies, material and design. Variables in Wire drawing, maximum reduction in one pass, forces required in drawing, multiple drawing, Lubrication in wire drawing. Force calculation in tube drawing.

Unit III: **(7)**

Rolling of metals:- Scope and importance of rolling, Types of rolling mills -construction and working, Deformation in rolling and determination force required, Process variable, redundant deformation, Roll flattening, Roll bite, Roll Camber and its effect on rolling process, Mill spring, Rolling Mill plant and accessories, Automatic gauge control – concept,need and methods, Roll pass classification.

Advance Metal forming Processes:-High velocity forming- principles, Comparison of high velocity and conventional forming processes. Explosive forming, Magnetic pulse forming, Electro Hydraulic forming.

Unit IV: **(7)**

Design of Casting: - Metal pouring, Gating system- design of gating system, solidification time, riser design, Principles of gating, risering and their design methods. Progressive and directional solidification, casting design consideration, Chvornov's rule, numericals on casting.

Design of Die casting dies: - Design of simple die for die casting. Detail calculation of cavity, core, shrinkage and other allowances, heat transfer consideration, directional solidification, design of cooling system, feed and flow system and ejection system. Role of computers in casting die design.

Unit V: **(7)**

Forging & Design of Forging Dies:-

Introduction, forgability tests, classification of forging processes, forging equipments, Basic forging operations such as drawing, fullering, edging, blocking etc, Friction in forging, New technologies:- Liquid metal forging, Isothermal forging, No draft forging, P/M forging, Rotary swaging. Design of forging die for multi-impression die: - selection of parting line, drafts, fillet & Corner radii, ribs and webs, stock size calculation, flash and gutter, design of fullering, edging, blocking, finishing impressions, trimming dies, Die block dimensions, die inserts. Rules for upset forging.

Unit VI **(7)**

Design of Injection Moulds:-

Introduction, Mould materials used for construction, consideration of plastic material parameters- shrinkage, density, bulk factor etc. general mould construction – basic terminology, mould cavities and core, bolsters, ancillary items. Ejection system - ejector grid, ejector plate assembly, ejection techniques, sprue pullers. Feed system - types of gates & runners, design of gates & runners. Cooling systems and heat transfer consideration. Use of CAD for mould design.

Text Books

1. Dieter George E., "Mechanical Metallurgy", McGraw Hill, ISBN 0-07-100406-8.
2. P. H. Joshi, "Press Tool Design & Construction", 1st edition, Wheeler Publication, ISBN 81-85814-46-5.
3. P. N. Rao, "Manufacturing Technology: Foundry, Forming & Welding", Tata McGraw Hill Publication, ISBN 0-07-451863-1.

4. Donaldson Cyril, Lecain Gilt and Goold V. C., "Tool Design", 3rd edition, Tata McGraw Hill Publication, ISBN 0-07-099274-6.
5. B. Ravi "Metal Casting: Computer Aided Design & Analysis", Prentice Hall of India, ISBN 81-203-2726-8.
6. A. Kumar, Fundamental of Tool Design, Danpat Rai & Sons.
7. R. Sharam, S.N. Parsad, N.P. Saxena, Forging die design and practice by; S. Chand and Company. New Delhi.

Reference Books:

1. J N Harris, "Mechanical Working of Metals", Pergmon Press
2. Avitzer, "Fundamental of Metal Working", McGraw Hill Publication
3. Dr. R. Narayanswamy, "Metal Forming Technology", Ahuja Book Company
4. ASME, "Metal Hand Book", Vol II and Vol III.
5. Slotten, "The Die Casting Hand Book".
6. Surendra Kumar, "Technology of Forming Processes", Prentice Hall of India.
7. R.G. W. Pye, "Injection Mould Design - An introduction & design manual for the thermoplastics industry", EWP.

Metrology and Quality Control
311125 (A)

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 Hrs/week	Theory: 03	In-Sem: 30 Marks
		End-Sem : 70 Marks

Prerequisites: Systems of Mechanical Engineering, Physics, Manufacturing processes

Course Outcomes
On completion of the course, students will be able to:

1. Understand the various Metrological equipments available to measure the dimension of the component.
2. Understand the correct procedure to be adopted to measure the dimension of the components.
3. Identify various applications of Measuring Instruments
4. Able to learn basic principles of metrology
5. Able to learn basic statistical process

Unit I **(7)**

Fundamentals of Metrology:
Introduction to Metrology – Need – Elements – Work piece, Instruments – Persons – Environment – their effect on Precision and Accuracy – Errors – Errors in Measurements – Types – Control – Types of standards.

Unit II **(7)**

Linear And Angular Measurements:
Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications.

Unit III **(7)**

Advances in Metrology:
Basic concept of lasers Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications.

Unit IV **(7)**

Form Measurement:
Principles and Methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications.

Unit V **(7)**

Measurement Of Power, Flow And Temperature:
Force, torque, power – Mechanical , Pneumatic, Hydraulic and Electrical type. Flow measurement: Venturimeter, Orifice meter, rotameter, pitot tube – Temperature: bimetallic strip, thermocouples, electrical resistance thermometer – Reliability and Calibration – Readability and Reliability

Unit VI **(7)**

Statistical Quality Control:
Statistical quality control: Frequency distribution, process capability variables and attributes control chart (X & R chart) for variables, control chart for attributes (p, np and C chart) OC curve single and double sampling plan.

Text Books:

1. Engineering Metrology R K Jain Khanna Publication, New Delhi. 2014, ISBN-10: 817409153X
2. Metrology and Measurement A K Bewoor and V A Kulkarni McGraw Hill Education (India) Pvt. Ltd. , New Delhi, 2017. ISBN13-9780070140004
3. Engineering Metrology and Measurement S B Raghvendra and Krishnamurthy Oxford Publication, New Delhi, 2013, ISBN-13: 978-0198085492
4. Measurement and Metrology R K Rajput S.K. Kataria and Sons, New Delhi, 2013, ISBN-13: 978-9350142301
5. F. W. Galyer and C.R. Shotbolt Prentice Hall Publication, New Delhi, 2007, ISBN-10: 8179928486

Reference Books:

1. Beckwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education , 2014.
2. Charles Reginald Shotbolt, “Metrology For Engineers”, 5th Edition, Cengage Learning Emea,1990.
3. Donald Peckman, “Industrial Instrumentation”, Wiley Eastern, 2004.
4. Raghavendra ,Krishnamurthy “Engineering Metrology & Measurements”, Oxford Univ. Press, 2013.
5. Alan S. Morris, “The Essence Of Measurement”, Prentice Hall Of India 1996.

Statistics and Numerical Methods
311088(A)

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 Hrs/week	Theory:03	In-sem Exam: 30 End-sem Exam: 70

Prerequisites: Engineering Mathematics- I and II, Design of Machine Elements

Outcomes: After studying the subjects students will be able to

1. Apply statistical methods to production engineering problems
2. Relate numerical methods to production engineering
3. Develop model of physical problem and subsequent solution by appropriate optimization method

Unit I **(7)**

Statistical hypothesis and tests

Testing of Hypothesis Sampling distributions - Estimation of parameters, Statistical hypothesis, Large sample tests based on Normal distribution for single mean and difference of means,-Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit

Unit II **(7)**

Design and Analysis of Experiments

Design and Analysis of Experiments: Importance of experiments, Experimental strategies, Basic Principles of Design Terminology, ANOVA, steps in experimentation, two and three full Factorial experiments, Taguchi Methods, Design using Orthogonal Arrays, S/N ratios, Data Analysis

Unit III **(7)**

Errors & approximations analysis

Errors & approximations: types of errors, error propagation. Numerical solution of algebraic and transcendental equations by bisection method. Newton Raphson Method. Numerical solution of Linear Simultaneous Equations by Gauss Elimination Method, Gauss-Siedel Method.

Unit IV **(7)**

Methods of curve fitting

Numerical methods - Curve Fitting, methods of curve fitting. Least square criterion- 1st and 2nd order Interpolation: Lagrange's formula, Newton forward difference method. Methods of moment for curve fitting.

Unit V **(7)**

Numerical Differentiation

Interpolation, Newton's forward and backward difference interpolation, Numerical Differentiation and Numerical Integration, Lagrange's and Newton's divided difference, Approximation of derivatives using interpolation, polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules

Unit VI **(7)**

Optimization Methods

Manufacturing Optimization- Method of Lagrange multipliers, steepest descent method, Introduction of classical optimization and multiple optimization. Generalized reduced gradient Method. Introduction to GA and SA. Case studies.

Reference Books:

1. Douglas C. Montgomery, Design and analysis of experiments, John Wiley and sons inc. New York 8th edition.
2. S.C. Chapra, R.P. Canale, ―Numerical Methods for engineers with programming and software applications, Tata McGraw Hill Co. Ltd, New Delhi, ISBN 0071158952.
3. Dr. Sadhu Singh, ―Computer aided Design and Manufacturing‖, Khanna Publication, New Delhi.
4. Ramin S. Esfandiari, Numerical Methods for Engineers and Scientists Using MATLAB, CRC press, Taylor and Francis group.
5. Jaan Kiusalaas, Numerical Methods in Engineering with Matlab, Cambridge University press.

Elective- 1
Advanced Materials
311126 (A)-I

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3Hrs / week	Theory: 03	In-Sem: 30 Marks End-Sem : 70 Marks

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Prerequisites: Physics, Chemistry and Knowledge of Basic Metallurgy and common Engineering Materials

Course Outcomes

After learning the course the students should be able to:

1. Describe metallic and non-metallic materials.
2. Identify various classes of composite materials, their properties and applications
3. Impart knowledge of manufacturing methods of advanced composite material
4. Explain different smart material with their application.
5. Describe properties and applications of Nano materials and biomaterials and suggest a biomaterial for a given application.
6. Explain different Super Alloys with their strengthening mechanism, composition properties and use of different types of light metal and their alloys with metallurgical aspects.

Unit I: **(7)**

Modern Metallic Materials

Dual Steels, Micro alloyed, High Strength Low alloy (HSLA) Steel, Transformation induced plasticity (TRIP) Steel, Maraging Steel, Inter metallics, Ni and Ti Aluminides. Non-metallic Materials: Polymeric materials and their molecular structures, Production Techniques for Fibers, Foams, Adhesives and Coatings, structure, Properties and Applications of Engineering Polymers

Unit II : **(7)**

Introduction to Composite Materials

Introduction, classification: polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon–carbon composites, fiber reinforced composites and nature-made composites, and applications. REINFORCEMENTS: Fibers- glass, silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibers, Polymer composites, thermoplastics, thermosetting plastics, manufacturing of PMC, MMC & CCC and their applications

Unit III: **(7)**

Manufacturing Methods for Advanced Materials

Autoclave, tape production, moulding methods, filament winding, hand layup, pultrusion, RTM. MACROMECHANICAL ANALYSIS OF A LAMINA: Introduction, generalized Hooke's law,

reduction of Hooke's law in three dimensions to two dimensions, relationship of compliance and stiffness matrix to engineering elastic constants of an orthotropic lamina, laminate-laminate code

Unit IV: **(7)**

Functionally Graded Materials
Types of functionally graded materials-classification different systems-preparation-properties and applications of functionally graded materials. Shape memory alloys: Introduction-shape memory effect-classification of shape memory alloys composition-properties and applications of shape memory alloys.

UNIT-V **(7)**

Nano materials and Biomaterials
Introduction-properties at nano scales-advantages & disadvantages-applications in comparison with bulk materials (nano – structure, wires, tubes, composites). Property requirement, biocompatibility, bio functionality, Important bio metallic alloys like: Ni-Ti alloy and Co-Cr-Mo alloys. Applications.

UNIT-VI **(7)**

Super alloys and Light metals
Iron base, nickel base and cobalt base super alloys: Strengthening mechanism, Composition, Properties and their applications. Aluminum, magnesium and titanium alloys: Metallurgical aspects, Properties and applications

TEXT BOOKS

1. Nano material /A.K. Bandyopadyay/New age Publishers
2. Material science and Technology: A comprehensive treatment/Robert W.Cahn,/VCH
3. Engineering Mechanics of Composite Materials / Isaac and M Daniel/Oxford University Press
4. Principles of Materials Science and Engineering, William F. Smith, Third Edition, 2002, McGraw-Hill

REFERENCE BOOKS:

1. Mechanics of Composite Materials – Second Edition (Mechanical Engineering) /Autar K.Kaw / CRC Press
2. P. Ramarao, "Advances in materials and their applications", Wiley Eastern Ltd.
3. Engineering Material Technology James A. Jacobs & Thomas F. Kilduff Prentice Hall
4. Materials Science and Engineering WD. Callister Jr. Wiley India Pvt. Ltd 2010
5. Introduction to Engineering Materials & Manufacturing Processes NIIT Prentice Hall of India
6. Engineering Materials Properties and Selection Kenneth G. Budinski Prentice Hall of India
7. Selection of Engineering Materials Gladius Lewis Prentice-Hall, New Jersey

8. Gandhi, M.V., Thompson, B.S., Smart Materials and Structures, Chapman and Hall
9. Ray, A.K. (ed), Advanced Materials, Allied publishers.
10. Rama Rao, P. (ed), Advances in Materials and their applications, Wiley Eastern Ltd.
11. Bhushan, B., Nano Technology (ed), Springer.
12. I.J.Polmear, Light Alloys, Butterworth Heinemann, Fourth Edition
13. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, "Biomaterials Science: An Introduction to Materials in Medicine, 3rd Edition, , 2013, Academic press, UK

Elective-I
Costing and Cost Control
311126 (A)-II

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3Hrs / week	Theory: 03	In-Sem: 30 Marks End-Sem : 70 Marks

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Prerequisites: Knowledge of Basic costs associated with Manufacturing and sales

Course Outcomes:

1) The student shall demonstrate the fundamentals of Costing System.
2) The student shall apply the costing methods based on type of industry.
3) The student shall be able to apply the different Cost accounting methods as per requirement.
4) The student shall suggest appropriate Cost control and Cost Reduction Techniques.

Unit-1 **(7)**

Cost and Cost Estimation: Concept of cost, cost unit, cost center, classification of cost, elements of cost, Definition of costing, desirable conditions for a costing system. Cost sheet. Cost Estimating: Definition, purpose and functions of estimation, role of estimator, constituents of estimates, estimating procedures.

Unit-2 **(7)**

Estimation of Weight and Material Cost: Process of breaking down product drawing in to simpler elements or shapes, estimating the volume, weight and cost. Purchasing procedure, Inventory Valuation by LIFO, FIFO, Weighted average method.

Unit-3 **(7)**

Estimation of fabrication, foundry, forging and machining cost Constitutes, direct cost, indirect cost, Procedure of estimation of cost for each type. Machine hour rate: definition, constituents, direct cost, indirect cost, steps for estimation of machine hour rate for conventional machines, CNC lathe and machining center.

Unit-4 **(7)**

Overheads: Elements of overheads, classification, general considerations for collection, analysis of overheads, different methods for allocation, apportionment, absorption of overheads.

Unit-5 **(7)**

Cost Accounting Methods: Job costing, Batch costing, Unit costing, Process costing, Contract costing, Activity based costing.

Unit-6 **(7)**

Cost Control: Budget and budgetary control, standard cost, variance analysis, Cost Reduction Areas: Value analysis and Value engineering, Zero Base Budgeting, Cost Volume profit Analysis, Profit volume ratio.

Text Books:

1. Cost Accounting: Jain, Narang (Kalyani Publishers)
2. A Text Book of Estimating and Costing Mechanical – J.S. Charaya & G. S. Narang (Satya Prakashan)
3. Mechanical Estimation and Costing – TTTI, Chennai (TMH)
4. Theory & Problems of Management & Cost Accounting – M.Y. Khan, P. K. Jain (TMH)

Reference Books:

1. Principles & Practice of Cost Accounting – N. K. Prasad (Book Syndicate Pvt. Ltd.)
2. Costing Simplified: Wheldom Series – Brown &Owier (ELBS)
3. Cost Accounting: B. Jawaharlal (TMH)
4. Cost Accounting: R.R. Gupta.
5. Cost Accounting, 13/e - B. K. Bhar, (Academic Publishers, Kolkata)

Elective-I
Advanced Joining Technology
311126 (A)-III

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3Hrs / week	Theory: 03	In-Sem: 30 Marks End-Sem : 70 Marks

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Prerequisites: Knowledge of Basic Metallurgy and Applications of Joining Processes

Course Outcomes:

Students should be able to:
1. Explain the working of various conventional & advanced Welding Processes.
2. Understand advantages & limitations of welding processes and select the appropriate welding process based on application; customer requirement and specifications.
3. Demonstrate an ability of inspection and testing of welded components and apply remedial measures to minimize defects in welding.

Unit I : **(7)**

Gas and Arc welding processes:
Fundamental principles – Air Acetylene welding, Oxyacetylene welding, Carbon arc welding, Shielded metal arc welding, Submerged arc welding, TIG & MIG welding, Plasma arc welding and Electroslag welding processes - advantages, limitations and applications

Unit II : **(7)**
Resistance Welding Processes:
Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding. Percussion welding and High frequency resistance welding processes - advantages, limitations and applications.

Unit III : **(7)**
Solid State Welding Processes:
Cold pressure welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forge welding, Roll welding and Hot pressure welding processes – advantages, limitations and applications, Advances in adhesive bonding, Brazing and soldering, cladding.

Unit IV : **(7)**
Advanced Welding Processes:
Thermit welding, Atomic hydrogen welding, Electron beam welding, Laser Beam welding - principle, working and applications, Friction stir welding, Cold Metal Transfer - concepts, processes and applications, Under Water welding, Welding automation in aerospace, nuclear and surface transport vehicles, Robotic Welding.

Unit V : **(7)**

Testing and Design of Weldments:

Design and quality control of welds. Edge preparation types of joints, weld symbols. Stresses in butt and fillet welds - weld size calculations. Design for fatigue. Destructive and non destructive testing of weldments. Weldability Testing - tensile, bend hardness. Impact, notch and fatigue tests. Visual examination - liquid penetration test, magnetic particle examination. Radio graphs, ultrasonic testing. Life assessment of weldments. IS codes.

Unit VI : **(7)**

Weld Metallurgy:

Weld thermal cycles and their effects, effects of pre and post weld heat treatments, concept of HAZ, concept of weldability and its assessment. Welding of different materials, defects in welds, their causes and remedies.

Text Books:

1. Parmer R.S., "Welding Engineering and Technology", Khanna Publishers, New Delhi, 2008.
2. Little R.L., "Welding and Welding Technology", Tata McGraw Hill Publishing Co., Ltd., New Delhi, 34th reprint, 2008.
3. Kalpakjian S. "Manufacturing Engineering and Technology" Prentice Hall Pearson Education India; 4th edition, 2002.

References:

1. Schwartz M.M. "Metals Joining Manual". McGraw Hill Books, 1979.
2. Tylecote R.F. "The Solid Phase Welding of Metals". Edward Arnold Publishers Ltd. London,
3. AWS- Welding Hand Book. 8th Edition. Vol- 2. "Welding Process"
4. Nadkarni S.V. "Modern Arc Welding Technology", 1st edition, Oxford IBH Publishers, 2005.
5. Christopher Davis. "Laser Welding- Practical Guide". Jaico Publishing House, 1994.
6. Davis A.C., "The Science and Practice of Welding", Cambridge University Press, Cambridge
7. Mishra. R.S and Mahoney. M.W, Friction Stir Welding and Processing, ASM,2007.

Elective-I
World Class Manufacturing
311129 (A)-IV

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3Hrs / week	Theory: 03	In-Sem: 30 Marks End-Sem : 70 Marks

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Prerequisites: Knowledge of Basic Production Processes

Course Outcomes:

The student will be able to –
1. Identify, eliminate and reduce the non-value added activities (wastes) in manufacturing organization
2. Apply the tools and techniques of lean manufacturing to improve productivity in manufacturing organizations
3. Understand the principles and benefits of Toyota Production System philosophy
4. Apply the concept, tools and techniques in TPM philosophy
5. Apply the tools and techniques of constraint management to improve productivity in manufacturing and service organizations
6. Apply the tools and techniques of lean manufacturing to improve productivity in service organizations

Unit I: **(7)**

Lean Manufacturing – Definition & Concept. Characteristics of Lean Manufacturing. Concept of MUDA, MURA & MURI, Value Added and NVA activities

Value Stream Mapping – VSM Symbols, Current State and Future State, Kaizen- Types, Format. Kaizen Development,

Unit II: **(7)**

Toyota Production System- Toyota's 14 Principles of Management, Problem Solving Approach, Design of JIT- Pull System, Kanban-Types, Calculations of Kanban, Concept of Standard Work – Standardization, Standard Operating Procedures, Set-up Time Reduction: SMED Methodology for Set-up reduction, OTED (One Touch Exchange of Dies), Quick Attachment Devices.

Unit III: **(7)**

Group Technology Approaches: Characteristics of A Group/Cell Families of Parts, Group Technology – Codification & Classification Systems , Production Flow Analysis and Choice Of Family , Benefits and Applications Of Group Technology. Cellular Manufacturing: Work cell concepts and applications, Work cell design, work cell staffing and equipment issues.

Unit IV: **(7)**

Japanese Lean Principles: Heijunka (Resource Leveling), Jidoka (Autonomation), Genechi Genbitsu (Go and See), Maintenance Management – Breakdown, Preventive, Predictive. Total Productive Maintenance (TPM): Concept & Origin, Outline of TPM – 8 Pillars, TPM Performance Measures – PQCDSM & OEE (Overall Equipment Effectiveness), Introduction to Autonomous Maintenance (Jishu Hozen) activities, Planned Maintenance, Small-Group activities of TPM.

Unit V: **(7)**

Visual Management System- , Introduction to 5S: Steps in 5S Methodology, Concept of 1S(Seiri), 2S(Seiton), 3S (Seiso), 4S (Shiketsu), 5S, (Shitsuke). Implementation of 1S & 2S, Visual Displays, Visual Controls, Theory of Constraints: Introduction to TOC, Concept, Constraints – Types, Factory Physics, Laws and Bottleneck Scheduling, Concept of Throughput, Inventory & Operating Expenses, Throughput Accounting, TOC Methodology, Numerical & Cases in TOC. Application of TOC in industry, Drum-Buffer-Rope Approach.

Unit VI: **(7)**

Lean Applications in Service Sector - Logistics, Healthcare
Industry 4.0: Introduction, Globalization and Emerging Issues, The Fourth Revolution, Smart Factories, Drivers and Enablers of Industry 4.0, Cyber Physical Systems, Industrial IoT (IIoT)

Text Books:

1. B.S. Sahay, Saxena, World Class Manufacturing - A strategic perspective, Laxmi Publications Pvt Ltd, 1st Edition, 2018
2. Richard Schonberger, World Class Manufacturing – The Next Decade: Building Power, Strength, and Value, Free Press, 1996
3. Jeffrey Liker, The Toyota Way, McGraw Hill Publications, Indian Edition, 2017

Reference Books:

1. Mishra R.C., Pathak K, Maintenance Engineering and Management, PHP Publications, 2nd Edition, 2016
2. James Womack & Daniel Jones, Learning to See, 1998
3. John Bicheno, Cause and Effect Lean – The essentials of Lean Manufacturing, 1994.
4. Nakajima Seiichi ,Introduction to TPM: Total Productive Maintenance, 1995
5. Terry Wireman, Total Productive Maintenance, Industrial Press, 2004
6. Kelley, M.J. Harris, Management Of Industrial Maintenance, Newness Butterworths Press, 2002

Kinematics and Design of Machines- Lab
311084(B)

Teaching Scheme Scheme	Credit Scheme	Examination
Practical: 2Hrs/Week	Pr/OR: 01	Oral:25 Marks

Term Work

Term work will be based on following practical/design assignments

1. To write a computer program for analysis and animation of any mechanism and test it.
2. Determination of holding torque in epicyclic gear train.
3. To draw a cam profile for specific follower motion
4. Study of Flywheel in punching machines.
5. Assignment on Design machine component for fluctuating load
6. Assignment on Design machine component for statistical considerations.
7. Assignment on Design machine component for optimum design

Material Forming and Mould Design – Lab
311124(B)

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2Hrs/Week	Pr/OR: 01	Oral: 25 Marks

Term Work: Oral is based on term work.

1. Assignment based on Unit No. I
2. Assignment based on Unit No. II
3. Assignment based on Unit No. III
4. Assignment based on Unit No. IV
5. Study of Roll pass Design for structural shapes. (At least two)
6. A Report on Factory Visit comprising of Product range, Processes, Plant layout, Auxiliary equipment, Process parameter etc.
7. Detail design and drawing of die for forging operation. (Use of CAD desirable)
8. Detail design and working drawing of plastic moulds for plastic components for manual and automatic machines. (Use of CAD desirable)

Statistics and Numerical Optimization Methods – Lab
311088(B)

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2 hours / week	Pr/OR:01	PR: 50 Marks

Each candidate shall be required to complete and submit the following term work.

1. Practical on parameter optimization of any one process using Taguchi based design of experiment. Validation of results using any statistical software (R/ Minitab/ Excel/ SigmaXL/ Statgraphics etc.).
2. Practical on determination of significant factors for any one process using ANOVA. Validation of results using any statistical software. (R/ Minitab/ Excel/ SigmaXL/ Statgraphics etc.).
3. Practical case study on regression analysis. (Data should be collected for some real life case). Validation of results using any statistical software. (R/ Minitab/ Excel/ SigmaXL/ Statgraphics/ Matlab etc.).
4. Practical case study on regression analysis. (Data should be collected for some real life case).
5. Practical case study on multivariable optimization with constraint using any one method.
6. C programming for any 3 practical mentioned above.

Metrology and Quality control Lab
311125 (B)

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2Hrs/Week	Pr/OR: 01	Oral : 25 Marks

Practical Report shall consist of the following:

1. Utilisation of measuring instruments – Vernier caliper, micrometer, Vernier height gauge – using gauge blocks
2. Calibration and use of measuring instruments – depth micrometer, bore gauge, telescopic gauge
3. Measurement of linear dimensions using Comparators and Measurement of angles using bevel protractor and sine bar
4. Measurement of screw thread parameters – Screw thread Micrometers and Three wire method '(floating carriage micrometer)
5. Measurement of gear parameters – disc micrometers, gear tooth vernier calliper
6. Programming of CNC Coordinate Measuring Machines for repeated measurements of identical components
7. Non-contact (Optical) measurement using Toolmaker's microscope / Profile projector and Video measurement system
8. Measurement of Surface finish in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus based instruments.
9. Industrial visit to see various advanced measuring instruments and its work on live project in an industry.

Elective-1
Advanced Materials Lab
311126 (B) -I

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2Hrs/Week	Pr/OR: 01	Term Work: 25 marks

Students should prepare practical report on following experiments.

1.Study and drawing of microstructures of High Strength Low alloy (HSLA) Steel, Transformation induced plasticity (TRIP) Steel.

2. Study and drawing of microstructures of Aluminum, magnesium and titanium alloys

3. Testing of Composite materials (Like Hardness, Impact, Tension etc.)

4.Heat treatment studies on super alloys and aluminum alloys to understand the precipitation hardening

5. Studies on shape memory effect on Nitinol

6. Virtual lab of Nano indentation

7. Characterization study of a ceramic matrix composite

8. Industrial visit to composite manufacturing Industry

Elective-1
Costing and Cost Control
311127 (B) -II

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2Hrs/Week	Pr/OR: 01	Term Work: 25 marks

Term Work:

Note: Use of computers is essential for at least one exercise.

1. Estimation of weight and material cost for an assembly of three to five components.

2. Valuation of inventory by LIFO, FIFO, Weighted average method

3. Estimation for machine hour rate for representative machines – one conventional machine and one CNC lathe or machining centre.

4. Case study on estimation of overheads for a manufacturing unit

5. Study of different methods for allocation, apportionment, absorption of overheads

6. Case study in any one industry using any of the method of costing.

7. Different examples illustrating cost control

8. Case studies of cost reduction

Elective-1
Advanced Joining Technology
311128 (B) -III

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2Hrs/Week	Pr/OR: 01	Term Work: 25 marks

Term Work will be based on following assignments:

1. Assignment based on Gas and Arc welding processes

2. Assignment based on Resistance Welding Processes

3. Assignment based on Solid State Welding Processes

4. Assignment based on Advanced Welding Processes

5. Assignment based on Testing and Design of Weldments

6. Assignment based on Weld Metallurgy

7. Students should visit at least one industry where welding process is used and prepare a report on it.

Elective-1
World Class Manufacturing
311129 (B) -IV

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2Hrs/Week	Pr/OR: 01	Term Work: 25 marks

Term Work will be based on following topics:

1. Waste Identification and Classification -3M of Lean
2. Kaizen preparation- operator or circle level
3. Value Stream Mapping- Current State and Future State **(e-VSM Software)**
4. Standardization of processes
5. Assignment on TPM Performance Measures 6.
6. Assignment on Overall Equipment Effectiveness
7. Autonomous Maintenance -Jishu Hozen
8. Industry 4.O applications

Entrepreneurship Development
311130

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2Hrs/Week	Pr/OR: 01	Term Work: 50 Marks

Prerequisites: Basic understanding of Entrepreneurship, finance, sales and marketing

Course Outcomes:
After studying the subject students will be able to

1. Recognize different types of Entrepreneurial ventures
2. Discover, develop, and assess opportunities
3. Identify opportunity and perform risk analysis
4. Evaluate the strategies for valuing your own company.
5. Identify different financial resources like venture capitalist and Business Angels.
6. write winning business plans

Term Work:

Term work consists of writing the journal based on following points.

Minimum one assignment on each point.

1) Market Research: Introduction to Entrepreneurship, Profile of the Entrepreneur, Market Gap / Opportunity Analysis, Market Research Methods, Defining the Focal Market: Market Segmentation, Industry analyzing – Research / Competitive Analysis
2) Types of Companies and Organizations: Company/ Organization Types, Legal Aspects, Taxation, Government Liaison, Building the Team, Mergers and Acquisitions
3) Business Finance: Shares and Stakes, Valuation, Finance Creation (Investors / Financers), Revenue Plans and Projections, Financial Ratios, Business Lifecycle, Break Even
4) Marketing: Marketing Basics, Marketing Strategy and Brand Positioning, Plans and Execution Techniques, Marketing Analytics, Online Marketing
5) Sales: Understanding Sales, Pitching Techniques, Sales strategies, Inside Sales v/s Outside Sales.
6) Start-ups: Start-up Basics, Terms, Start-up Financing, Start-up Incubation.
7) Identify Business opportunity and prepare a business plan containing a report on surveys, probable finance providers/investors, technological-financial feasibility, sales and marketing strategy.

Text Books:

1. The Startup Playbook: Secrets of the Fastest-Growing Startups From Their Founding Entrepreneurs by David Kidder

2. Creativity, Inc.: Overcoming the Unseen Forces That Stand in the Way of True Inspiration by Ed Catmull
3. True North by Bill George and Peter Sims
4. Bhargava, S. (2003). Transformational leadership: Value based management for Indian Organizations (Ed.). New Delhi: Response-Sage.
5. Cardullo, M. W. P. E. (1999). Technological entrepreneurism: Enterprise formation, financing, and growyh. England: Research Studies press Ltd.

References:

1. Kanungo, R. N. (1998). Entrepreneurship and innovation: Models for development (Ed., Vol.2). New Delhi: Sage.
2. McClelland, D. C. (1961). Achieving society. Princeton
3. Van Nostrand. Verma, J. C., & Singh, G. (2002). Small business and industry: A handbook for entrepreneurs. New Delhi: Response-Sage.
4. Richard A Brealy & Steward C Myres. Principles of Corporate Finance, McGraw Hills, 7th Edn, 2004
5. Prasanna Chandra, Financial Management: Theory and Practice, Tata McGraw Hills, 6th Edn, 2004
6. I M Pandey, Financial Management, Vikas Publishing, 9th Ed, 2004
7. Aswath Damodaran, Corporate Finance-Theory and Practice , John Wiley & Sons, 1997
8. I.M. Pandey & Ramesh Bhat, "Cases in Financial Management", Tata McGraw-Hill, New Delhi.
9. Horowitch (ED), Technology in the modern Corporation: A Strategic perspective, Pergamon Press, 1986.
10. M. Dodgson (ED), Technology and the firm: Strategies, management 7 Public Policy, Longman, Harlow, 1989.

Audit Course 6

Technical writing and communication skill

311094

This course is intended to equip the students with skills to write technical reports and also to equip them with skills to communicate and articulate in English (verbal as well as writing)

Technical Writing –

- Various forms of scientific writings- theses, technical papers, reviews, manuals, etc.
- Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.;
- Commonly used abbreviations in the theses and research communications;
- Illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations;
- Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills –

- Grammar (Tenses, parts of speech, clauses, punctuation marks);
- Error analysis (Common errors);
- Concord;
- Collocation; Phonetic symbols and transcription;
- Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview;
- Presentation of scientific papers

Audit Course 6
Energy Auditing and Management in Industries

311094

Course outcomes:

- Understand the basic concepts of energy audit and energy management
- Explain different types of energy audit, maximizing and optimizing system efficiency.
- Summarize energy management systems, prepare and present energy audit report
- Identify energy saving potential of thermal and electrical systems
- Discuss Energy audit instruments, Procedures and Techniques.

Energy Auditing: Concepts, Need of Energy audit, Types of energy audit, Energy management (audit) approach, understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Energy audit instruments, Procedures and Techniques.

Energy Management: Design of Energy Management Programmes, Development of energy management systems, Importance, Industrial need of Energy Management, Preparation and presentation of energy audit reports, Monitoring and targeting, some case study and potential energy savings.

Text Books:

1. Murphy, W. R., Energy Management, Elsevier, 2007.
2. Smith, C. B., Energy Management Principles, Pergamum, 2007
3. Sonal Desai, Handbook of Energy Audit, , McGraw Hill Education Private Ltd.,

Reference Books:

1. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
3. W.C. Turner, Energy Management Handbook, John Wiley and Sons.
4. L.C. Witte, P.S. Schmidt, D.R. Brown, Industrial Energy Management and Utilisation, Hemisphere Publication, Washington, 1988
5. Elias P. Gyftopoulos, Industrial Energy Conservation Manuals, MIT Press, Mass, 1982