With effect from the Academic year 2021-2022

DEPARTMENT OF MECHANICAL ENGINEERING

Scheme of Instruction

and

Syllabus of

M.E. (MECHANICAL ENGG)

PRODUCTION ENGINEERING

Full Time & PTPG

AICTE Model Curriculum

2021-22

UNIVERSITY COLLEGE OF ENGINEERING

(Autonomous)

Osmania University

Hyderabad – 500 007, TS, INDIA

With effect from the Academic year 2021-2022

UNIVERSITY COLLEGE OF ENGINEERING, OSMANIA UNIVERSITY

VISION OF THE INSTITUTE

The Vision of the Institute is to generate and disseminate knowledge through a harmonious blending of Science, Engineering and Technology. To serve the society by developing a modern technology in students' heightened intellectual, cultural, ethical and humane sensitivities, fostering a scientific temper and promoting professional and technological expertise.

MISSION OF THE INSTITUTE

- To achieve excellence in Teaching and Research.
- To generate, disseminate and preserve knowledge.
- To enable empowerment through knowledge and information.
- Advancement of knowledge in Engineering, Science and Technology.
- Promote learning in free thinking and innovative environment.
- Cultivate skills, attitudes to promote knowledge creation.
- Rendering socially relevant technical services for the community.
- To impart new skills of technology development.
- To inculcate entrepreneurial talents and technology appreciation programmes.
- Technology transfer and incubation.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION OF THE DEPARTMENT

To generate and disseminate knowledge in Mechanical Engineering and nurture professional, technical and scientific temper for serving the needs of the industry, research organizations and society.

MISSION OF THE DEPARTMENT

- Create technically competent mechanical engineers to suit the changing needs of global industry and society.
- To cultivate skills, attitudes to promote knowledge creation and technology development.
- Interact with prominent educational institutions and R&D organizations for enhancing teaching, research and consultancy services.

With effect from the Academic year 2021-2022

DEPARTMENT OF MECHANICAL ENGINEERING
M.E (Production Engineering)
PROGRAM EDUCATIONAL OBJECTIVES

PEO-1	To provide students with in depth knowledge on advanced areas of production engineering enabling them identify, analyse and solve complex engineering problems using computational tools.
PEO-2	To enable students to carryout innovative and independent research work in production engineering with multidisciplinary applications duly considering economical and financial factors for solving industrial and societal needs.
PEO-3	To provide graduates with professional skills like communication, writing, presentation and management capabilities that enable them to become world class professionals, administrators and academicians.
PEO-4	To imbibe moral ethics and enthusiasm in students to engage in as a lifelong learning process.

PROGRAM OUTCOMES

At the end of the programme the student shall be able to:

PO-1	Ability to independently carry out research/ investigation and development work to solve practical problems
PO-2	ability to write and present a substantial technical report/document
PO-3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PO-4	Apply the appropriate knowledge, techniques, skills and modern tools to solve manufacturing related problems
PO-5	Ability to collaborate and develop optimal solutions for manufacturing a product.

With effect from the Academic year 2021-2022

AICTE-Model Scheme
Scheme of Instructions & Examination
M.E. (Mechanical Engineering) 4 Semesters (Full Time)

Semester-I							
S.No.	**Subject**	**Scheme of Studies per Week**			**Max.Marks**		**Credits**
		L	**T**	**P**	**CIE**	**SEE**	
1.	Program Core I	3	0	0	30	70	3
2.	Program Core II	3	0	0	30	70	3
3.	Program Elective I	3	0	0	30	70	3
4.	Program Elective II	3	0	0	30	70	3
5.	Research Methodology in Mechanical Engineering	3	0	0	30	70	3
6.	*Audit Course I	2	0	0	30	70	0
7.	Laboratory I	0	0	3	50	--	1.5
8.	Seminar	0	0	3	50	--	1.5
	Total	**17**	**0**	**6**	**280**	**420**	**18**
Semester-II							
1.	Program Core III	3	0	0	30	70	3
2.	Program Core IV	3	0	0	30	70	3
3.	Program Elective III	3	0	0	30	70	3
4.	Program Elective IV	3	0	0	30	70	3
5.	*Audit Course II	2	0	0	30	70	0
6.	Laboratory II	0	0	3	50	--	1.5
7.	Laboratory III	0	0	3	50	--	1.5
8.	**Mini Project	0	0	6	50	--	3
	Total	**14**	**0**	**12**	**300**	**350**	**18**
Semester-III							
1.	Program Elective V	3	0	0	30	70	3
2.	Open Elective	3	0	0	30	70	3
3.	***Major Project Phase I	0	0	20	100	--	10
	Total	**6**	**0**	**20**	**160**	**140**	**16**
Semester-IV							
1.	****Major Project Phase II	0	0	32		200	16
	Total	**0**	**0**	**32**		**200**	**16**

Total Credits: 18 + 18 + 16 + 16 = 68

Note :1. L– Theory lecture, T –Tutorial; P–Lab work
CIE :Continuous Internal Evaluation SEE : Semester End Examination

2. *For Audit Course even though the credits are Zero. It is mandatory for the students to secure 50% in that particular subject.
3. ** Mini Project total marks 50 out of which 25 marks will be awarded by Guide and 25 marks by internal committee.
4. *** Major Project Phase I total marks 100 out of which 50 marks will be awarded by Guide and 50 marks by internal committee.
5. **** Major Project Phase II, Total marks 200 to be awarded by External Examiner

Note: 1) *For Audit Course even though the credits are Zero. It is mandatory for the students to secure 50% in that particular subject.

2) ** Mini Project total marks 50 out of which 25 marks will be awarded by Guide and 25 marks by internal committee.

3) *** Major Project Phase I total marks 100 out of which 50 marks will be awarded by Guide and 50 marks by internal committee.

4) **** Major Project Phase II, Total marks 200 to be awarded by External Examiner.

5) For Program Elective-V and Open Elective*:*

If the student is selected for Industry Internship, then he/she has to complete the required courses of Program elective V and Open Elective through ***SWAYAM-NPTEL MOOCS*** *Courses for getting the required credits. However the students are required to consult Head &CBoS (Autonomous) for due approval, before he/ she registers for the course in SWAYAM-NPTEL portal.*

AICTE-Model Scheme
Scheme of Instructions & Examination
M.E.(Mechanical Engineering) 6 Semesters (Part Time)
Semester-I

S.No.	Subject	Scheme of Studies per Week			Max.Marks		Credits
		L	T	P	CIE	SEE	
1.	Program Core -I	3	0	0	30	70	3
2.	Program Elective -I	3	0	0	30	70	3
3.	Program Elective -II	3	0	0	30	70	3
4.	Laboratory-I	0	0	3	50	--	1.5
	Total	**9**	**0**	**3**	**140**	**210**	**10.5**
Semester -II							
1.	Program Core-II	3	0	0	30	70	3
2.	Program Elective-III	3	0	0	30	70	3
3.	Program Elective-IV	3	0	0	30	70	3
4.	Seminar	0	0	3	50	--	1.5
	Total	**9**	**0**	**3**	**140**	**210**	**10.5**
Semester -III							
1.	Program Core-III	3	0	0	30	70	3
2.	Research Methodology in Mechanical Engineering	3	0	0	30	70	3
3.	*Audit Course I	2	0	0	30	70	0
4.	Laboratory-II	0	0	3	50	--	1.5
	Total	**8**	**0**	**3**	**140**	**210**	**7.5**
Semester -IV							
1.	Program Core-IV	3	0	0	30	70	3
2.	Open Elective	3	0	0	30	70	3
3.	Program Elective-V	3	0	0	30	70	3
4.	**Mini Project	0	0	3	50	--	1.5
	Total	**9**	**0**	**3**	**140**	**210**	**10.5**
Semester -V							
1.	*Audit Course II	2	0	0	30	70	0
2.	Laboratory-III	0	0	3	50	--	1.5
3.	***Major Project Phase I	0	0	20	100		10
	Total	**9**	**0**	**29**	**200**	**--**	**11.5**
Semester -VI							
1.	****Major Project Phase II	0	0	32		200	16
	Total			**32**		**200**	**16**

Total Credits: 11 + 11 + 8 + 8+14+16 = 68

Note :1. L– Theory lecture, T –Tutorial; P–Lab work

CIE :Continuous Internal Evaluation SEE :Semester End Examination

2. *For Audit Course even though the credits are Zero. It is mandatory for the students to secure 50% in that particular subject.
3. ** Mini Project total marks 50 out of which 25 marks will be awarded by Guide and 25 marks by internal committee.
4. ***Major Project Phase I total marks 100 out of which 50 marks will be awarded by Guide and 50 marks by internal committee.
5. **** Major Project Phase II, Total marks 200 to be awarded by External Examiner

Note: 1) *For Audit Course even though the credits are Zero. It is mandatory for the students to secure
50% in that particular subject.

2) ** Mini Project total marks 50 out of which 25 marks will be awarded by Guide and 25 marks by internal committee.
3) *** Major Project Phase I total marks 100 out of which 50 marks will be awarded by Guide and 50 marks by internal committee.
4) **** Major Project Phase II, Total marks 200 to be awarded by External Examiner
5) At least two laboratory course should be completed.

M.E. (Mechanical Engineering) Specialization: **Production Engineering**

Type of course	Course Code	Course Name	Contact hours per week			Scheme of Examination		Credits
			L	T	P	CIE	SEE	
SEMESTER-I								
Core-I	ME101	Advanced Casting and Joining Processes	3			30	70	3
Core-II	ME102	Theory of Metal Forming	3			30	70	3
Program Elective-I	ME113	Flexible Manufacturing Systems	3					
	ME602	Additive Manufacturing Technologies and Applications						
	ME123	Advanced Metrology						
	ME501	Finite Element Techniques				30	70	3
	ME126	Industry 4.0						
Program Elective-II	ME111	Manufacturing Automation	3			30	70	3
	ME601	Process Design Reengineering						
	ME116	Theory of Elasticity and Plasticity						
	ME122	Surface Engineering						
	ME131	Tool Engineering						
Audit-I	AC031	English for Research Paper Writing	2			30	70	0
	AC032	Disaster Management						
	AC033	Sanskrit for Technical Knowledge						
	AC034	Value Education						
Lab-I	ME151	Production Engineering Lab			3	50	-	1.5
Lab-II	ME161	Seminar			3	50	-	1.5
Core	ME100	Research Methodology in Mechanical Engineering	3			30	70	3
TOTAL			16		6	280	420	18
SEMESTER-II								
Core-III	ME103	Theory of Metal Cutting	3			30	70	3
Core-IV	ME104	Product Design and Process Planning	3			30	70	3
Program Elective-III	ME114	Micro and Nano Manufacturing	3			30	70	3
	ME115	Mechatronics & Industrial Robotics						
	ME117	Experimental Techniques and Data Analysis						

	ME404	Material Science and Technology						
	ME118	Optimization Techniques						
Program Elective-IV	ME504	Computer Aided Manufacturing	3			30	70	3
	ME119	Smart Materials and MEMS						
	ME120	Manufacturing of Non-metallic Products						
	ME112	Computer Integrated Manufacturing						
	ME121	High Speed Machining						
Audit-II	AC035	Stress management by Yoga	2			30	70	0
	AC036	Personality Development						
	AC037	Constitution of India						
	AC038	Pedagogy studies						
Core	MC070	Mini Project			6	50		3
Lab-III	ME152	Computational Lab for PE			4	50	-	1.5
Lab-IV	ME153	Manufacturing Simulation Lab			4	50	-	1.5
TOTAL			14		12	300	350	18
SEMESTER-III								
Program Elective-V	ME124	Non Destructive Evaluation Techniques	3			30	70	3
	ME125	Tribology						
	ME127	Machine Tool Dynamics						
	ME128	Manufacturing Management						
	ME129	Sustainable Manufacturing						
Open Elective	**OE941**	Business Analytics	3			30	70	3
	OE942	Industrial Safety						
	OE943	Operations Research						
	OE944	Cost Management of Engineering Projects						
	OE945	Composite Materials						
	OE946	Waste to Energy						
	OE947	Intellectual Property rights						
	ME181	Major Project Phase-I			20	100		10
TOTAL			12		20	160	**140**	16
SEMESTER-IV								
	ME182	Major Project Phase-II			32		200	16
GRAND TOTAL								68

ME101

ADVANCED CASTING & JOINING PROCESSES

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To familiarize students with the design principles of gates and risers to obtain defect free casting
- To study casting and welding metallurgy concepts for obtaining sound castings and weldments respectively
- To provide knowledge on recent trends in casting and welding processes and their automation

Course Outcomes: After completion of the course student will be able to

1. Design gating system elements for sound casting
2. Apply the knowledge of casting metallurgy to minimize casting defects
3. Identify the recent trends in casting processes and automation of foundry
4. Apply welding metallurgy concepts to design defect free welds
5. Identify the recent trends in welding processes and its automation

UNIT - I

Casting Metallurgy: Solidification of pure metal and alloys, grain structure of cast metals,shrinkage in cast metals, progressive and directional solidification, Degasification of the melt-casting defects, refractories, metallurgical control, Inoculation, malleabilisation. Castability of steel, Cast Iron- Heat treatment of cast steel, cast iron, stress relieving, solution treatment, age hardening of castings.

UNIT - II

Casting Design: Heat transfer between metal and mould - Design considerations in casting – Designing for directional solidification and minimum stresses- principles and design of gating and risers.

UNIT - III

Recent Trends in Casting and Foundry Layout: Continuous casting, Counter gravity low pressure casting, Squeeze casting and semisolid processes. Layout of mechanized foundry, sand reclamation, material handling in foundry, pollution control in foundry, Computer aided design of casting.

UNIT - IV

Welding Metallurgy and Design: Heat affected Zone and its characteristics –Carbon Equivalent of Plain and alloy steels-Schaeffler diagram, Delta Ferrite, Austenite, pearlite, Martensite. Effect of Alloying elements on microstructure- Residual stress – Distortion and its control -Weld cracks – cold and hot cracks; Liquation cracks, Hyd.rogen Induced cracks, Lamellar cracks.Pre and post

welding heat treatments –weld joint design – welding defects – Weldability of steels, cast iron, stainless steel.

UNIT - V

Recent Trends In Welding: Friction welding, friction stir welding, explosive welding, diffusion bonding, high frequency induction welding, ultrasonic welding, electron beam welding, Laser beam welding, Plasma welding, Electro slag welding, narrow gap, hybrid twin wire active TIG, Tandem MIG, modern brazing and soldering techniques, induction, dip resistance, diffusion processes, Hot gas, wave and vapour phase soldering. Overview of automation of welding in aerospace, nuclear, surface transport vehicles and under water welding.

Suggested Reading:

1. Parmer R.S., "Welding Engineering and Technology",Second Edition, Khanna Publishers,2013
2. Srinivasan N.K., "Welding Technology", Fourth Edition, KhannaPublishers, 2002
3. Heineloper& Rosenthal, "Principles of Metal Casting", Fourth Edition, Tata McGraw Hill, 2008.
4. Jain P.L., "Principles of Foundry Technology",Fourth Edition,TataMcGrawHill Publishers, 2003
5. Carrry B., "Modern Welding Technology", Sixth Edition, Prentice Hall Pvt Ltd., 2005.
6. Cornu.J. "Advanced welding systems" – Volumes I, II and III, JAICO Publishers, 1994.
7. Lancaster.J.F. – "Metallurgy of welding", Sixth Edition, GeorgeAlien& Unwin Publishers, 1999.
8. ASM Handbook, Vol 15, Casting, 2004
9. ASM Handbook vol.6, welding Brazing & Soldering,2003

ME102

THEORY OF METAL FORMING

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives: After completion of the course student will be able to

- To understand the fundamentals of metal forming processes.
- To learn the basic principle of sheet metal and bulk metal deformation.
- To know the principle and applications of un-conventional forming techniques.

Course outcomes: After completion of the course student will be able to

1. Illustrate the mechanism of plastic deformation of metals
2. Identify different types of sheet metal forming techniques
3. Analyze the various forming process and estimate the forming loads
4. Apply the knowledge of powder metallurgy principles and applications
5. Illustratethe principle and applications of un-conventional forming techniques

UNIT-I

Fundamentals of Metal Forming: Classification of metal forming processes, Mechanism of plastic deformation, Factors affecting plastic deformation, Strain hardening behavior. Recovery, Recrystallization and grain growth. Ideal & Practical stress-strain curves. Cold working, warm working and hot working. Plasticity cycle. Yield criteria.

UNIT-II

Sheet Metal Working: Formability tests for sheet metals. Erichsen and Fukui tests. F.L.D. and Shape analysis concepts. Sheet metal dies, Process parameters and estimation of loads in shearing, bending, deep drawing and spinning operations. Superplastic forming, Stretch forming. Fine blanking, Incremental forming.

UNIT-III

Analysis of plastic deformation: Forging, Rolling, Extrusion, rod/wire drawing and tube drawing – Effect of friction – calculation of forces, work done – Process parameters, equipment used – Defects – applications – Recent advances in Forging, Rolling, Extrusion and Drawing processes – Design consideration in forming. Hydrostatic Extrusion. Metal working lubricants.

UNIT-IV

Powder Metallurgy Technique: Advantages – applications – Powder preform forging –powder rolling – Tooling, process parameters and applications. Orbital forging –Isothermal forging – Hot and cold isostatic pressing – High speed extrusion,

UNIT-V

Unconventional Forming: High energy rate forming. Merits and limitations of HERF Processes. Principle, merits, limitations and applications of Explosive forming, electromagnetic forming, electro -hydraulic forming and water hammer forming. Forming with rubber pads.

Suggested Reading:

1. Geoffrey W. Rowe, “An introduction to the Principles of Metal Working”, First Edition, St Martin's Press, London, 1965.
2. SeropeKalpak Jain, “Mechanical Processing of Materials”, D.VanNostrand Company, Inc., First Edition, Princeton, New Jerseey, 1955.
3. Surender Kumar, “Principles of Metal Working”,Second Edition, Oxford & IBH Publishing Co. Pvt. Ltd., 1985.
4. P.C. Sharma, “A Text Book of Production Engineering”,Eleventh Edition,S.Chand& Co. Ltd. New Delhi, 2013.
5. G.E. Dieter, “Mechanical Metallurgy”, ThirdEdition,McGraw - Hill Publications, 1988.

ME113

FLEXIBLE MANUFACTURING SYSTEMS
(Programme Elective-I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To learn the evolution of flexible manufacturing systems, layouts human resources involvement.
- To know the manufacturing driving force, design scheduling of jobs, classification and coding technique.
- To understand the working of automated movement, storage systems, tool management, fault detection and relationship with workstations.

Course Outcomes: After completion of the course student will be able to

1. Classify and distinguish FMS layouts and planning preparation for FMS
2. Identify design, manufacturing attributes and human resources involvement
3. Explain processing stations and material handling systems used in FMS environments
4. Analyze tool management in FMS
5. Evaluate the relationship with FMS workstations and networks

UNIT - I

Evolution of Manufacturing Systems: FMS definition and description, General FMS considerations, Manufacturing cells, Cellular versus Flexible Manufacturing. Systems Planning: Objective, introduction planning, preparation guidelines, the project team, supplier selection, system description and sizing, facility preparation planning, FMS layouts, Just in-time manufacturing, Benefits and relationship to FMS, quality and quantity application principles.

UNIT - II

Group Technology: Concepts, classification, coding,Reasons for Adopting Group Technology, Production Flow Analysis, Benefits and relationship to FMS,Problems in Group Technology, Quantitative Analysis in Cellular Manufacturing, **Human Resources**: staff considerations, team work, communication and involvement, the supervisor's role, personnel selection, job classifications, employee training.

UNIT - III

Automated Material Movement and Storage Systems: AGVs, Robots. Automated Storage and retrieval Systems, Conveyers and pallet floatation systems, queuing Carrousels and automatic work changes, Coolant and chip disposal and recovery systems, Cleaning and Deburring, Wash station types and operation description, Deburring station types and operation description, Importance to Automated Manufacturing, Coordinate measuring machines & types of CMM.

UNIT - IV

Cutting Tools and Tool Management: Introduction, getting control of cutting tools, Tool Management, tool strategies, data transfer, tool monitoring and fault detection, Experimental Setup and Data Collection, Work holding considerations, Fixture support and location principles, Fixture considerations in an FMS environment.

UNIT - V

FMS Networks: computer Hardware, Software, Communications networks, FMS implementation, hardware configuration, programmable logic controllers, cell controllers, general phases of simulation, reasons to integrate FMS computer system to a central host computer, maintenance concerns.

Suggested Reading:

1. Groover, M.P., "Automation, Production Systems and CIM", Third Edition, Prentice Hall India, 2012.
2. Parrish, D.J, "Flexible Manufacturing", New Edition, Butter Worths, Heinemann, Oxford, 1993
3. H.K. Shivanand, M.M. Benal and V. Koti, "Flexible Manufacturing System", First Edition, New Age International (P) Ltd., 2006.
4. Kusiak, A, "Intelligent Manufacturing Systems", First Edition, Prentice Hall, 1990
5. William W. Luggen., "Flexible Manufacturing Cells and Systems",First Edition, Prentice Hall, Englewood, 1991.

ME602

ADDITIVE MANUFACTURING TECHNOLOGIES AND APPLICATIONS
(Programme Elective-I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To know the fundamentals of Additive Manufacturing (AM) and compare it with conventional CNC technology
- To understand the working principle, advantages, limitations and applications of various AM Technologies and also various types of data formats and errors.
- To know the role of AM in Topology optimization and understand the applications of AM in various fields like Biomedical, Aerospace, Automobile and other domains.

Course outcomes: After completion of the course student will be able to:

1. Interpret the features of Additive Manufacturing and compare it with conventional CNC Technology
2. Illustrate the working principle, advantages, limitations and applications of various Additive Manufacturing Technologies and Rapid Tooling systems
3. Interpret various types data formats and STL file errors used in AM and identify the role of Topology optimization in AM
4. Analyze the features of different types of software's used in 3D Printing
5. Applythe knowledge of various AM technologies for developing new and innovative applications

UNIT – I

Introduction: Prototyping fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies. Role of AM in Industry 4.0.

UNIT – II

Working principle,Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following AM Technologies

VatPhotopolymerizationAM Systems: Photopolymers, photo polymerization Stereo lithography Apparatus (SLA), Direct Light Processing (DLP) and Continuous Direct Light Processing (CDLP).
Material Jetting AM Systems: Material Jetting, Nano particle jetting and Drop-On-Demand (DOD) material jetting **Binder JettingAM Systems:** Three dimensional Printing (3DP).
Material ExtrusionAM Systems: Fused Deposition Modeling (FDM)

UNIT – III

Working principle,Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following AM Technologies

Powder Bed Fusion AM Systems: Selective laser sintering (SLS), Selective Laser Melting (SLM) and Direct Metal Laser Sintering (DMLS), Electron Beam Melting (EBM).

Direct Energy Deposition (DED) AM Systems: Laser Engineered Net Shaping (LENS) and Electron Beam Additive Manufacturing (EBAM).
Sheet Lamination AM Systems: Laminated Object Manufacturing (LOM) and Ultrasonic Additive Manufacturing (UAM).
Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods.

UNIT – IV
Reengineering in AM: Reengineering Engineering (RE) Methodologies and Techniques, Selection of RE systems, RE software, RE hardware, RE in product development
AM Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Slicing Algorithms: Rock Algorithm, Crawford's algorithm, Other Translators, Newly Proposed Formats. Mesh Refining by Sub division Techniques, Topology optimization and Additive Manufacturing.
AM Software's: Need for AM software, Features of various AM software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor, SurgiGuide, 3-matic, Simplant, MeshLab.

UNIT –V
AM Applications: Application – Material Relationship, Application in Design, Engineering Analysis and Planning, Aerospace, Automotive, Jewelry, Coin, GIS, Arts, Architecture. Medical and Bioengineering Applications, Forensic Science and Anthropology, Visualization of Biomolecules.
Cost Estimation in AM: Cost Model, Build Time Model, Laser Scanning Vat Photopolymerization Example, Life-Cycle Costing.

Suggested Readings:

1. Ian Gibson, David W Rosen, Brent Stucker,"Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", Second Edition, Springer, 2010.
2. Chee Kai Chua and Kah Fai Leong, "3D Printing and Additive Manufacturing Principles and Applications" Fifth Edition, World scientific, 2017.
3. Frank W.Liou"Rapid Prototyping & Engineering Applications", Second Edition, CRC Press, Taylor &Francis Group, 2019.
4. RafiqNoorani, "Rapid Prototyping: Principles and Applications in Manufacturing", First Edition, John Wiley & Sons, 2006.
5. NPTEL Course on Rapid Manufacturing.

ME123

ADVANCED METROLOGY
(Programme Elective-I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- Learn the Industrial practice of length measurement
- Study the Dimensional of parts manufactured the process
- Study the geometrical forms of parts
- Study the verification geometric configuration

Course Outcomes: At the end of the course the student will be able to:

1. Understand the functioning of slip gauges, micrometer and concept of interchangebility
2. Understand the working of Fixed and Indicating gauges
3. Know the working of measuring machines
4. Identify various types of form errors and their rectification
5. Understand the measurement of screw threads and gears

UNIT-I

End & line standards for length, Airy & Bessel points, desirable features of end standards, slip gauge manufacture, calibration of end standards by interferometry. NPL gauge interferometer, calibration of line standards by micrometer microscope – superposition, coincidence and symmetric straddling, photoelectric microscope and Moiré fringe techniques, measurement of large displacements using lasers, calibration of Tomlinson gauges by interferometry. Photoelectric Autocollimator, calibration of polygons & circular scales. Types of interchangeability, dimensional chains.

UNIT-II

Fixed & Indicating Gauges: Taylor's principles of gauge design, limitations of ring & plug gauges, position and receiver gauges, types of indicating gauges. **Comparators:** Multirange Sigma comparator, Back pressure and free flow type pneumatic comparators, Differential back pressure gauge, usage of different types of jets, contact &non contact tooling. Amplification selection. Air to electric transducer, Differential transducer, Variation transducer, Pre process, In-process & Post process gauging, computation & match gauging. Usage of LVDT & Capacitive type gauge heads, Automatic inspection.

UNIT-III

Measuring Machines: Floating carriage diameter measuring m/c. Universal measuring m/c. Matrix internal diameter measuring machine. Optical dividing head. Coordinate measuring machine, Optical projector-light beam systems, Work tables, measurement techniques, fixturing& accessories. Sources of error in measurement. Design principles of measuring machines Abbe's rule, Kelvin coupling, flexible steel strip, advantages & limitations of hydrostatic & aerostatic bearings.

UNIT-IV

Form Errors: Evaluation of straightness & flatness, usage of beam comparator, evaluation of roundness – intrinsic & extrinsic datum's. Talyrond. PGC, RGC, MZC & LSC, methods, roundness evaluation for even & odd number of lobes. Surface Finish: stylus instrument (TALYSURF). M & E Systems, numerical assessment, vertical & horizontal descriptors, profile as a random process, usage of interferograms. Plastic replica technique.

UNIT-V

Screw Threads: Measurement of thread elements for internal & external threads, progressive periodic, drunkenness and irregular pitch errors. NPL pitch measuring machine, virtual effective diameter, thread gauging. Gears: measurement of tooth thickness, involute profile, pitch, concentricity and alignment, rolling gear test.

Suggested Reading:

1. R.K.Jain, "Engineering Metrology", 21st Edition,Khanna Publishers, 1984.
2. ASTME, "Hand Book of Industrial Metrology",First Edition,Prentice Hall of India Pvt Ltd, 1967.
3. I.C. Gupta, "A Textbook of Engineering Metrology", First Edition,Dhanpat Rai & Sons, 1899.

ME501

FINITE ELEMENT TECHNIQUES
(Programme Elective-I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To familiarize students with the displacement-based finite element method for displacement and stress analysis and to introduce related analytical and computer tools.
- To provides a bridge between hand calculations and numerical solutions for more complex geometries and loading states.
- To study approximate nature of the finite element method and convergence of results are examined.
- It provides some experience with a commercial FEM code and some practical modeling exercises.

Course Outcomes: After completion of the course student will be able to

1. Summarize the basics of finite element formulation
2. Derive interpolation functions and characteristic matrices for different 1D, 2D and 3D elements.
3. Apply the knowledge in solving one dimension and two dimensional static stress and dynamic analysis problems.
4. Solve the steady state and transient heat transfer analysis using FEA.
5. Analyzethree dimensional stress analysis and fluid flow problems.

UNIT-I

Introduction: Historical Background, General description of the finite element method, Mathematical Modeling of field problems in Engineering, Governing Equations, Discrete and continuous models, Boundary, Initial and Eigen Value problems, Weighted Residual Methods, Variational Formulation of Boundary Value Problems, Potential energy method, Rayleigh Ritz method, Galerkin's method of finite element formulation. Strain displacement relations, Stress strain relations, Interpolation models: Simplex, complex and multiplex elements, Linear interpolation polynomials in terms of local,naturalandglobalcoordinates for 1D, 2D, 3D Simplex Elements. Finite element equations, treatment of boundary conditions.

UNIT-II

One-Dimensional Elements-Analysis of Bars and Trusses, Linear interpolation polynomials in terms of local coordinate's for 1D, 2Delements. Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, Analysis of plane truss with number of unknowns not exceeding two at each node. Analysis of frames with two translations and a rotational degree of freedom at each node. Analysis of Beams: Element stiffness matrix for two noded, two degrees of freedom per node for beam element. Torsion of Shafts: Finite element formulation of shafts, determination of stress and twists in circular shafts.

UNIT-III

Finite element modeling of two dimensional stress analysis problems with constant strain triangles and treatment of boundary conditions. Two dimensional four noded isoparametric elements and numerical integration. Plane stress, plane strain and axisymmetric problems, Body forces and temperature effects. Stress calculations, Plate and shell elements. Elements. Convergence requirements and geometric isotropy. Application to Field Problems, Thermal problems, Analysisofauniformshaftsubjectedtotorsionusing Finite ElementAnalysis. Quadrilateral elements and Higher Order Elements.

UNIT-IV

Steady state heat transfer analysis: One dimensional analysis of a fin, composite walls and two dimensional conduction analysis of thin plate. Time dependent field problems: Application to one dimensional heat flow in a rod. Dynamic analysis: Formulation of finite element modeling of Eigen value problem for a stepped bar and beam.EvaluationofEigenvaluesandEigenvectors.

UNIT-V

Finite element formulation of three dimensional problems in stress analysis. Fluid Flow: Flow through a porous medium, Flow through pipes of uniform and stepped sections, Flow through hydraulic net works.Finite Element formulation of an incompressible fluid. Potential flow problems Bending of elastic plates. Introduction to non-linear problems and Finite Element analysis software.

Suggested Readings:

1. TirupathiRChandraputlaandAshok.D.Belegundu, "IntroductionofFiniteElementInEngineering", Third Edition, Prentice Hall of India, 2002.
2. Rao S.S., "The Finite Element Methods in Engineering", Fifth Edition, Pergamon Press, 2010.
3. Segerland. L.J., "Applied Finite Element Analysis", Second Edition, Wiley Publication,1984.
4. Reddy J.N., "An Introduction to Finite Element Methods", Fourth Edition, Mc Graw Hill Company,2020.
5. P.Seshu, "Text book of Finite Element Analysis", Tenth Edition, PHI Learning Pvt. Ltd., 2012.

ME126

INDUSTRY 4.0
(Programme Elective-I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*

CIE: 30 marks *SEE: 70 marks*

Credits: 3

Course Objectives:

- To know the Main concepts and components of Industry 4.0
- To understand the role of data analytics, Internet of Things (IoT), robotics and augmented reality in the implementation of Industry 4.0
- To learn the working of various Additive Manufacturing (AM) Technologies, Virtual Factory and role of Cyber security in the successful implementation of Industry 4.0

Course outcomes: After completion of the course student will be able to

1. Interpret the meaning and scope of Industry 4.0
2. Illustrate the role of Data Analytics and IoT in a Manufacturing Industry
3. Recognise the role of Robotics and Augmented Reality in the implementation of Industry 4.0
4. Identify the role of Additive Manufacturing Technology in Industry 4.0 and interpret the working of various AM technologies and their applications
5. Analyse the role of virtual factory, digital traceability and Cyber Security in the implementation of Industry 4.0

UNIT – I: Introduction

Definition, Main concepts and components of Industry 4.0, Proposed Framework of Industry 4.0, Smart and Connected Product Business Models, Smart Manufacturing, Lean Production Systems for Industry 4.0, The changing role of Engineering Education in Industry 4.0 Era, Industry 4.0 laboratories, Opportunities and Challenges of Industry 4.0, Future Skills required by Workers in the Industry 4.0 Era, Strategies for competing in an Industry 4.0 world.

UNIT – II: Data Analytics and Internet of Things in Manufacturing

Introduction to data analytics, Techniques used for Predictive Analytics, Forecast Accuracy Calculations, A real world Case Study; Introduction to IoT, Examples for IoTs Value Creation in Different Industries.IoTs Value Creation Barriers: Standards, Security and Privacy Concerns.

UNIT – III: Robotics and Augmented Reality in Industry 4.0

Introduction, Recent Technological Components of Robots: Advanced Sensor Technologies, Artificial Intelligence, Internet of Robot Things, Cloud Robotics, Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications. Introduction to Augmented Reality: Augmented Reality Hardware and Software Technology, Industrial Applications of Augmented Reality

UNIT – IV: Additive Manufacturing Technologies and Applications

Introduction, Additive Manufacturing (AM) Technologies: Stereolithography, 3DP, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, Laser Engineered Net shaping, Advantages and Disadvantages of Additive Manufacturing. Applications of Additive Manufacturing in Medical, Surgical Planning, Implant and Tissue Design, Automotive, Aerospace, Electronics, Education and Oceanography. Impact of AM Technologies on society: Impact on health care, Environment, Manufacturing and Supply Chain.

UNIT – V: Virtual Factory, Digital Traceability and Cyber Security

Introduction to Virtual Factory, Virtual Factory Software, Limitations of Commercial Software; Introduction to Digital Traceability, Digital Traceability Technologies, Architectural Framework, Applications, Project Management in Digital Traceability; Introduction to Cyber Security, Security Threats and Vulnerabilities of IoT, Industrial Challenges, Evolution of Cyber Attacks, Cases on Cyber Attacks and Solutions, Strategic Principles in Cyber Security, Cyber Security Measures.

Suggested Readings:

1. Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing the Digital Transformation" 1stEdition,Springer Series, 2018.
2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", 1st edition,Apress, 2019.
3. Dr.-Ing. Klaus Schwab, "The fourth Industrial Revolution", 1st edition,Penguin Publisher, 2017.

ME111

MANUFACTURING AUTOMATION
(Programme Elective-II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To learn the concepts and principles of manufacturing automation
- To understand the components of automation and their practical use in manufacturing application
- Learn principles of assembly systems and material handling systems.
- Understand quality control and other support systems used in automated system
- To provide information integration and data warehousing
-

Course Outcomes: At the end of the course, student will be able to

1. Understand the concepts and the effect of manufacturing automation strategies
2. Apply the principles of automation
3. Design automated material handling and storage systems
4. Analyze automated flow lines and assembly systems, and balance the line.
5. Make use of automated inspection methods

UNIT – I

Introduction: Definition of automation, Types of production, Functions of Manufacturing, Organization and Information Processing in Manufacturing, Production concepts and Mathematical Models, Automation Strategies, Production Economics: Costs in Manufacturing, Break-Even Analysis, Unit cost of production, Cost of Manufacturing Lead time andWork-in-process.

UNIT – II

Automation Production Lines: Automated Flow lines, Methods of Workpart Transport, Transfer Mechanism, Buffer Storage, Control Functions, Automation for Machining Operations, Design and Fabrication Considerations. Analysis of Automated Flow Lines: General Terminology and Analysis, Analysis of Transfer Lines Without Storage, Partial Automation, Automated Flow Lines with Storage Buffers, Simulation of Automated FlowLines.

UNIT – III

Assembly Systems and Line Balancing: The Assembly Process, Assembly Systems, ManualAssembly Lines, Methods of Line Balancing, Other ways to improve the Line Balancing, The Line Balancing Problem, Flexible Manual Assembly Lines. Automated Assembly Systems: Design for Automated Assembly, Types of Automated Assembly Systems, Part Feeding Devices, Analysis of Multi-station Assembly Machines, Analysis of a Single Station Assembly Machine.

UNIT –IV

Automated Materials Handling: The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. Automated Storage Systems: Storage System

Performance, Automated Storage/Retrieval Systems, Carousel Storage Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing.

UNIT – V

Automated Inspection and Testing: Inspection and testing, Statistical Quality Control, Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, Other optical Inspection Methods. The Future Automated Factory: Trends in Manufacturing, The Future Automated Factory, Human workers in the Future Automated Factory and the social impact.

Suggested Reading:

1. MikellP.Grover, "Automation, Production Systems and Computer Integrated Manufacturing", Fourth Edition, Pearson EducationAsia, 2016.
2. C.RayAsfahl, "Robots and manufacturing Automation", Second Edition, John Wiley and Sons NewYork, 1992.
3. N.Viswanadham and Y.Narahari, "Performance Modeling of Automated Manufacturing Syetms", First Edition,Printice Hall India Pvt.Ltd, 1992.
4. Stephen J. Derby, Design of Automatic Machinary, Special Indian Edition, Marcel Decker, New York, Yesdee publishing Pvt. Ltd,Chennai 2004.

ME601

PROCESS DESIGN REENGINEERING
(Programme Elective - II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- Redesign of Manufacturing Processes in producing parts utilizing various Raw materials, appropriate tolerances combination for most convenient manufacturing without compromising the Quality.
- Understand use of metallic, non-metallic, welded, assembled components design involving various forming and machining processes with their capabilities and limitations.
- Understand achieving overall economics due to implementation of positive impact of Assembled part modifications and latest techniques. Make case studies to identify opportunities for economic design and redesign for manufacture.

Course Outcomes:

1. Evaluate and suggest/use of appropriate tolerances with suitable economic raw material for the parts design.
2. Planthe use of metallic components design involving various metal forming and basic machining processes with their capabilities and limitations
3. Plan the utilization ofmetallic components design for planned shaped, centre less ground, EDM, roll finished,, Electrochemical and advanced machine parts.
4. Calculate the economics of using non-metallic component design made with various plastics and ceramics. Assembled and welded parts.
5. Explain the overall economics using, Low Cost Automation, GT& FMS, Assembled Part Modifications. Make case studies to identify opportunities for economic design and redesign for manufacture

UNIT – I: Introduction

General design principles for manufacturability, strength and mechanical factors, mechanisms selection, evaluation method, geometrical tolerances, tolerance control and utilization. Economic Use of Raw Materials: Ferrous steel, hot rolled steel, cold finished steel, stainless steel, non ferrous materials aluminium, copper, brass, non metallic materials, plastics, rubber and composites.

UNIT – II: Metallic Components Design

Metal extrusion, metal stamping, fine blanking, four slide parts, spring and wire forms, spun metal parts, cold headed parts, extruded parts, tube and section bends, rolled formed parts, power metal parts, forging electro forming parts, specialized forming methods, turned parts, machined round holes, drilled parts, milled parts.

UNIT-III:Metallic Components Design

Planned shaped and slotted parts, screw threaded contoured and internal ground parts, center less ground, electrical discharged, rolled furnished parts, electro chemical and advanced machine parts. Sand cast, die cast, investment cast and other cast products.

UNIT-IV: Non Metallic Components Design

Thermosetting plastic, injection moulded and rotational moulded parts, blow moulded, welded plastic articles, ceramics. Assembled Parts Design: Welded parts, arc, resistance, brazed and soldered parts, gear box assembly, bearing assembly.

UNIT-V: Assembled Parts Design

Retension, bolted connection, screwed connections, flanged connections, centred connections, press fitted connections, surface finishing, plated parts, heat treated parts, NC machining, group technology, low cost automation, computer aided manufacture, product design requirements. **Case Studies:** Identification of economical design and redesign for manufacture.

Suggested Readings:

1. James G. Bralla, “Hand book of product design for manufacturing”, First Edition, McGraw Hill Co., 1986
2. K.G. Swift,“Knowledge based design for Manufacture”, First Edition, Kogan page Limited, 1987.

ME116

THEORY OF ELASTICITY AND PLASTICITY
(Programme Elective-II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To understand the basic concepts and stress and strain.
- To know stress-strain relationships for isotropic body and plane stress and plane strain
- conditions
- To learn the difference between True stress and true strain and analysis methods.

Course outcomes: After completion of the course student will be able to:

1. Analyse the problems of 2-D elasticity in Cartesian/Polar Coordinates.
2. Analyze the structures using plasticity.
3. Demonstrate various theories of torsion of prismatic bars of various cross sections and can solve the problems of torsion.
4. Describe the application of plane stress and plane strain in a given situation.
5. Able to solve the problems of 3-D elasticity.

UNIT-I

Basic Concepts of Stress: Definition, State of Stress at a point, Stress tensor, invariants of stress tensor, principle stresses, stress ellipsoid, derivation for maximum shear stress and planes of maximum shear stress, octahedral shear stress, Deviatoric and Hydrostatic components of stress, Invariance of Deviatoric stress tensor, plane stress.

UNIT-II

Basic concepts of Strain: Deformation tensor, Strain tensor and rotation tensor; invariants of strain tensor, principle strains, derivation for maximum shear strain and planes of maximum shear strain, octahedral shear strain, Deviatoric and Hydrostatic components of strain tensor, Invariance of Deviatoric strain tensor, plane strain.

UNIT-III

Generalized Hooke's Law: Stress-strain relationships for an isotropic body for three dimensional stress space, for plane stress and plane strain conditions, differential equations of equilibrium, compatibility equations, Material (D) matrix for Orthotropic Materials.

UNIT-IV

True stress and true strain, Von-Mises and Tresca yield criteria, Haigh–Westergard stress space representation of Von-MisesandTresca yield criteria, effective stress and effective strain, St. Venants theory of plastic flow, Prandtle–Reuss and Levy–Mises constitutive equations of plastic flow, Strain hardening and work hardening theories, work of plastic deformation.

UNIT-V

Analysis methods: Slab method, Slip line field method, uniform deformation energy method, upper and lower bound solutions. Application of Slab method to forging, wire drawing, extrusion and rolling processes.

Suggested Readings:

1. Timoshenko and Goodieer, “Theory of Elasticity”, Mcgraw Hill Publications 3rd Edition, 2017.
2. J. Chakrabarty, “Theory of Plasticity”, 2nd edition, McGraw Hill Publications, 1998.
3. George E Dieter, “Mechanical Metallurgy”, Third Edition, McGraw Hill Publications 2017.

ME122

SURFACE ENGINEERING
(Programme Elective-II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives

- To learn the physics and concept of surface of engineering
- To explore various methods of methods of surface can be created
- To characterize and validate the surface properties

Course Outcomes

1. To Understand properties of surface engineering
2. Learn various methods of surfaces can be modified for Engineering application
3. To apply the surface engineering parts for particular application
4. Analyse the surface for engineering service
5. Evaluate the engineering surface to different environments

UNIT I

Introduction- Significance of surface engineering- Solid surface- Surface energy-Superficial layer-Physico-chemical parameters- Properties of the superficial layer-Surface coating- Classification.

UNIT II

Physical Vapor Deposition (PVD): Ion plating- Sputter deposition- Reactive deposition-Magnetron sputtering- Chemical vapor deposition (CVD)- Ion implantation- Electron beam technology- Applications.

UNIT III

Thermal Spraying Techniques- Flame Spraying, Atmospheric Plasma Spraying (APS), Vacuum Plasma Spraying (VPS), Detonation-Gun Spraying (D-GUN), High-Velocity Oxy-Fuel (HVOF) Spraying-Applications.

UNIT IV

Laser Surface Engineering- Laser transformation hardening - Laser remelting- Laser alloying-Laser cladding- Laser ablation- Pulsed laser deposition- Laser doping - Laser crystallization- Laser surface texturing- Laser shock peening.

UNIT V

Methods of characterization-Microstructure- Mechanical: Adhesion-Hardness-micro hardness-Residual stress-Friction-Wear- Physical: Porosity-Density- Electrical: Conductivity- Magnetic-Chemical.

References

1. TadeuszBurakowski, Tadeusz Wierzchon, “Surface Engineering of Metals-Principles, Equipment and Technologies”, First Edition, CRC Press, 1999.
2. Lech Pawlowski, "The Science and Engineering of Thermal Spray Coatings", 2nd Edition, John Wiley & Sons, 2008.
3. William M. Steen, JyotirmoyMazumder, “Laser Material Processing”, 4th Edition, Springer Verlag, 2010.

ME131

TOOL ENGINEERING
(Programme Elective-II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- Understand the geometry and manufacturing of single point cutting tools, form tools and multi point cutting tools.
- To study the design of press tools and Jigs and fixtures for a given component
- To acquire knowledge in tooling for automats , economics of tooling and gauge design

Course Outcomes: After completion of the course student will be able to

1. Acquire knowledge in single point cutting tools, form tools.
2. Interpret the design and manufacturing of multi point cutting tool to machine a required job.
3. Design a die and punch for blanking, piercing, drawing and bending operations.
4. Design a location and clamping system for a given component.
5. Design of gauge to measure a given component and acquire knowledge in forging die design and economics of tooling

UNIT-I

Design of single-point cutting tools: Tool strength and rigidity calculation, selection of tool angles, chip breakers, carbide, tipped tools. Manufacturing of single point cutting tool. **Form Tools**: Types of form tools, method of determining the profile of circular and flat form of tool, analytical and grapignical method.Cutting principle by form generation gear shapers & hobs.

UNIT-II

Design of Multi Point Cutting tools: Geometry, types and design of Twist drills, Reamers, Milling cutters, broaches.

Manufacturing of Multi Point Cutting Tools: Manufacturing of Twist drills, Reamers, Milling cutters, broaches.

UNIT-III

Design of Press Tools: blanking, piercing, bending and drawing operations, center of pressure clearances, strip layout, punch force, blank size, number of draws, single, compound and progressive press tools. Drawing dies,Deep Drawing of Cups, Blank diameter, Drawing force Design of bending die.

UNIT-IV

Design of Jigs and Fixtures: Principles of location and clamping, locating and clamping elements and their standardization, Diamond pin, Redundant location, fool proofing, classification of Drill

Jigs, Drill bushings and liners. Quick clamping devices. Designing jig and fixture. Design principles of Drilling Jigs, Milling fixtures, welding fixtures, fixturing of NC machines.

UNIT-V

Forging Die Design: Allowances, Forging process, Forging die design, Drop forging Dies and auxiliary tools, Upset forging.

Gauge design: Gauge principles, types, gauge allowances and tolerance, materials for gauges.

Economics of Tooling: Economics if small tool selection, Break even point analysis, Economic lot size, Tooling for Automats: Cam design for automats,

Suggested Reading:

1. ASTME, Fundamentals of Tool Design.
2. P.C.Sharma, A textbook of Production Engineering, 8th Edition, S Chand, 1999.
3. G.R. Nagpal, Tool Engineering and Design., 1st Edition,Khanna Publication, 2000.
4. P.H.Joshi, Press Tools Design And Construction, First edition ,S Chand, 2017
5. John G. Nee, Fundamentals of Tool Design, Sixth Edition, Society of Manufacturing Engineers 2010.
6. P.H.Joshi, Jigs and Fixtures, third edition, Tata McGraw-Hill Education,2017.
7. K. Venkataraman, Design of Jigs, Fixtures and Press Tools, John Wiley & Sons Ltd. Athena Academic, 2015.

AC 031

ENGLISH FOR RESEARCH PAPER WRITING
(AUDIT COURSE-I)

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

- *Understand that how to improve your writing skills and level of readability*
- *Learn about what to write in each section*
- *Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission*

Outcomes:

1. *Able to plan and prepare paragraphs, avoiding ambiguity*
2. *Writing of abstracts, paraphrasing and plagiarism*
3. *Providing of critical and thorough review of literature, discussions and conclusions*
4. *Able to exhibit key skills for writing titles, introduction, abstract.*
5. *Able to show key and necessary skills for paper writing, phrases, results.*

Unit I

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Unit II

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

Unit III

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Unit IV

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

Unit V

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions -Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Suggested Studies:

1. Goldbort R, Writing for Science, First Edition Yale University Press (available on Google Books), 2006.
2. Day R, How to Write and Publish a Scientific Paper, 7th Edition, Cambridge University Press, 2006.
3. Highman N Handbook of Writing for the Mathematical Sciences, 2nd Edition, SIAM. Highman'sbook. 1998
4. Adrian Wallwork English for Writing Research Papers, First Edition, Springer New York Dordrecht Heidelberg London. 2011.

AC032

DISASTER MANAGEMENT
(AUDIT COURSE-I)

Instruction: 2 periods per week Duration of SEE: 3 hours
CIE: 30 marks SEE: 70 marks
Credits: 0

Course Objectives:

- To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters
- To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters
- To enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographic, etc.

Course Outcomes: At the end of this course, students will be able to:

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction
2. Humanitarian response
3. Critically evaluate disaster risk reduction and humanitarian response policy and Practice from multiple perspectives.
4. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
5. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

UNIT-I

Introduction

Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT-II

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT-III

Disaster Prone Areas in India

Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.

UNIT-IV

Disaster Preparedness and Management

Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data From Meteorological and other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT-V

Risk Assessment

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

UNIT-VI

Disaster Mitigation

Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster
Mitigation in India.

Suggested Readings:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies" 1st Edition, New Royal book Company, 2007.
2. Sahni, Pardeep Et.Al. (Eds.), "Disaster Mitigation Experiences and Reflections", New title Edition, Prentice Hall of India, New Delhi, 2004.
3. Goel S. L. Disaster Administration and Management Text and Case Studies", 1st Edition, Deep & Deep Publication Pvt. Ltd., New Delhi, 2007.

AC 033

SANSKRIT FOR TECHNICAL KNOWLEDGE
(AUDIT COURSE-I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 0

Objectives:

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Outcomes:

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

UNIT-I:

- Alphabets in Sanskrit.
- Past/Present/Future Tense.
- Simple Sentences.

UNIT-II:

- Order
- Introduction of roots
- Technical information about Sanskrit Literature

UNIT-III:

- Technical concepts of Engineering-Electrical,
- Mechanical,
- Architecture,
- Mathematics

References:

1.Dr.Vishwas, "Abhyaspustakam",Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication 2013 Edition.
3. Suresh Soni, "India's Glorious Scientific Tradition", 1st Edition, Ocean books (P) Ltd., New Delhi, 2006.

AC034

VALUE EDUCATION
(AUDIT COURSE-I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 0

Course Objectives:

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

Course Outcomes:

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

UNIT I:

- Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism.
- Moral and non- moral valuation. Standards and principles.
- Value judgements.

UNIT II:

- Importance of cultivation of values.
- Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness.
- Honesty, Humanity. Power of faith, National Unity.
- Patriotism. Love for nature, Discipline.

UNIT III:

- Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline.
- Punctuality, Love and Kindness.
- Avoid fault Thinking.
- Free from anger, Dignity of labour.
- Universal brotherhood and religious tolerance.
- True friendship.
- Happiness Vs suffering, love for truth.
- Aware of self-destructive habits.
- Association and Cooperation.
- Doing best for saving nature

UNIT IV:

- Character and Competence –Holy books vs Blind faith.
- Self-management and Good health.
- Science of reincarnation.
- Equality, Nonviolence,Humility, Role of Women.
- All religions and same message.

- Mind your Mind, Self-control.
- Honesty, Studying effectively

References:

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi, 2014 Edition.

ME151

PRODUCTION ENGINEERING LAB

Instruction 3 Periods/week *CIE: 50 Marks*
Credits: 1.5

Objectives:

- Study the chip morphology and evaluate chip thickness and shear angle
- Perform formability studies on sheet metals.
- Evaluate the mechanical properties of welded joints
- Test the properties of moulding sands and tribological properties of a given material

Course Outcomes: After completion of the course student will be able to

1. Ability to perform simulations/ experiment and understand the phenomenon
2. Critically evaluate and interpret the results
3. Prepare a well-organized record

List of Experiments:

1. Study of the morphology of chips produced from different materials sand machining processes.
2. Study of cutting ratio/chip thickness ratio in simulated orthogonal cutting with different materialsand tool geometry.
3. Roughness of machined surface. Influence of tool geometry and feed rate
4. Study of cutting forces using Lathe tool dynamometerby varying machining parameters.
5. Study of the construction and operating parameters of metal spinning Lathe.
6. Study of the water hammer equipment and hydrostatic extrusion setup.
7. Extrusion of cylindrical billets through dies of different included angles and exit diameters and their effect on extrusion pressure.
8. Practice and study of blanking and punching process and their characteristic features on mechanical press with existing dies.
9. Experiments on EDM to measure MRR and Surface roughness of different metals.
10. Experiments on MIG/MAG welding to find out the mechanical properties of metals.
11. Testing of mechanical properties of metals by using UTM.
12. Fatigue Testing of metals on Rotary Fatigue Testing Machine.
13. Evaluation of moulding sand properties by varying the silica, clay and binder proportions
14. Evaluation wear characteristics of cutting tool materials using PIN on DISC and Abrasion Tester.

ME161

SEMINAR

Instructions *3 periods/week* *CIE: 50 Marks*
Credits *1.5*

Course Objectives:

- Identify appropriate topic of relevance.
- Update literature on technical articles of selected topic and develop comprehension.
- Prepare a technical report.
- Deliver presentation on specified technical topic.

Course outcomes: After completion of the course student will be able to

1	Identify and compare technical and practical issues related to manufacturing and production Engineering related systems.
2	Interpret the working of Manufacturing systems.
3	Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting.
4	Criticize and experiment to arrive at solutions for real world Production engineering problems.
5	Analyse and evaluate to obtain solution for problems in Production systems.

Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Objectives and Methodology
5. Results and Discussions& Summary
6. Conclusions
7. References

Each student is required to:

1. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.

2. Submit the detailed report of the seminar in spiral bound in a précised format as

suggested by the Department.

Guidelines for awarding marks		
S. No.	**Description**	**Max. Marks**
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

Note:

1. The seminar presentation should be a gist of at least five research papers from Peer-reviewed or UGC recognised journals.
2. The seminar report should be in the following order: Background of work, literature review, techniques used, prospective deliverables, discussion on results, conclusions, critical appraisal and reference.
3. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
4. Attendance of all the students for weekly seminar presentations is compulsory.

ME100

RESEARCH METHODOLOGY IN MECHANICAL ENGINEERING

Instructions 3 periods/week *Duration of university Examination: 3 hours*
Credits 3 *SEE: 70 Marks*
CIE: 30 Marks

Course Objectives:

- Learn to focus on research related activities.
- Learn methods to devise and develop the various research designs
- Learn basic principles of data collection and analysis techniques
- Learn the style and format of writing a report for technical papers
-

Course Outcomes: After completion of the course student will be able to

1. Motivate the orientation towards research related activities
2. Formulate the research problem, analyze research related information
3. Identify various sources for literature review and design an experimentation set-up
4. Apply the basic principles of data collection and analysis techniques
5. Improve the style and format of writing a report for technical / Journal articles

UNIT – I

Research Methodology: Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods verses Methodology, Research and Scientific Method, Important of Research Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general.

Defining the Research Problem: Definition of Research Problem, Problem Formulation, Necessity of Defining the Problem, Technique involved in Defining a Problem.

UNIT – II

Literature Survey: Importance of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet. **Literature Review**: Need of Review, Guidelines for Review, Record of Research Review.

UNIT – III

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set-up, Use of Standards and Codes.

UNIT – IV

Data Collection: Collection of primary data, Secondary data, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Sample Design, Need for sampling, some important sampling definitions, Estimation of population, Role of Statistics for Data Analysis, Parametric V/s Non Parametric methods, Descriptive Statistics, Measures of central tendency and Dispersion, Hypothesis testing, Use of Statistical software.

Data Analysis: Deterministic and random data, Uncertainty analysis, Tests for significance: Chi-square, student's t-test, Regression modeling, Direct and Interaction effects, ANOVA, F-test, Time Series analysis, Autocorrelation and Autoregressive modeling.

UNIT – V

Research Report Writing: Format of the Research report, Synopsis, Dissertation, Thesis its Differentiation, References/Bibliography/Webliography, Technical paper writing/Journal report writing, making presentation, Use of visual aids. **Research Proposal Preparation**: Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

Suggested Reading:

1. C.R Kothari, Research Methodology, Methods & Technique; Revised Edition, New Age International Publishers, 2004.
2. R. Ganesan, Research Methodology for Engineers, 1st Edition, MJP Publishers, 2011.
3. RatanKhananabis and SuvasisSaha, Research Methodology, 1st Edition, Universities Press, Hyderabad, 2015.
4. Y.P. Agarwal, Statistical Methods: Concepts, Application and Computation, 1st Edition, Sterling Publs., Pvt., Ltd., New Delhi, 2004
5. Vijay Upagade and AravindShende, Research Methodology, 1st Edition, S. Chand & Company Ltd., New Delhi, 2009
6. G. Nageswara Rao, Research Methodology and Quantitative methods, 2nd Edition, BS Publications, Hyderabad, 2012.

SEMESTER - II

ME103

THEORY OF METAL CUTTING

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To emphasize upon the prominent theories, concepts and constructional features of machines related to them.
- To analyze cutting forces, temperature, power and specific energy along the shear and rake Planes
- To introduce various non- traditional machining processes
- To lay groundwork for further studies in manufacturing stream.

Course Outcomes: At the end of the course, student will be able to

1. Demonstrate ASA, ORS and NRS systems of tool geometry and derive their interrelationship.
2. Develop the relations for chip reduction coefficient, shear angle, shear strain, forces, power, specific energy and temperatures associated with orthogonal cutting.
3. Evaluate shear angle relationships and coefficient of friction in natural and controlled contact cutting.
4. Select cutting fluids, cutting tool materials and tool geometry for improving machinability and tool life
5. Select modern machining processes for machining a given material and required part accuracies.

UNIT I

Geometry of Cutting Tools: Geometry of single-point cutting tool: Tool-in hand system, ASA, ORS, and NRS system, Conversions between ASA and ORS systems – Graphical Method, Normal Rake System (NRS) & relation with ORS.

Mechanics of Machining Processes: Orthogonal cutting, Mechanics of Chipformation: Types of chips, chip-breakers, Chip reduction coefficient, shear angle, shear strain, Built-Up-Edge and its effect in metal cutting, Merchant's analysis of metal cutting process - Various forces, power and specific energy in cutting, Problems on Tool Geometry and Mechanics of Machining, Theories of Metal Cutting: Ernst & Merchant, theory, ModifiedMerchant's theory, Lee & Shaffer Theory. Stress distribution at Chip-Tool Interface –Machining with controlled contact cutting, Chip breakers.

UNIT II

Thermal aspects in machining: Sources of heat generation, Effects of temperature,Determination of cutting temperature using analytical methods, Determination of cuttingtemperature using experimental methods, Methods of Controlling Cutting Temperature, Cutting Fluids: Functions, characteristics and types, selection of cutting fluids, Tool wear, Tool life, **Machinability and Machining Economics:** Wear Mechanisms, Types oftool wear, Tool Life and Machinability, Problems on Economics of Machining, Cutting Tool Materials:

UNIT III

Mechanics of Multipoint Machining processes: Drill geometry & Mechanics of drillingprocess, Geometry of milling cutters and Mechanics of milling process, Mechanics of grinding (plunge grinding and surface grinding), Grinding wheel wear.

UNIT IV

Material Removal Mechanism of Advanced Machining Processes:

Need for non-traditional machining processes. Processes selection, classification, and comparative study of different processes. Mechanical Process: **Ultrasonic Machining**-Definition-Mechanism of metal elements of the process- Tool feed mechanism. Theories of mechanics of causing effect of parameter applications. **Abrasive Jet Machining**: Principles - parameters of the process, applications, advantages and disadvantages. **Water Jet Machining (WJM):** Schematic diagram, equipment used, advantages, disadvantages and applications. **Abrasive Water Jet Machining (AWJM):** Schematic sketch, equipment and abrasives used, advantages, disadvantages and applications.**Thermal Metal Removal Process**: Electric discharge machining Principle and operation – mechanism of metal removal, basic EDM circuitry-spark erosion. Dielectric fluids- flushing-Electrodes, surface finish. Applications. **Wire EDM** principle and operation. Wire materials, wire tension and its parameters. Applications.

UNIT V

Electro Chemical and Chemical Processes: Electro chemical machining (ECM) Classification ECM process-principle of ECM Chemistry of the ECM parameters of the processes-determination of the metal removal rate.Tool Design-advantages and disadvantages - applications. Electro Chemical Grinding-Electro Chemical honing,electrochemicaldeburring.

Electron Beam Machining (EBM): Introduction-Equipment for production of Electron beam - Theory of electron beam machining, Thermal & Non thermal type's characteristics – applications. **Laser Beam Machining (LBM)**: Introduction-principle of generation of lasers equipment and machining procedure-types of Lasers-process characteristics-advantages and limitations-applications.**Plasma Arc Machining (PAM)**: Introduction-Plasma-generation of Plasma and equipment,mechanism of metals removal, PAN parameters-process characteristics - type of torches, applications.

Suggested Readings:

1. David A. Stephenson, Johs S. Agapiou, Metal Cutting Theory and Practice, CRC Press, 3rd Edition, March 2016.

2. M.C. Shaw, Metal cutting principles, First Edition, CBS Publishers and distributors., New Delhi, 2002
3. Bhatta Charya, Metal Cutting Theory and Practice, Central book publishers, Calcutta, 2012.
4. Bhattacharya,New Technology- Institution of Engineers, First Ediion, India, 1973.
5. Adithan,Modern Manufacturing Method,1st Edition, New Age International (p) Limited, 1996.
6. P.K. Mishra, Non-Conventional Machining, 1st Edition,Narosa Publishing House, New Delhi, 1997.
7. J.A. McGeough,Advanced Methods of Machining, First Edition, Springer, New Delhi-2011.

ME104

PRODUCT DESIGN AND PROCESS PLANNING

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To learn the essential factors with innovative ideas to develop successive right product.
- To acquaint with product reliability, copyrights, value Engineering in product design and cost estimation of product.
- To understand the various machining processes, improving tolerances methods, selection of materials and their importance.
- To understand the modern approaches, ergonomics considerations in product design, integration of design, manufacturing and production control.

Course Outcomes: After completion of the course student will be able to

1. Identify and analyze the product design and development processes in manufacturing industry.
2. Perform function analysis to improve the value of the product by value Engineering, estimate the cost of the product and be familiar with the Intellectual Property rights.
3. Suggest an appropriate manufacturing process for a given product using product design rules of various manufacturing process.
4. Illustrate the importance of ergonomics in the design of new products
5. Comprehend the role of computer in product design, Manufacturing and Management

UNIT - I

Introduction to product design, Design by Evolution, Design by Innovation, Essential factors of product design, Production-Consumption Cycle, Morphology of design, evaluation of new product ideas. Analysis of the product, The Three S'sProduct reliability, Mortality Curve, Reliability systems, Manufacturing reliability and quality control.

UNIT - II

Patents: Definitions, classes of patents, applying for patents. Trademarks and copyrights. Cost and quality sensitivity of products, Elements of cost of a product, costing methods, cost reduction and cost control activities. Economic analysis, Break even analysis Charts. Value engineering in product design, Case study, Function analysis system technique (FAST) Procedures of value analysis – cost reduction, material and process selection.

UNIT - III

Various manufacturing processes, degree of accuracy and finish obtainable, process capability studies. Basic product design rules for Casting, Forging, Machining, Sheet metal and Welding. Physical properties of engineering materials and their importance on products. Selection of plastics, rubber and ceramics for product design.

UNIT - IV

Industrial ergonomics: Man-machine considerations, ease of maintenance. Ergonomic considerations inproduct design-Anthropometry, Design of controls, man-machine information exchange. Process sheet detail and their importance, Value of appearance, colours and Laws of appearance. advanced techniques for higher productivity. Just -in -time and Kanban System.

UNIT - V

Role of computer in product design, Manufacturing and Management. Modern approaches to product design; quality function development, Rapid prototyping. Computer Integrated Manufacturing, communication network, production flow analysis, Group Technology, Computer Aided process Planning. Flexible manufacturing system

Suggested Reading:

1. Chitale, A.K, and Gupta, R.C., Product Design and Manufacturing, 5th Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2011.
2. Karl T Ulrich, Steven D Eppinger, "Product Design & Development." 7th Edition, Tata McGraw hill New Delhi, 2020.
3. Mahajan, M. Industrial Engineering and Production Management, 1st Edition, Dhanpath Rai& Co., 2014.
4. Anil Kumar Mukhopadhyaya, Value Engineering Mastermind- From Concept to Value Engineering Certification, 1st Edition, SAGE Publications Ltd, 2009.

ME114

MICRO AND NANO MANUFACTURING
(Programme Elective - III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To give awareness of different techniques used in micro and nano manufacturing.
- To introduce Non conventional micro nano manufacturing and finishing approaches.
- To introduce Nanofabrication Techniques and other processing routes in Micro and nano manufacturing.
- To know different techniques used in synthesis of nano- materials.

Course Outcomes: After completion of the course student will be able to

1. Differentiate Macro, micro operations and explain importance of precision in machining.
2. Analyze methods and tools for micro and nano-manufacturing.
3. Illustrate different techniques for the synthesis and processing of nano-materials.
4. Select micro and nano-manufacturing methods and identify key variables to improve quality of MEMS.
5. Select appropriate industrially viable process, equipment and tools for a specific product.

UNIT I

Micro Machining Techniques:

Introduction to Micro machining Techniques:Principle and applications of Ultrasonic Micro Machining, Abrasive jet Micro machining,Electro discharge Micro machining, Electrochemical Micro machining, Laser beam Micro machining, Electron Beam Micro machining, and **Ion Beam Machining (IBM).**

UNIT II

Micro Finishing Techniques:

Introduction to Micro finishing Techniques: Principle and applications of Chemo-Mechanical Polishing (CMP), Abrasive flow finishing (AFF), Magnetic abrasive finishing (MAF), Magnetic Float polishing (MFP), and Magnetorheological finishing (MRF), Elastic Emission Techniques.

UNIT III

Introduction: Importance of Nano-technology, Emergence of Nanotechnology, Bottom-up and Top-down approaches, challenges in Nanotechnology, Scaling Laws/Sizing effects.

Nano-materials Synthesis and Processing: Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of nano-materialssol-gel process, Liquid solid reactions; Gas Phase synthesis of nano-materials-Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing (GPC), Chemical Vapour Condensation(CVC)- Cold Plasma Methods, Laser ablation, Vapour –

liquid –solid growth, particle precipitation aided CVD, summary of Gas Condensation Processing(GPC).

UNIT IV

Micro fabrication Techniques: Lithography, Thin Film Deposition and Doping, Etching andSubstrate Removal, Substrate Bonding, MEMS Fabrication Techniques, Bulk Micromachining, Surface Micromachining, High- Aspect-Ratio Micromachining

UNIT V

Nanofabrication Techniques: E-Beam and Nano-Imprint Fabrication, Epitaxy and Strain Engineering, Scanned Probe Techniques, Self-Assembly and Template Manufacturing.

MEMS devices and applications: Pressure sensor, inertial sensor, Optical MEMS and RFMEMS, Micro-actuators for dual-stage servo systems.

Suggested Reading:

1. Marc Madou, Fundamentals of Micro-fabrication: The Science of Miniaturization, SecondEdition CRC Press, 2002.
2. Mark James Jackson, Micro-fabrication and Nano-manufacturing, 2nd Edition, CRC Press, 2002.
3. Gabor L. Hornyak, H.F Tibbals, Joydeep Dutta & John J Moore, Introduction to Nano-science and Nanotechnology, 1st Edition, CRC Press, 2008.
4. Ray F. Egerton , Physical Principles of Electron Microscopy: An Introduction to TEM,SEM, and AEM , 1st Edition, Springer, 2005.
5. Robert F Speyer, Thermal Analysis of Materials,1st Edition, Marcel Dekker Inc , New York, 1994.
6. B.D. Cullity - Elements of X-Ray Diffraction, 3rdedition, Prentice Hall , 2002.

ME115

MECHATRONICS AND INDUSTRIAL ROBOTICS
(Programme Elective - III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives: After completion of the course student will be able to

- Model analyze and control engineering systems
- Select appropriate sensors, transducers and actuators to monitor and control thebehavior of a process or product.
- Develop PLC programs for a given task.
- Evaluate the performance of mechatronic systems.
- Understand the evolution, classification, structures and drives for robots.

Course Outcomes

1. Learn the mechatronics system components and its construction
2. Apply the sensors in designing of mechatronics systems
3. Develop the new mechatronics system suitable to situation
4. Create the new mechatronics systems for different application
5. Explore the new mechatronics system

UNIT I

Introduction: Introduction, elements of mechatronic systems, needs and benefits ofmechatronics in manufacturing.

Design of Sensors: Classification of sensors basic working principles, Displacement Sensor Linear and rotary potentiometers, LVDT and RVDT, incremental and absolute encoders. Strain gauges. Force/Torque – Load cells. Temperature – Thermocouple, Bimetallic Strips, Thermistor, RTD.

Accelerometers, Velocity sensors – Tachometers, Proximity and Range sensors – Eddy current sensor, ultrasonic sensor, laser interferometer transducer, Hall Effect sensor, inductive proximity switch. Light sensors – Photodiodes, phototransistors, Flow sensors – Ultrasonic sensor, laser Doppler anemometer tactile sensors – PVDF tactile sensor, micro-switch and reed switch Piezoelectric sensors, vision sensor. Selection of appropriate sensor for real time applications.

UNIT II

Design of Actuator Circuits: Electrical Actuators : Solenoids, relays, diodes, thyristors, triacs, BJT, FET, DC motor, Servo motor, BLDC Motor, AC Motor, stepper motors. Hydraulic & Pneumatic devices – Power supplies, valves, cylinder sequencing. Development

of Hydraulic & Pneumatic circuits for automation applications. Piezoelectric actuators, Shape memory alloys.

Basic System Models & Analysis: Modelling of one and two degrees of freedom mechanical, Electrical, Fluid and thermal systems, Block diagram representations for these systems. Dynamic Responses of System: Transfer function, Modelling Dynamic systems, first order systems, second order systems.

UNIT III

Digital Electronics: Number systems, BCD codes and arithmetic, Gray codes, self-complimenting codes, Error detection and correction principles. Boolean functions using Karnaugh map, Design of combinational circuits, Design of arithmetic circuits. Design of Code converters, Encoders and decoders.

Signal Conditioning: Operational amplifiers, inverting amplifier, differential amplifier, Protection, comparator, filters, Multiplexer, Pulse width Modulation Counters, decoders. Data acquisition – Quantizing theory, Analog to digital conversion, digital to analog conversion.

UNIT IV

Controllers: Classification of control systems, Feedback, closed loop and open loop systems, Continuous and discrete processes, control modes, Two step Proportional, Derivative, Integral, PID controllers.

PLC Programming: PLC Principles of operation PLC sizes PLC hardware components I/Osection Analog I/O section Analog I/O modules, digital I/O modules CPU Processor memorymodule Programming. Ladder Programming, ladder diagrams, timers, internal relays and counters, data handling, analogue input and output. Application on real time industrial automation systems.

UNIT V

Case studies of Mechatronics systems: Pick and place robot, Bar code, Engine Management system, Washing machine etc.

Robotics: Introduction to Robotics, Robot anatomy physical configurations, Manipulator, Kinematics and dynamics, Technical features of Industrial robots.

Suggested Reading:

1. W. Bolton, "Mechatronics", 5th edition, Addison Wesley Longman Ltd, 2010
2. DevdasShetty& Richard Kolk "Mechatronics System Design", 3rd edition. PWS Publishing, 2009.
3. Alciatore David G &Histand Michael B, "Introduction to Mechatronics and Measurement systems", 4th edition, Tata McGraw Hill, 2006.
4. Saeed B Niku, "Introduction to Robotics: Analysis, Systems, Applications ", 2nd edition,Pearson Education India, PHI, 2003.

ME117

EXPERIMENTAL TECHNIQUES AND DATA ANALYSIS
(Programme Elective-III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course objectives:

- To familiarize students with the machining processes forces on machine tool structures
- To understand the various process parameters affecting the components manufacturing both internal structure and external form features
- To study the effects of variables in experimental design methods and its verification tests
- To identify the robust method of experiment that given reliable and acceptable results

Course Outcomes:

1. Understand the effect of machining process variables
2. Derive and measure the process variable by experimentation
3. Design of experiments for the given application
4. Evaluate the experiment results with tests and verify the data
5. Test and validate robust method of experiments

UNIT – I

Measurement of Cutting Forces: Strain gauge and piezoelectric transducers and their characteristics.Dynamometer construction, Bridge circuits. Instrumentation and calibration. Displacement and strain measurements by photo-elasticity. Holography, interferometer, Moiré techniques,strain gauge rosettes.

UNIT – II

Temperature Measurement: Circuits and instrumentation for different transducers viz, bimetallic, expanding fluid, electrical resistance, thermistor, thermocouples, pyrometers. **Flow Measurement**: Transducers for flow measurements of Non-compressible and compressible fluids.Obstruction and drag methods. Vortex shredding flow meters. Ultrasonic, Laser Doppler and Hotwire anemometer. Flow visualization techniques, Shadow graphs, Schlieren photography. Interferometer.

UNIT – III

Metallurgical Studies: Optical microscopy, Scanning Electron Microscopy and Transmission Electron Microscopy, X-Ray diffraction, Bragg's Law and its application for studying crystal structure and residual stresses. Electron spectroscopy, **Surface**

Measurements: Micro hardness, roughness, accuracy of dimensions and forms. 3 -D co-ordinate measuring machines.

UNIT - IV

Experiment design & data analysis: Statistical methods, Randomized block design, Latin and orthogonal squares, factorial design,Replication and randomization, response surface methodology.**Data Analysis**: Deterministic and random data, uncertainty analysis, tests for significance: Chi -square,student's t-test. Regression modeling, direct and interaction effects. ANOVA, F-test. Time Series analysis, Autocorrelation and autoregressive modeling.

UNIT – V

Taguchi Methods: Experiment design and planning with orthogonal arrays and linear graphs. Additive cause effect model. Optimization of response level. Identification of Design and noise factors.Performance evaluation and Optimization by signal to noise ratios. Concept of loss function and its application.

Suggested Reading:

1. Holman, J.P.: Experimental Methods for Engineers, 8th Edition, McGraw Hill Int., New York, 2012.
2. Venkatesh, V.C., and Chandrasekharan, Experimental Methods in Metal Cutting, 1st Edition, Prentice Hall of India, Delhi, 1982.
3. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rdedition,John Wiley & Sons, New York, 2001
4. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
5. A.M. Dean, and D. T.Voss,Design and Analysis of Experiments (Springer text in Statistics), 1st Edition, Springer, 1999.
6. Tapan P. Bagchi, Taguchi Methods Explained, 1st Edition, Prentice Hall of India, Delhi, 1993.

ME404

MATERIAL SCIENCE AND TECHNOLOGY
(Programme Elective - III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- Understand strengthening mechanisms and testing methods like hardness, fracture, creep and fatigue in materials
- Comprehend the applications, properties and composition of various tool steels
- Understand the heat treatment of various tools steels, and specifications of die castings

Course Outcomes: After completion of the course student will be able to

1. Recognize strengthening mechanisms of metals and Categorize the behaviour of fracture, creep and fatigue in materials
2. Determining mechanical properties and understand the concepts of fracture analysis
3. Classify the tool and die steels and interpret the applications, properties and composition of various tool steels, modern cutting tool materials and plastics
4. Distinguish the requirements and specifications of ferrous and non ferrous die castings according to Bureau of Indian Standards(IS)
5. Assess the heat treatment of various types of tool steels.

UNIT-I:

Crystal Structure: Types and Crystal Structures. Imperfections. Strain hardening, Plasticity range, Recovery, Recrystallisation and Grain growth. Mechanism of strengthening in metals. Grain size and its relation to mechanical properties.

Failure of Materials: ductile fracture, brittle fracture, fatigue, crack initiation and propagation, creep. Fatigue and Creep testing of materials.

UNIT-II

Testing of Materials: Review and brief discussion on stress strain diagram of steel and the parameters for ductility, toughness, tensile strength, percentage of elongation etc,, True stress and strain, Elastic Recovery After Plastic Deformation, Hardness, types of hardness measurements, comparison among hardness methods and scales. Fracture toughness testing. Failure analysis, Fractography.

UNIT-III

Tool and die steels: Classification, selection and properties of tool steels. Effect of alloying elements in tool steels. Water-hardening tool steels, Shock-resisting tool steels, Cold work tool steels, Hot work tool steels, High speed tool steels, Mould steels and Special purpose tool steels. Types of modern Cutting Tool materials like Carbide, Coated carbides, Ceramics, CBN, Diamod, Sialons, Impregnated tools.

PlasticsProperties of plastics-Thermo plastics-Thermo setting plastics.Methods of processing of plastics and plastic processing machines.

UNIT-IV

Ferrous and Non-ferrous Die castings: Specifications, Properties and applications of Carbon and alloy Steels, Specification of Grey iron casting IS: 210 SG Cast Iron IS: 1865, Malleable iron castings IS: 14329. Selection and specification of die casting non-ferrous zinc (IS 713, IS742) and Aluminium(LM series).

Powder Metallurgy: Production of powders by various methods. Compacting, Sintering applications.

UNIT-V

Phase Diagrams: Effect of alloying elements on Iron- Iron carbide equilibrium diagram**.** Isothermal Transformation diagrams.Microstructural and property changes in Iron-carbon alloys.

Heat treatment: Introduction and types,Hardenability. Heat treatment of Water-hardening tool steels, Shock-resisting tool steels, Cold work tool steels, Hot work tool steels, High speed tool steels. Case hardening methods. Heat treatment of non-ferrous materials.

Suggested Readings:

1. William D Callister, Materials Science and Engineering an Introduction, 6th Edition, John Wiley & Sons, 2003.
2. Raghavan V., Materials Science and Engineering: A First Course, Prentice Hall,Fifth Edition, PHI , New Delhi, 2011.
3. Sidney H Avner, Introduction to Physical Metallurgy, 2nd Edition, McGraw Hill Book Company, 1974.
4. William E. Bryson, Heat Treatment,Selection, and Application of Tool Steels, 2nd edition,Hanser Publishers, 2009.
5. George Krauss, “Steels; Processes, Structure& Performance”, ASM International, The Materials Information Society, 2005 IS Standards, BIS, New Delhi.

ME118

OPTIMIZATION TECHNIQUES
(Programme Elective - III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives

- To understand basic processes of physical phenomenon in industrial use
- To learn various methods of modeling the process on scientific basis for linear and nonlinear
- To solve for the unconstrained optimization of single and multi variables of the processes
- To learn to solve the process by fraction or integer numbers for optimization
- To solve by heuristic methods for optimization of the process

Course Outcomes

1. Understand the basic modeling of the industrial processes
2. Identify the mathematical modeling through simulation
3. Analyse the simulation models with unbounded conditions
4. Apply the un bounded models to multi objective purposes
5. Formulate the model for a given situation/s

UNIT – I

Simulation: Introduction, Types of Simulation, Simulation Models, Monte Carlo Simulation, Random Number, Pseudo Random Number, Mid-Square Method of generating Random Numbers, Application & Limitation, Application of Simulation to Inventory Control and Queuing Problem

UNIT – II

Classical Optimization: Introduction; Unconstrained problems of maxima and minima, constrained problems of maxima and minima; Constraints in the form of equations – Lagrangian method; Constraints in the form of inequalities -Kuhn-tucker conditions.

UNIT – III

Single Variable Non-Linear Unconstrained Optimization: Elimination methods: Uni-Model function-its importance, Fibonacci method & Golden section method. Interpolation methods: Quadratic & Cubic interpolation methods.

UNIT – IV

Multi variable non-linear unconstrained optimization: Direct search methods–Univariant method, Pattern search methods –Powell's, Hook -Jeeves, Rosenbrock search methods. Gradient methods: Gradient of function& its importance, Steepest descent method, Conjugate direction methods: Fletcher-Reeves method & variable metric method.

UNIT – V

Integer Programming: Introduction, Types of Integer Programming Problems, Gomory's Cutting Plane method. Branch and Bound method for all Integer Programming Problems & Mixed Integer Programming Problems.

Stochastic Programming: Basic concepts of probability theory, random variables-distributions-mean, variance, correlation, co variance, joint probability distribution. Stochastic linear programming: Chance constrained algorithm.

Suggested Reading:

1. S.S.Rao, Optimization Theory and Applications, 3rd Edition, NAI Publishers, Hyderabad, 2010.
2. S.D.Sharma, Operations Research, Kedarnath and Co. Publishers, Meerut, 2020th Edition.
3. V. K. Kapoor, Operations Research, 2nd Edition, S. Chand, New Delhi, 2007.
4. HamdyA.Taha, Operations Research, 10th Edition, Pearson Education, New York, 2019.
5. Bronson-Schaum Series, Operations Research, 2nd Edition, McGraw Hill, Singapore, 1997.
6. David Goldberg, Genetic Algorithms, 13th Edition, S Chand Publications, 1989.

ME 504

COMPUTER AIDED MANUFACTURING
(Programme Elective - IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- Provide concepts and knowledge in computer aided manufacturing
- Apply CAD/CAM conceptS to product design and manufacturing
- Learn working principles of NC machines CNC control and part programming
- Analyse concepts of Group Technology, FMS and CIM

Course outcomes: After completion of the course student will be able to

1. Describe basic concepts of CAM and demonstrate engineering design concepts
2. Apply Product specification methods in design
3. Develop CNC programs for manufacturing of different geometries
4. Describe process planning
5. Explore the application of PPC, JIT, MRP-I, MRP-II, and Expert system to CAM

UNIT–I

Computer Aided Manufacturing: CAM Concepts, Objectives & scope, Nature & Type of manufacturing system, Evolution, Benefits of CAM, Role of management in CAM, Concepts of Computer Integrated Manufacturing, Impact of CIM on personnel, Role of manufacturing engineers.

UNIT-II

NC/CNC Machine Tools: NC and CNC Technology: Types, Classification, Specification and components, Construction Details, Controllers, Sensors and Actuators, CNC hardware: Re circulating ball screw, anti friction slides, step/servo motors. Axis designation, NC/CNC tooling. Fundamentals of Part programming, Types of format, Part Programming for drilling, lathe and milling machine operations, subroutines, do loops.

UNIT–III

DNC Systems and Adaptive Control: Introduction, type of DNC systems, advantages arid disadvantages of DNC, adaptive control with optimization, Adaptive control with constrains, Adaptive control of machining processes like turning, grinding. Post Processors for CNC: Introduction to Post Processors: The necessity of a Post Processor, the general structure of a Post Processor, the functions of a Post Processor, DAPP — based- Post Processor

UNIT – IV

Micro Controllers: Introduction, Hardware components, selection of Micro Controllers, Applications, and Programming of Micro Controllers. Programming Logic Controllers (PLC's): Introduction, Hardware components of PLC, System, basic structure, principle of operations, Programming mnemonics timers, Internal relays and counters, Applications of PLC's in CNC Machines.

UNIT – V

Integrated Production Management System: Introduction, PPC fundamentals, Problems with PPC, MRP-I, MRP-II. Just in Time philosophy: JIT & GT applied to FMS, concepts of Expert System in Manufacturing and Management Information System.

Suggested Reading:

1. P.N. Rao, N. K. Tewari, T K Kundra " Computer Aided Manufacturing" 2nd Edition, McGraw Hill, 2017.
2. P.N. Rao, CAD/CAM Principles and Applications, 3rd Edition, TMH, 2017.
3. Hsu Pin Wang, Richard A. Wysk, Tien Chien Chang, Computer-Aided Manufacturing 3rd Edition, Hardcover , Pearson Education 2005.
4. Yoram Koren, Computer Control of Manufacturing Systems, 1st Edition, McGraw Hill, 1983
5. Radha krishnan and Subramanian, CAD / CAM / CIM, 1st Edition, New Age International Publishers, 2007.
6. Mikell P Groover, Automation, Production Systems and Computer Integrated Manufacturing , 4th Edition, Pearson Education, 2016.
7. P. Radhakrishnan, " Computer Numerical Control ", 1st Edition, New Central Book Agency, 2013.
8. S. Kant Vajpayee, Computer integrated manufacturing, 1st Edition, Prentice Hall of India, 1998.
9. Nanua Singh, System Approach to Computer Integrated Manufacturing, Volume 28,Wiley and sons Inc, 1996.
10. Ibrahim Zeid, R.Sivasubramanian, CAD/CAM : Theory & Practice, 2nd Edition, Tata McGraw Hill, 2009.

ME119

SMART MATERIALS AND MEMS
(Programme Elective - IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- This course provides a detailed overview to smart materials, piezoelectric materials structures and its characteristics.
- To study of Smart structures and modeling helps in Vibration control using smart materials in various applications.
- To familiarize with various microelectronic mechanical systems which find extensive usage in industrial applications.
- to understand the principles and concepts of using MEMS, ER & MR Fluids for various applications

Course outcomes: After completion of the course student will be able to

1. Describe the overview of different kinds of smart materials and their applications
2. Explain the principle concepts of Smart materials, structures, Fibre optics, ER & MR Fluids, Biomimetics and MEMS with principles of working.
3. Describe the various fabrication processes of smart materials and MEMS
4. Analyze the properties of smart structures, MEMS, with the applications and select suitable procedure for fabrication.
5. Summarize the methods and uses of Micro fabrications, Biomimetics, types of polymers used in MEMS, Fibre optics, piezoelectric sensing and actuation.

UNIT I

Introduction to smart materials and MEMS: an overview- scaling issues in MEMS -Micro sensors, some examples –Micro actuators, some examples– Micro systems – Examples of smart systems.

UNIT II

Smart composites - piezoelectric materials, shape memory alloys, magnetic materials - Electro and magneto-statics, Electro active polymers and electrostrictive materials - measurement techniques for MEMS.

UNIT III

Fabrication processes - Structure of silicon and other materials Silicon wafer processing; Thin-film deposition, Lithography, Etching, LIGA, Micromachining, Thick-film processing, Smart material processing.

UNIT IV

Mechanics of materials- Stresses and deformation: bars and beams - Micro device suspensions: lumped modeling -Residual stress and stress gradients - Thermal loading; bimorph effect - Vibrations of bars and beams - Gyroscopic effect

UNIT V

Electronics and packing - Semiconductor devices - Signal conditioning for microsystems devices-Vibration control of a beam - Integration of microsystems and microelectronics - Packaging of microsystems.

Suggested Reading:

1. Donald J. Leo, Engineering analysis of smart material systems, 1st Edition, John Wiley Sons, 2007.
2. R.C. Smith, Smart material systems: model development, 1st Edition, SIAM, 2005.
3. S.D. Senturia, Microsystem Design, 2nd Edition, Kluwer Academic Publishers, 2004.
4. Tai-Ran Hsu, MEMS & Microsystems Design and Manufacture, 1st Edition, McGraw Hill, 2002.
5. V.K. Varadan, K.J. Vinoy, and S. Gopalakrishnan, Smart Material Systems and MEMS: Desig and Development Methodologies, 1st Edition, Wiley, 2006.

ME120

MANUFACTURING OF NON-METALLIC PRODUCTS
(Programme Elective - IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives: After completion of the course student will be able to

- To understand the basic principles and manufacturing methods of polymers and rubber.
- To learn the applications and processing of glass and ceramics.
- To know the manufacturing and applications of composites.

Course outcomes: After completion of the course student will be able to

1. Describethetypesofpolymers andrubberandselecttheinmanufacturingtechniques.
2. Describetheapplication,typesofglass andselectitsmanufacturingmethods.
3. Describethetypesofceramicsandselectappropriateprocessingtechniques.
4. Knowledgeintypesofcompositesandtheirmanufacturingtechniques
5. Describethetypesofpolymers andrubberandselecttheirmanufacturingtechniques.

UNIT I

Polymers - classification - Thermoplastics and thermosetting plastics - Thermoforming processes - compression and transfer molding - injection molding - extrusion - blow molding - calendaring - lamination and pultrusion.

UNIT II

Rubber - additives - applications. Stages in raw rubber and latex rubber technology - Processing of rubbers –Manufacturing techniques - tires - belts - hoses - foot wears - cellular products - cables. Manufacture of latex based products

UNIT III

Glass - characteristics - application - glass making - Glass forming machines - hollow wares flat glasses, fiberglass, bulbs, bottles, heat absorbing glasses, amber glass and their manufacturing methods, general plant layouts for manufacture of different types of glasses.

UNIT IV

Ceramics - classification - traditional ceramics - structural ceramics - fine ceramics - bio ceramics - ceramic super conductors. Ceramic processing techniques - hot pressing - hot isostatic pressing (HIP) - Sintering - injection molding - slip casting - tape casting - gel casting - extrusion.

UNIT V

Composites - requirements of reinforcement and matrix - Manufacturing of composites - casting - solid state diffusion - cladding - HIP - liquid metal infiltration - liquid phase sintering - preparation of molding compounds and prepregs - hand layup method - autoclave method - filament winding method - compression molding - reaction injection molding - knitting - braiding.

Suggested Readings:

1. Ghosh, Polymer Science and Technology – Plastics, Rubber, Blends, and Composites, 2nd Edition, Tata-Mcgraw hill, 2001.
2. J.L.White, Rubber Processing Technology, Materials and Principles, Illustrated Edition, Hanser Publishers, 1995.
3. E. B. Shand, Glass Engineering Handbook, 2nd Edition, McGraw-Hill, 1958.
4. Kingery, w d &etc Introduction to ceramics 2nd edtion, John Wiley & Sons publishers, 2004.
5. ASM Handbook, Vol. 21 Composites, 2001 Lubin, Handbook of Composites, Springer,1st Edition, 1982.

ME112

COMPUTER INTEGRATED MANUFACTURING
(Programme Elective - IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To familiarize students the fundamental concepts of CIM and the Importance of Concurrent engineering
- To understand the role of database management systems, concepts like CAPP, MRP, Cellular manufacturing, FMS and various networking technologies in the successful implementation of CIM.
- To learn the concepts of Lean, Agile, Web based Manufacturing systems and their role in a CIM environment.

Course Outcomes: After completion of the course student will be able to:

1. Interpret the meaning and scope of CIM
2. Apply the knowledge of Database Management System in writing SQL Statements for creating and manipulating manufacturing databases
3. Illustrate the working of CAPP, MRP, FMS and Solve problems on cell formation approaches and lot sizing techniques
4. Select various types of network technologies that will help in establishing
5. Enterprise wide integration
6. Illustrate the working of Lean, Agile and Web Based Manufacturing systems

UNIT – I: Introduction to CIM

The meaning of Manufacturing, Types of Manufacturing; Basic Concepts of CIM: CIM Definition, Elements of CIM, CIM wheel, concept or technology, Evolution of CIM, Benefits of CIM, Needs of CIM: Hardware and software. Concurrent Engineering: Definition, Sequential Engineering Versus Concurrent Engineering, Benefits of Concurrent Engineering, Characteristics of concurrent Engineering, Framework for integration of Life-cycle phases in CE, Concurrent Engineering Techniques, Product Life-Cycle Management (PLM).

UNIT – II: CIM database and database management systems

Introduction, Manufacturing Data: Types, sources; Database Terminology, Database requirements, Database models, Database Management System, DBMS Architecture, Query Language, Structural Query Language (SQL): Basic structure, Data definition Language (Create, Alter, Drop, Truncate, View), Data Manipulation Language (store, retrieve, update, delete). Illustration of Creating and Manipulating a Manufacturing Database. SQL as a Knowledge Base Query Language. Features of commercial DBMS: Oracle, MySQL, SQL Access, Sybase, DB2. Product Data Management (PDM), Advantages of PDM.

UNIT – III: CIM Technology and Systems

Computer-Aided Process Planning: Basic Steps in developing a process plan, Variant and Generative Process Planning, Feature Recognition in Computer-Aided Process Planning.

Material Requirements Planning (MRP): Lot Sizing Techniques: Lot for Lot (LFL), Fixed Order Quantity (FOQ), Periodic Order Quantity (POQ), Economic Order Quantity (EOQ), Fixed Period Requirement (FPR). Manufacturing Resource Planning (MRP –II). Cellular Manufacturing: Design of Cellular Manufacturing Systems, Cell Formation Approaches: Machine–Component Group Analysis, Similarity Coefficients-Based Approaches. Evaluation of Cell Design. Flexible Manufacturing Systems: Physical Components of an FMS, Types of FMS layouts, Operational Problems of FMS. FMS benefits.

UNIT –IV: Enterprise Wide Integration in CIM

Introduction to Networking, Principles of Networking, Network Terminology, Types of Networks: LAN, MAN, WAN; Selection of Network Technology: Communication medium, Network Topology, Medium access control Methods, Signaling methods; Network Architectures and Protocols: OSI Model.

UNIT – V: Future Trends in Manufacturing Systems

Lean Manufacturing: Definition, Principles of Lean Manufacturing, Characteristics of Lean Manufacturing, Value of Product, Continuous Improvement, Focus on Waste, Relationship of Waste to Profit, Four Functions of Lean Production, Performance Measures, The Supply Chain, Benefits of Lean Manufacturing. Introduction to Agile and Web Based Manufacturing systems.

Suggested Readings:

1. S. Kant Vajpayee, Computer integrated manufacturing, 1st Edition, Prentice Hall of India, 1998
2. Nanua Singh, System Approach to Computer Integrated Manufacturing, Volume 28,Wiley and sons Inc, 1996.
3. P. Radhakrishnan, S. Subramanyam: CAD/CAM/CIM, 1st Edition, New Age International, 2007.
4. Alavudeen, Venkateshwaran: Computer Integrated Manufacturing, 1st Edition, Printice-HallIndia, 2010.

ME121

HIGH SPEED MACHINING
(Programme Elective - IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To emphasize the importance of advanced machining Processes.
- To study the appropriate cutting tools and materials for High speed machining
- To know the importance of dry and near dry machining
- To provide few practical applications of high speed machining

Course Outcomes: After completion of the course student will be able to

1. Distinguish between conventional machining and high speed machining.
2. Analyze the determinants of high speed machining and improve its performance.
3. Evaluate the requirements on machine tool technology to support High Speed Machining
4. Identify and Select the suitable cutting tool material for high speed machining.
5. Estimate the impact of dry and near dry machining on environment

UNIT I

Introduction: Advanced Machining Processes, A new Era.
The Determinants of High-Speed Machining: Weight, Materials, Machine Tools, Simple processes and Systems, Fast Machining, Response Time, and Throughput, Smart Machines,Tools, and Processes.Characteristics of High-Speed Machining: Machining Parameters.

UNIT II

Machine-tool Technology: Manufacturing and Multi-task Machining Systems, High-SpeedMachining, Support Technology.

UNIT III

Advanced Cutting Tools: Cutting-Tool Materials, Cutting-Tool Design, Tool Guidance andStability, Chip Control, Burr Control, Stringent Finish Requirements, Cost and Quality, Intelligent Tooling.

UNIT IV

Precision Tooling Interface: Connection and Interface, Tool Clamping, Balancing, Run-out.**Dry and Near-dry Machining:**Environmental Impact, Dry Machining, Near-dry Machining,Reducing Coolant Use.

UNIT V

Practical Applications: Precision Hard Machining, Machining Compacted Graphite Iron,Precision Roughing, Advanced Milling Operations, Machining with Multi-cut Tools.

Suggested Reading:

1. Bert P. Erdel, High Speed Machining, 1st Edition, SME Publications, Michigan, 2003
2. Dale Mickelson, Hard Milling and High Speed Machining, 1st Edition, Industrial Press Inc, United States, 2007.

AC 035

STRESS MANAGEMENT BY YOGA
(AUDIT COURSE-II)

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

- *Creating awareness about different types of stress and the role of yoga in the management of stress.*
- *Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).*
- *Prevention of stress related health problems by yoga practice.*

Outcomes:*Students will be able to*

1. *To understand yoga and its benefits.*
2. *Enhance Physical strength and flexibility.*
3. *Learn to relax and focus.*
4. *Relieve physical and mental tension through Asanas*
5. *Improve work performance and efficiency.*

UNIT-I

Meaning and definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.

UNIT–II

Meaning and definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

UNIT-III

Concept of Stress according to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress.

UNIT-IV

Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar

UNIT-V

Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama – Kapalabhati-Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.

Meditation techniques: Om Meditation - Cyclic meditation : Instant Relaxationtechnique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT).

Suggested Reading:

1. "Yogic Asanas for Group Training - Part-I": Janardhan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or Conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata
3. Nagendra H.R nadNagaratna R, "Yoga Perspective in Stress Management", Bangalore, Swami Vivekananda Yoga Prakashan

Online Resources:

https://onlinecourses.nptel.ac.in/noc16_ge04/preview
https://freevideolectures.com/course/3539/indian-philosophy/11

AC 036

PERSONALITY DEVELOPMENT THROUGH LIFE ENHANCEMENT SKILLS (AUDIT COURSE-II)

Instruction: 2periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives :

- *To learn to achieve the highest goalhappily*
- *To become a person with stable mind, pleasing personality anddetermination*
- *To awaken wisdom instudents*

Outcomes: *Upon completing this course, students will be able to:*

1. *Develop their personality and achieve their highest goal of life.*
2. *Lead the nation and mankind to peace and prosperity.*
3. *To practice emotional self regulation.*
4. *Develop a positive approach to work and duties.*
5. *Develop a versatile personality.*

UNIT-I

Neetisatakam – Holistic development of personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

UNIT-II

Neetisatakam – Holistic development of personality (cont'd) - Verses 52, 53, 59 (dont's) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.

UNIT-III

Introduction to Bhagavad Geetha for Personality Development - Shrimad Bhagawad Geeta: Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 – Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48

UNIT-IV

Statements of basic knowledge - Shrimad BhagawadGeeta: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.

UNIT-V

Role of Bahgavadgeeta in the present scenario - Chapter 2 – Verses 17 – Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

Suggested Reading:

1.. “Srimad Bhagavad Gita” by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata.

2. Bhartrihari’s Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi

Web resource:

1. NTPEL:http://nptel.ac.in/downloads/109104115/

AC 037

CONSTITUTION OF INDIA
(AUDIT COURSE-II)

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

- *The history of Indian Constitution and its role in the Indian democracy.*
- *Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.*
- *Have knowledge of the various Organs of Governance and Local Administration.*

Outcomes: *Upon completing this course, students will be able to:*

1. *Understand the making of the Indian Constitution and its features.*
2. *Understand the Rights of equality, the Right of freedom and the Right to constitutional remedies.*
3. *Have an insight into various Organs of Governance - composition and functions.*
4. *Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.*
5. *Understand Electoral Process, special provisions.*

UNIT-I

History of making of the Indian constitutions: History, Drafting Committee(Composition & Working).**Philosophy of the Indian Constitution**: Preamble, Salient Features.

UNIT-II

Contours of Constitutional Rights and Duties Fundamental Rights, Right toEquality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT-III

Organs of Governance": Parliament: Composition, Qualifications, Powers andFunctions, Union executives : President, Governor, Council of Ministers, Judiciary, appointment and transfer of judges, qualifications, powers and functions.

UNIT-IV

Local Administration - District's Administration head: Role and importance.Municipalities: Introduction, ayor and role of Elected Representative, CEO ofMunicipal Corporation. Panchayati Raj: Introduction, PRI: Zilla Panchayat,Elected Officials and their roles, CEO Zilla Panchayat: positions and role. Block level: Organizational Hierarchy (Different

departments) Village level: role of elected and appointed officials. Importance of grass root democracy.

UNIT-V

Election commission: Election Commission: Role and functioning, Chief ElectionCommissioner and Election Commissioners, State Election Commission :Role and functioning. Institute and Bodies for the welfare of SC/ST/OBC and women**.**

Suggested Reading:

1. "The Constitution of India", 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar, "Framing of Indian Constitution", 1st Edition, 2015.
3. M. P. Jain, "Indian Constitution Law", 7th Edition, Lexis Nexis, 2014.
4. D.D. Basu, "Introduction to the Constitution of India", 25th Edition, Lexis Nexis, 2021.

Web Resource:

1. http://www.nptel.ac.in/courses/103107084/Script.pdf

AC038

PEDAGOGY STUDIES
(AUDIT COURSE-II)

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 0

Course Objectives:

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

Course Outcomes:

1. What pedagogical practices are being used by teachers in formal and informal classrooms inDeveloping countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, andwith what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidancematerials best support effective pedagogy?

UNIT-I

Introduction and Methodology:

- Aims and rationale, Policy background, Conceptual framework and terminology
- Theories of learning, Curriculum, Teacher education.
- Conceptual framework, Research questions.
- Overview of methodology and Searching.

UNIT-II

- Thematic overview: Pedagogical practices are being used by teachers in formaland informal classrooms in developing countries.
- Curriculum, Teacher education.

UNIT-III

- Evidence on the effectiveness of pedagogical practices
  Methodology for the in depth stage: quality assessment of included studies.
- How can teacher education (curriculum and practicum) and the school
- Curriculum and guidance materials best support effective pedagogy?
- Theory of change.
- Strength and nature of the body of evidence for effective pedagogical practices.
- Pedagogic theory and pedagogical approaches.
- Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT-IV

- Professional development: alignment with classroom practices and followup support
- Peer support
- Support from the head teacher and the community.
- Curriculum and assessment
- Barriers to learning: limited resources and large class sizes

UNIT-V

- Research gaps and future directions
- Research design
- Contexts
- Pedagogy
- Teacher education
- Curriculum and assessment
- Dissemination and research impact

Suggested reading:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of
   Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher educationresearch project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning ofbasic maths and reading in Africa: Does teacher preparation count? International Journal
   Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education.Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, ‘learning to read’ campaign.
7. ww.pratham.org/images/resource%20working%20paper%202.pdf.

MC070

MINI PROJECT

Instructions: 6 periods/week
Credits 3 *CIE: 50 Marks*

Course Objectives:

- Understand the purpose of doing mini project
- Learn the resources available at the college and outside for pursuing project
- Importance of literature review
- Learn to select appropriate software and procedure
- Learn to document results and arrive at required conclusions

Course Outcomes: At the end of the course, the student will be able to:

1. Identify engineering problems reviewing available literature
2. Study different techniques used to analyze complex systems.
3. Use related techniques and software's for solving the problem
4. Interpret the results and arrive at the relevant conclusions.
5. Document the findings as a technical report with proper references

Guidelines

1. Guide allocation will be done at the beginning of the semester. Identification of will be done with Guides consultation

2. Mini project presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution.

3. Evaluation of Mini project will be done by the Departmental Committee. Half of the marks are awarded by the Guide and the remaining half of the marks will be awarded by Departmental Committee.

ME152

COMPUTATIONAL LABORATORY FOR PE

Instruction 3 Periods/week *CIE: 50 Marks*
Credits: 1.5

Course Objectives:

- Understanding the MATLAB environment
- To introduce to the software MATLAB for numerical computations
- Carry out simple numerical computations and analyses using MATLAB
- Able to implement matlab and SIMULINK for real time projects
- Introduce Genetic Algorithms, PSO, ANN for production Engineering applications

Course Outcomes: After completion of the course student will be able to

1. Ability to perform simulations/ experiment and understand the phenomenon
2. Critically evaluate and interpret the results
3. Prepare a well-organized record

MATLAB programs

1. Introduction to MATLAB
2. Evaluate the mathematical expressions in Matlab
3. Write scripts and functions to make single-index arrays
4. Basic syntax and command-line exercises, Basic array exercises, Relational and logical operations
5. Matrices operators
6. Control of flow: if-blocks , Loop constructs: for and while
7. Problems on generating various kinds of 2D & 3D Plots
8. Solving ordinary differential equations
9. Solving non-linear algebraic equations
10. Applications of Curve fitting and interpolation
11. Usage of Data Analysis and statistics
12. Introduction to optimization methods like Genetic Algorithms, Fuzzy, Neural & PSO
13. Simulink applied to manufacturing processes

ME153

MANUFACTURING SIMULATION LAB

Instruction 3 Periods/week *CIE: 50 Marks*
Credits: 1.5

Course Objectives:

- Simulate the deformation, stress distribution of simple configurations
- Analyze and understand thermal related problems
- Write manual part program & generate tool path for turning and Milling operation

Course Outcomes: After completion of the course student will be able to

1. Ability to perform simulations/ experiment and understand the phenomenon
2. Critically evaluate and interpret the results
3. Prepare a well-organized record

List of Experiments:

Modeling & simulation

1. Introduction to Finite Element Analysis Software.
2. Static Analysis of a corner bracket.
3. Determination of Beam stresses and Deflection.
4. Analysis of cylindrical shell under pressure.
5. Thermal mixed boundary problem
6. Transient Heat transfer in an infinite slab.
7. Stress analysis in a long cylinder.

Manufacturing:

8. Manual part programming & tool path simulation for CNC turning
9. Manual part programming & tool path simulation for CNC Tapping cycle
10. Manual part programming & tool path simulation for CNC Threading cycle
11. Manual part programming & tool path simulation for CNC drilling cycle
12. Manual part programming & tool path simulation for CNC milling
13. Generation of part program, using CAPS turn and CAPS mill

SEMESTER-III

ME124

NON-DESTRUCTIVE EVALUATION TECHNIQUES
(Programme Elective - V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives

- To understand the need of NDT for defect detection in Industry.
- To learn the principles and techniques and applications of contact and Non-Contact type of NDT methods.
- To know the reference standards used for calibration and specifications related to NDT technology.
- To know the appropriate NDT method for various Industrial Inspection needs.

Course Outcomes: After completion of the course student will be able to

1. Comprehend the basic principles of non-destructive testing (NDT) methods
2. Identify appropriate nondestructive testing methods for failure identification
3. Select NDT methods for quality analysis of industrial components
4. Analyze and interpret results from various NDT techniques along with calibration of these NDT.
5. Illustrate the advanced NDT techniques used in medical and non-medical field.

UNIT-I

Types of defects and characteristics, Quantification aspects relevant for NDE including fracture aspects and stress intensity factors - NDT overview – quality assurance–visual inspection–comparative features of conventional Non-destructive Testing and Evaluation Methods including Optical, Radiography, Ultrasonic Testing, Dye penetrant testing, Eddy current testing etc.

UNIT-II

Leak testing – liquid penetrant testing – penetrant used – equipment – penetration, emulsification, solvent removal. **Eddy current testing** – material conductivity – coil impedance–coils and instruments–testing in non-ferromagnetic conducting materials and ferro magnetic materials – skin effect – frequency used – inspection probes – phase analysis. **Magnetic particle testing**–magnetization methods–continuous and residual methods – sensitivity – demagnetization.

UNIT-III

Radiography–sources of radiation–shadow formation, enlargement and distortion – recording media – exposures, markers. **Ultrasonic testing** – generation of ultrasound – methodologies – transducers and equipment used – flaw detection - sensitivity and calibration.Computer aided image processing methods for radiography and ultrasonics, tomography in these areas. .

UNIT-IV

Optical techniques of non-destructive evaluation: Machine Vision-system components, Sensors, specifications for resolution & range. Use of fibre optics, Principles of Photo elasticity, holographic Interferometry; Laser speckle techniques and shearography, Grid and Moiré NDT.

UNIT-V

Principles of acoustic emission techniques – Instrumentation-analysis methods, Thermal testing: Infrared and Microwave Thermography– imaging systems – detectors – analysis methods, non-invasive techniques in medical field and NDT.

Suggested Readings:

1. Barry Hull, "Non-Destructive Testing", 1st Edition, Vernon John, ELBS/ Macmillan, 1988.
2. J. Prasad, C.G.K. Nair: Non-Destructive Testing and Evaluation of Materials, 2nd Edition, Tata McGraw Hill, 2011

3. Paul E. Mix: Introduction to Non-destructive Testing- A Training Guide, 2nd Edition, John Wiley & Sons, 2005.

4. Louis Cartz: Nondestructive testing- radiography, ultrasonics, liquid penetrant, magnetic particle, eddy current, 1st Edition, ASM International, 1995.

5. ASM Metals Handbook, Vol 17: Non-Destructive Examination and Quality Control, 9th Edition, ASM, 1989.

6. Don.E. Bray, Roderic K. Stanley: Nondestructive Evaluation- A Tool in Design, Manufacturing, and Service, Revised Edition, CRC Press, 1997.

ME125

TRIBOLOGY
(Programme Elective - V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives
- Learn basic understand of surface of metals
- Understand the classification of surfaces
- Learn wear mechanism methods
- Learn methods to reduce friction between mating surfaces
- Learn to measure surface using equipment

Course Outcomes
1. Learn basic concept and types of metallic surface
2. Understand the classification of surfaces
3. Analyse the types of wear mechanism
4. Suggest methods of wear on surfaces
5. Design the functional surface for application

UNIT I
Industrial significance of tribology– Strength and deformation properties of solids – physio-chemical characteristics of solid surfaces –fracture-modes of fracture- ductile-brittle-Analysis of surface roughness – measurement.

UNIT II
Friction – classification – Adhesion theory of friction – Elastic, plastic and visco– elastic effects in friction – rolling friction – friction of materials – alloys – ceramics – polymers – Interface temperature of sliding surfaces – measurement.

UNIT III
Wear– forms of wear-abrasive wear –adhesive wear-erosive wear-cavitation wear-corrosive wear-oxidative wear-fatigue wear-melting wear-diffusive wear-mechanisms-wear of non-metallic materials.

UNIT IV
Lubrication –types of lubrication-hydro dynamic lubrication – Reynolds equation – hydrostatic lubrication – bearing analysis – elasto-hydrodynamic lubrication – solid lubrication – boundary lubrication.

UNIT V
Micro/nano tribology – Measurement techniques – Surface Force Apparatus (SFA) – Scanning Probe Microscopy – Atomic Force Microscopy (AFM)-Nano-mechanical Properties of Solid Surfaces and Thin Films – Computer Simulations of Nanometer-Scale Indentation and Friction.

Suggested Reading:

1. I.M. Hutchings, "Tribology: Friction and Wear of Engineering Materials", 2nd Edition, Elsevier Limited, 2007.
2. G. W. Stachowiak, A. W. Batchelor, "Engineering Tribology", 3rd Edition, Elsevier Limited, 2005.
3. K.C. Ludema, "Friction, wear, lubrication: A text book in tribology", 1st Edition, CRC Press, 1996.
4. Bharat Bhushan, "Principles and applications of tribology", 1st Edition, John Wiley & Sons, 1999.
5. Bharat Bhushan, "Nanotribology and Nanomechanics: An Introduction", 2nd Edition, Springer, 2008.

ME127

MACHINE TOOL DYNAMICS
(Programme Elective - V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objective:

- To learn machine tool structure vibration
- To learn causes and types of vibration machine tool strucutes
- To find suitable methods solve the vibration of structures
- To mitigate the vibration of machine tool structures

Course Outcomes:

1. Learn vibration of machine tool structures
2. Understand the causes of machine tool structures
3. Analyse and evaluate the machine tool vibrations
4. Design suitable damping procedure to mitigate machine tool vibration
5. Able to identify any vibration of machine motion and make correction

UNIT-I

Vibration theory: Review of systems with one and two degrees of freedom, damped, undamped free and forced vibrations, beat phenomenon. Transmissibility of vibration and vibration isolation. Vibration measurement.

UNIT-II

Dynamics of structures: Force and stiffness methods, Eigen value problem using lumped mass technique, application to simple structures with damping.

UNIT-III

Chatter in Machine Tools: Basic pattern of chatter in metal cutting. Regenerative chatter, node coupling. Limit width of cut. Importance of negative real component of receptance. Dynamic cutting force co-efficient. Prediction of machine tools instability. Study of chatter behavior of lathe, drilling and milling machines. C.I.R.P., rig stick-slip phenomenon.

UNIT-IV Stability of Machine tools: Individual steps in the procedure-Directional factors cutting tests, Measurement of dynamic data by excitation tests. Evaluation of the test examples of the analysis of the stability of machine tools like Horizontal knee-type milling machine, vertical knee-type milling machine, center lathes.

UNIT-V

Damping in Machine Tools: Material and system damping. Dampers – Dynamic, impact and active type. Methods of improving damping in machine tools. Examples of the use of dampers, practical design consideration. Dynamic measurement of forces and vibration – Oscillating tools. Vibration isolation system.

Suggested Reading:

1. F.Keeningsberager and J. Tlusty, Machine Tool Structure, Volume 1, Porgamon press, 1970.
2. G.Sweeney, Vibration of Machine Tools, 1st Edition, Machinery Publishing Co. 1971.
3. Walter C. Hurty and M.F. Bubinstein, Dynamics of Structures, 2nd Edition, Prentice Hall, 1967.
4. W.T.Thomson, Vibration Theory And Applications, Revised Edition, Prentice Hall, 1965.
5. S.A. Tobias, Machine Tool Vibrations, 1st Edition, Blackie publications, 1965.

ME128

MANUFACTURING MANAGEMENT

(Programme Elective - V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To know the history of manufacturing and the importance of recent challenges in Manufacturing.
- To understand the working of Enterprise Resource Planning and importance of Human Factors Engineering, Just in Time and Total Productive Maintenance (TPM) in the functioning of an Enterprise
- To study the various manufacturing strategies and modern methods of manufacturing performance.

Course Outcomes: After completion of the course student will be able to:

1. Interpret the history of manufacturing and recent challenges in manufacturing
2. Identify Enterprise Resource Planning as a new manufacturing management tool.
3. Recognize the role of Human Factors Engineering in the effective management of a manufacturing enterprise
4. Summarize the role of JIT, TPM and purchasing function in effective running of an enterprise.
5. Analyze the modern methods of measuring manufacturing performance

UNIT-I

Introduction to Manufacturing: History of manufacturing, Selection of manufacturing processes, CIM, Global competitiveness and manufacturing costs, Environmental consciousness in Manufacturing. Terms and Definitions used in materials handling, Principles of material handling equipments, Factors in selection of Materials handling system.

UNIT-II

Enterprise Resource Planning: An Overview Integrated Management Information, Business Modeling, Integrated Data Model, Benefits of ERP,ERP and Related Technologies, Various ERP Modules, Features of ERP Software like SAP AG, PeopleSoft, Baan, JD Edwards, Oracle. ERP and E-Commerce, ERP and Internet.

UNIT-III

Human Factors Engineering: Introduction, Focus of Ergonomics, Basic Work system, History of Ergonomics, Human performance Psychology, Fit the Man to the Job (FMJ), fitting the Job to the Man (FJM), Man-Machine Interface, human body measurement – layout

of equipment – seat design - design of controls and compatibility – environmental control – vision and design of displays, design of work space, Anthropometry. Case Studies.

UNIT-IV

JIT Approach: Just In Time (JIT), JIT in repetitive production environments, batch manufacturing environment, JIT-Production Control – the KANBAN System, Benefits of JIT. Total Productive Maintenance(TPM), TPM and JIT.

Purchasing and Physical Distribution: Purchasing Function, Supplier Management and monitoring, Purchasing methods, Distribution and logistics, Distribution strategy.

UNIT-V

Manufacturing Strategy: Strategic Business units, the strategy document, Generic Strategies.Manufacturing Performance Measurement, Performance Monitoring, Accounting based methods of measuring manufacturing performance, Modern Methods of Measuring Manufacturing Performance.

Suggested Readings:

1. SeropeKalpakjain and Steven R. Schmid, Manufacturing Engineering and Technology,4th Edition, Pearson Education Inc., 2013.
2. Peter Gibson, R. Kerr, "Manufacturing Management: Principles and Concepts", Springer; 1995 edition.
3. S.Sadagopan, ERP: A managerial Perspective, 1st Edition, Tata McGraw-Hill publishing company Limited, 1999.
4. KanishkaBedi, Production and Operations Management, Oxford University Press, 3rd Edition, 2013.

ME129

SUSTAINABLE MANUFACTURING

(Programme Elective - V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To understand the fundamentals of Sustainable Manufacturing and various tools and techniques of sustainability.
- To know the principles of sustainable design
- To understand the role of customer and user needs assessment for sustainability

Course Outcomes: After completion of the course student will be able to:

1. Summarize the basic concepts in sustainability
2. Apply sustainable engineering design tools for life cycle assessment (LCA) and examine the features of various LCA Software
3. Interpret the Principles of Sustainable Breakthrough Design
4. Summarize the various design concepts for sustainability
5. Identify Customer and User Needs Assessment for sustainable manufacturing

UNIT-I: Basic Concepts in Sustainability

Understanding the language of sustainable engineering design, construction and operation. Natural resources terminology. Carrying capacity. Sustainable development, corporate responsibility, biophysical constraints, environmental management.

UNIT-II: Tools and Techniques of Sustainability

Sustainable Engineering Design Tools – Life cycle analysis, carbon footprinting. Life cycle assessment (LCA), Types of LCA's: baseline, comparative, streamlined. LCA inventory analysis: process or input-output. Hybrid inventory analysis. Sustainable Product Design. Whole systems design. Lightweighting and materials reduction. Designing for a lifetime. Design for durability, repair and upgrade, disassembly and recycling. Energy use in design. Reducing energy losses in design.

UNIT- III: Foundational Concepts & Principles for Sustainable Breakthrough Design

Infrastructure for managing flows of materials, energy and activities; sustainable value creation approaches for all stakeholders, environmental design characteristics; design changes & continual improvement; inclusive sustainable design principles, crowd sourcing, multiple-objective designs; infrastructures that support system thinking; knowledge management for sustainable design, learning systems and experimentation; smart data systems, understanding variation.

UNIT-IV: Sustainable Design

Industrial ecology, multiple life cycle design, principles of design, green engineering, cradle to cradle design, The Natural Step, biomimicry, design for reuse, dematerialization, modularization, design for flexibility, design for disassembly, design for inverse manufacturing, design for the environment, etc.

UNIT-V: Customer and User Needs Assessment

Identification & breakdown structures that describe customers & stakeholders, green marketing, socially conscious consumerism, sources of customer information, collecting information, analyzing customer behaviour, translating the voice of the customer, use analysis, structuring customer needs, service gap analysis, prioritizing customer needs, strategic design, Kano technique.

Suggested Readings:

1. Clarke, Abigail & John K. Gershenson Design for the Life Cycle, Life-cycle Engineering Laboratory, Department of Mechanical Engineering-Engineering Mechanics, 2nd Edition, Michigan Technological University, 2007.
2. Finster, Mark P., Sustainable Perspectives to Design and Innovation, 2013.
3. Ramaswamy, Rohit, Design and Management of Service Processes: Keeping Customers for Life, 1st Edition, Prentice Hall1996.
4. Schmitt, Brent, Customer Experience Management, 1st Edition, Wiley and Sons, 2003.

OE 941

BUSINESS ANALYTICS
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *Understanding the basic concepts of business analytics and applications*
- *Study various business analytics methods including predictive, prescriptive and prescriptive analytics*
- *Prepare the students to model business data using various data mining, decision making methods*

Outcomes: *Upon completing this course, students will be able to:*

1. *To understand the basic concepts of business analytics*
2. *Identify the application of business analytics and use tools to analyze business data*
3. *Become familiar with various metrics, measures used in business analytics*
4. *Illustrate various descriptive, predictive and prescriptive methods and techniques*
5. *Model the business data using various business analytical methods and techniques*

UNIT-I

Introduction to Business Analytics: Introduction to Business Analytics, needand science of data driven (DD) decision making, Descriptive, predictive, prescriptive analytics and techniques, Big data analytics, Web and Social media analytics, Machine Learning algorithms, framework for decision making, challenges in DD decision making and future.

UNIT-II

Descriptive Analytics: Introduction, data types and scales, types of measurementscales, population and samples, measures of central tendency, percentile, decile and quadrille, measures of variation, measures of shape-skewness, data visualization

UNIT-III

Forecasting Techniques: Introduction, time-series data and components,forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient

UNIT-IV

Decision Trees: CHAID, Classification and Regression tree, splitting criteria,Ensemble and method and random forest. **Clustering**: Distance and similarity measures used in clustering, Clustering algorithms, K-Means and Hierarchical algorithms, **Prescriptive Analytics**- Linear Programming(LP) and LP model building,

UNIT-V

Six Sigma: Introduction, introduction, origin, 3-Sigma Vs Six-Sigma process,cost of poor quality, sigma score, industry applications, six sigma measures, DPMO, yield, sigma score, DMAIC methodology, Six Sigma toolbox

Suggested Reading:

1. Dinesh Kumar, "Data Analytics", Wiley Publications, 1st Edition, 2017
2. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications with SAS", 2nd Edition, Associate Publishers, 2015
3. S. Christian Albright, Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making", 5th Edition, Cengage, 2015

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc18-mg11/preview
2. https://nptel.ac.in/courses/110105089/

OE942

INDUSTRIAL SAFETY
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Causes for industrial accidents and preventive steps to be taken.*
- *Fundamental concepts of Maintenance Engineering.*
- *About wear and corrosion along with preventive steps to be taken*
- *The basic concepts and importance of fault tracing.*
- *The steps involved in carrying out periodic and preventive maintenance of various equipments used in industry*

Course Outcomes:

1. *Identify the causes for industrial accidents and suggest preventive measures.*
2. *Identify the basic tools and requirements of different maintenance procedures.*
3. *Apply different techniques to reduce and prevent Wear and corrosion in Industry.*
4. *Identify different types of faults present in various equipments like machine tools, IC Engines, boilers etc.*
5. *Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machine tools etc*

UNIT-I

Industrial safety: Accident, causes, types, results and control, mechanical andelectrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes, Fire prevention and firefighting, equipment and methods.

UNIT–II

Fundamentals of Maintenance Engineering: Definition and aim of maintenanceengineering, Primary and secondary functions and responsibility of maintenancedepartment, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT–III

Wear and Corrosion and their Prevention: Wear- types, causes, effects, wearreduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications of Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication, Wick feed lubrication, Side feed lubrication, Ring lubrication, Definition of corrosion, principle and factors affecting the corrosion, Types of corrosion, corrosion prevention methods.

UNIT–IV

Fault Tracing: Fault tracing-concept and importance, decision tree concept,need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, any one machine tool, Pump, Air compressor, Internal combustion engine, Boiler, Electrical motors, Types of faults in machine tools and their general causes.

UNIT–V

Periodic and Preventive Maintenance: Periodic inspection-concept and need,degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of Machine tools, Pumps, Air compressors, Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Suggested Reading:

1. H. P. Garg, "Maintenance Engineering", 1st Edition, S. Chand and Company, 2014.
2. Audels, "Pump-hydraulic Compressors", NAP Edition, Mcgraw Hill Publication, 1949.
3. Higgins & Morrow, "Maintenance Engineering Handbook", 7th Edition, Da Information Services, 2008.
4. Winterkorn, Hans, "Foundation Engineering Handbook", Reprint Edition, Van Nostrand Reinhold, 1975.

OE 943

OPERATION RESEARCH
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives

1. To understand the dynamic programming to solve problems of discrete and continuous variables
2. To apply the concept of non-linear programming and carry out sensitivity analysis
3. To understand deterministic and probabilistic inventory control models.

Course Outcomes

After the completion of this course, the students shall be able to:

1. To understand the basics of OR, including mathematical modeling, feasible solutions and optimization
2. Able to carry out sensitivity analysis
3. Apply PERT/CPM in project management
4. Select appropriate inventory control model
5. Able to apply dynamic programming and understand the concept of non-linear programming

UNIT I

Development, Different Phases, Characteristics, Operations Research models and applications.

Linear Programming Problem:

Introduction, Basic Assumptions, Formulation, graphical method, simplex method :Big M and Two Phase method.

UNIT II

DUALITY: duality theory, primal-dual relationships, Economicinterpretation, Dual simplex method, Post optimal or sensitivity analysis,
UNIT III

Project Management:
Introduction to PERT and CPM, critical Path calculation, float calculation and its importance. Cost reduction by Crashing of activity.

Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

UNIT IV

Sequencing Models : Introduction, General assumptions, processing n jobs through 2 machines,processing 'n' jobs through m machines

Game Theory:

Introduction, Characteristics of Game Theory, Dominance theory, Mixed strategies (2x2, mx2), Algebraic and graphical methods

Nonlinear programming problem: - Kuhn-Tucker conditions

UNIT V:

Queueing models - Queueing systems and structures – Notation parameter – Single server and multi server models – Poisson arrivals – Exponential service times – with finate population – Infinite population .

Dynamic Programming: Characteristics, principle of optimality, deterministic problems.

Suggested Reading:

1. Hamdy, A. Taha, Operations Research – An Introduction, Seventh Edition, Prentice Hall of India Pvt. Ltd., 2002.

2. Ronald L. Rardin, Optimization in Operations Research, First Indian Reprint 2002, Pearson Education Asia.

3. R. Paneerselvam, Operations Research, 2nd Edition, Prentice Hall of India Private Ltd., 2006.

4. Singiresu S. Rao, Engineering Optimization Theory of Practice, 3rd edition, New Age International (P) Ltd. Publishers, 2010.

5. S.C. Sharma, Operations Research, 1st Edition, Discovery Publishing House, 2006

6. J.C. Pant, Introduction to Optimisation: Operations Research, 7th reprinted Edition, Jain Brothers, Delhi, 2015.

7. Frederick S. Hillier,Gerald J. Lieberman, Operations Research, 10thEdition, McGraw Hill Pub. 2017.

8. Harvey M Wagner, Principles of Operations Research, 1st Edition, Prentice Hall of India 2010

OE 944

COST MANAGEMENT OF ENGINEERING PROJECTS
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- Introduce the concepts of cost management, inventory valuation , decision making
- Fundamentals of cost overruns, project execution and technical activities
- Introduce the concepts of Quantitative techniques for cost management, Linear Programming, PERT/CPM

Outcomes:

1. Understanding of strategic cost management process, control of cost and decision making based on the cost of the project.
2. Ability to appreciative detailed engineering activities of the project and execution of projects
3. Preparation of project report and network diagram
4. Able to plan Cost Behavior , Profit Planning , Enterprise Resource Planning, Total Quality Management.
5. Applications of various quantitative techniques for cost management

UNIT I

Introduction and Overview of the Strategic Cost Management Process-Cost concepts in decision-making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System- Inventory valuation- Creation of a Database for operational control; Provision of data for Decision-Making.

UNIT II

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning- Project execution as conglomeration of technical and non- technical activities- Detailed Engineering activities.

UNIT III

Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

UNIT IV

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems- Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector-Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints- Activity-Based Cost Management,

Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets- Performance budgets- Zero-based budgets. Measurement of Divisional profitability pricing decisions including transferpricing.

UNIT V

Quantitative techniques for cost management, Linear Programming, PERT/CPM,- Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Suggested Reading :

1. Charles T. Horngren,Cost Accounting A Managerial Emphasis, 13th Edition, Prentice Hall of India, NewDelhi, 2008.
2. Charles T. Horngren and George Foster, Advanced ManagementAccounting, 14th Edition, Pearson Publisher, 2007.
3. Robert S Kaplan Anthony A. Alkinson, Management & CostAccounting, 1st Edition, Pearson Education, 1994.
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting, 3rd Edition, A. H. Wheelerpublisher, 2012.
5. N.D. Vohra, Quantitative Techniques in Management, 1st Edition, Tata McGraw Hill Book Co.Ltd, 2000.

OE 945

COMPOSITE MATERIALS
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *Study the concepts of composite construction.*
- *Learn analysis and designs of composite beams, floors, columns and trusses as per the recommendations of IS codes of practice.*
- *Apply the concepts for design of multi-storey composite buildings.*
- *Scope of analysis is restricted to skeletal structures subjected to prescribed dynamic loads.*

Outcomes :

1. *Understand the fundamentals of composite construction, and analysis and designs of composite beams.*
2. *Analyse and design the composite floors*
3. *Select suitable materials for composite columns,*
4. *Analyse composite trusses and understand connection details.*
5. *Analyse and design the multi-storey composite buildings*

UNIT-I

Introduction of composite constructions:Benefits of composite construction - Introduction to IS - BS and Euro codal provisions.

Composite beams:Elastic behaviour of composite beams - No and full interaction cases - Shear connectors - Ultimate load behaviour - Serviceability limits - Effective breadth of flange - Interaction between shear and moment - Basic design consideration and design of composite beams.

UNIT-II

Composite floors:Structural elements - Profiled sheet decking - Bending resistance - Shear resistance - Serviceability criterion - Analysis for internal forces and moments - Design of composite floors.

UNIT-III

Composite columns:Materials - Concrete filled circular tubular sections - Non-dimensional slenderness - Local buckling of steel sections - Effective elastic flexural stiffness - Resistance of members to axial compressions - Composite column design - Fire resistance.

UNIT-IV

Composite trusses:Design of truss - Configuration - Truss members - Analysis and design of composite trusses and connection details.

UNIT-V

Design of multi-storey composite buildings:Design basis - Load calculations - Design of composite slabs with profile decks - Composite beam design - Design for compression members - Vertical cross bracings - Design of foundation.

Suggested Reading:

1. R.P. Johnson, "Composite Structures of Steel and Concrete - Beams, Slabs, Columns and Frames in Buildings", 3rd Edition, Blackwell Publishing, Malden, USA, 2004.
2. "INSDAG Teaching Resources for Structural Steel Design", Vol-2, Institute for Steel Development and Growth Publishers, Calcutta, India.
3. "INSDAG Handbook on Composite Construction – Multi-Storey Buildings", Institute for Steel Development and Growth Publishers, Calcutta, India.
4. "INSDAG Design of Composite Truss for Building", Institute for Steel Development and Growth Publishers, Calcutta, India.
5. "INSDAG Handbook on Composite Construction – Bridges and Flyovers", Institute for Steel Development and Growth Publishers, Calcutta, India.
6. IS: 11384-1985, "Code of Practice for Composite Construction in Structural Steel and Concrete", Bureau of Indian Standards, New Delhi, 1985.

OE 946

WASTE TO ENERGY
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To know the various forms of waste*
- *To understand the processes of Biomass Pyrolysis.*
- *To learn the technique of Biomass Combustion*.

Outcomes: *Upon completing this course, students will be able to:*

1. *Understand the concept of conservation of waste.*
2. *Identify the different forms of wastage.*
3. *Chose the best way for conservation to produce energy from waste.*
4. *Explore the ways and means of combustion of biomass.*
5. *Develop a healthy environment for the mankind.*

UNIT-I:

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT-II:

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT-III:

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT-IV:

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT-V:

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Suggested Reading:

1. Desai, Ashok V,Non Conventional Energy, 1st Edition, Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Challal, D. S,Food, Feed and Fuel from Biomass, 1st Edition, IBH Publishing Co. Pvt. Ltd., 1991.
4. C. Y. WereKo-Brobby and E. B. Hagan, Biomass Conversion and Technology, 1st Edition, John Wiley & Sons, 1996.

ME181

MAJOR PROJECT PHASE I

Instructions : 20 periods/week *End Semester Presentation*
Credits : 10 *CIE: 100 Marks*

Objectives:

- Understand the purpose of Project work
- Learn the resources available at the college and outside for pursuing project
- Importance of literature review
- Learn to select appropriate software and procedure
- Learn to document results and arrive at required conclusions

Course Outcomes: At the end of the course the students will be able to:

1. Identify suitable engineering problems reviewing available literature.
2. Study different techniques used to analyze the problem
3. Use related techniques and software's for solving the problem
4. Interpret the results(if any) and defend your work in front of technically qualified audience
5. Document the findings as a technical report with proper references

Guidelines

1. The Dissertation Workshould preferably be a problem with researchpotential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
2. Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M.E..
3. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review.
4. The preliminary results (if available) of the problem may also be discussed in the report.
5. The work has to be presented in front of the examiners panel set by Head and Faculty Advisor.
6. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.

SEMESTER - IV

ME181

MAJOR PROJECT PHASE II

Instructions : 32 periods/week
Credits : 16 *SEE:200 Marks*

Course Objectives:

- *Understand the purpose of doing project work*
- *Learn the resources available at the college and outside for pursuing project*
- *Importance of literature review*
- *Learn to select appropriate software and procedure*
- *Learn to document results and arrive at required conclusions*

Course Outcomes: At the end of the course, the student will be able to:

1. Use different Simulation models /experimental techniques/ software/ computational /analytical tools.
2. Design and develop Simulation model/Mathematical model/ experimental set up/ equipment/ testrig.
3. Conduct tests and draw logical conclusions from the results after analyzing them.
4. Work in either in research environment or in an industrial environment and Conversant with technical report writing.
5. Present and defend their work to the evaluation committee.

Guidelines

1. It is a continuation of Major Project Phase I work started in semester III.
2. The dissertation should be presented in standard format as provided by the department.
3. The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) adopted & Result analysis.
4. The report must bring out the conclusions of the work and future scope for the study and also should be properly referenced.
5. Student has to submit the report in prescribed format and also present a seminar.
6. Student should present a Seminar in front of Internal committee consisting of Head, CBoS, Guide, Subject expert, Faculty Advisor. Further the suggestions of the committee have to be incorporated in the final Report.
7. The final work has to be presented in front of the examiners panel consisting of an approved external examiner, an internal examiner and a guide, co-guide etc. as decided by the Head.
8. The candidate has to be in regular contact with his/her guide.