ERODE SENGUNTHAR ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University)

PERUNDURAI, ERODE - 638 057

PG Curriculum and Syllabus

(1 to 4 Semesters)

M.E – MANUFACTURING ENGINEERING

Choice Based Credit System (CBCS)

REGULATION 2019

ERODE SENGUNTHAR ENGINEERING COLLEGE, ERODE
DEPARTMENT OF MECHANICAL ENGINEERING

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM

I TO IV SEMESTERS CURRICULUM

M.E. MANUFACTURING ENGINEERING
Total Credits : 71

SEMESTER I

THEORY

Code No	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19MF101	Probability and Statistics	I	1,2,3,4	-	3	1	0	4	40	60	100	BS
19MF102	Advances in Manufacturing Technology	I, II,III	1,2,3,4,8 ,9	1,2	3	0	0	3	40	60	100	PC
19MF103	Computer Integrated Manufacturing Systems	I,II,III	1,2,3,4,6	1,2	3	0	0	3	40	60	100	PC
19MF104	Metal Cutting Theory and Practice	I, II,III	1,2,3,4,7 ,9	1,2	3	1	0	4	40	60	100	PC
	Elective I	-	-	-	3	0	0	3	40	60	100	PE
	Elective II	-	-	-	3	0	0	3	40	60	100	PE
PRACTICAL												
19MF105	CAD/CAM Laboratory	I,II,III	3,4,5,10	1,2	0	0	4	2	60	40	100	PC
TOTAL					19	2	04	22	280	400	700	-

SEMESTER II

THEORY

Code No	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19MF201	Optimization Techniques in Manufacturing	I,II,III	1,2,3,4, 5, 6, 11	1,2	3	1	0	4	40	60	100	PC
19MF202	Advances in Metrology and Inspection	I,II,III	1,2, 3,5,9,10	1,2	3	0	0	4	40	60	100	PC

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Dept. of Mech Engg. - ESEC

19MF203	Theory of Metal Forming	I,II, III	1,2, 3, 5,6,9	1,2	3	0	0	3	40	60	100	PC
19MF204	Tooling for Manufacturing	I,II, III	1,2, 3, 5,9,10	1,2	3	1	0	3	40	60	100	PC
	Elective III	-	-	-	3	0	0	3	40	60	100	PE
	Elective IV	-	-	-	3	0	0	3	40	60	100	PE
PRACTICAL												
19MF205	Automation and Metal Forming Laboratory	I,II, III	1,2,3,4, 5,6,8,9	1,2	0	0	4	2	60	40	100	PC
19MF206	Technical Seminar	I,II, III	1,5,6,8, 11	1,2	0	0	2	0	60	40	100	BS
Total					18	2	6	22	360	440	800	-

SEMESTER III

THEORY

Code No	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19MF301	Research Methodology	I,II,III	1,2,3,4, 5, 6,8,9	1,2	3	0	0	3	40	60	100	PC
19MF302	Materials Testing and Characterization Techniques	I,II,III	1,2,3,5,9	1,2	3	0	0	3	40	60	100	PC
	Elective V	-	-	-	3	0	0	3	40	60	100	PE
19MF303	Project Work - Phase I	I,II,III	1,2,3,4,5, 6,7,8,9, 10,11	1,2	-	-	12	6	60	40	100	PC
Total					9	0	12	15	220	180	400	-

SEMESTER IV

THEORY

Code No	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19MF401	Project Work - Phase II	I,II,III	1,2,3,4,5,6 ,7,8,9, 10,11	1,2,3	-	-	24	12	60	40	100	PC
Total					-	-	24	12	60	40	100	-

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PROFESSIONAL ELECTIVES

PROFESSIONAL ELECTIVES								
Code No.	Course	Objective & Outcomes			L	T	P	C
		PEOs	POs	PSOs				
PROFESSIONAL ELECTIVE - I								
19MFX01	Advances in Casting and Welding	I,II,III	1,4,5,7,9	2	3	0	0	3
19MFX02	Industrial Robotics and Machine Vision	I,II,III	1,2,4,5,7,9	2	3	0	0	3
19MFX03	Manufacturing Information Systems	I,II,III	1,2,3,4,6,7,9	2	3	0	0	3
19MFX04	Advances In CNC Systems	I,II,III	1,2,3,4,6,7,9	2	3	0	0	3
PROFESSIONAL ELECTIVE - II								
19MFX05	Advanced Metrology and Non Destructive Testing	I,II,III	1,2,6,7,8,9	2	3	0	0	3
19MFX06	Productivity Management and Re-Engineering	I,II,III	1,6,10	2	3	0	0	3
19MFX07	Supply Chain Information Systems	I,II,III	1,5,6,7,8	2	3	0	0	3
19MFX08	Design of Cellular Manufacturing System	I,II,III	1,2,3,4	2	3	0	0	3
PROFESSIONAL ELECTIVE - III								
19MFX09	Precision Engineering	I,II,III	1,2,3	2	3	0	0	3
19MFX10	Reliability and Total Productive Maintenance	I,II,III	1,5,6,7,8	2	3	0	0	3
19MFX11	Computer Aided Process Planning	I,II,III	1,2,3,4,6,7,8,9	2	3	0	0	3
19MFX12	Flexible Competitive Manufacturing System	I,II,III	1,2,3,4,6,7,8,9	2	3	0	0	3
PROFESSIONAL ELECTIVE - IV								
19MFX13	Advanced Tool Engineering and Design	I,II,III	1,2,3,4,6,7,8,9	2	3	0	0	3
19MFX14	Plastics and Composite Materials	I,II,III	1,5,6,7,8	2	3	0	0	3
19MFX15	Total Quality System and Engineering	I,II,III	1,5,6,7,8	2	3	0	0	3
19MFX16	Advances in Foundry Technology	I,II,III	1,2,6,7,8,9	2	3	0	0	3
PROFESSIONAL ELECTIVE - V								
19MFX17	Finite Element Analysis in Manufacturing Engineering	I,II,III	1,2,3,4	2	3	0	0	3
19MFX18	Advanced Agile and Lean Manufacturing System	I,II,III	1,2,3,4	2	3	0	0	3
19MFX19	Smart Materials & Systems	I,II,III	1,5,6,7,8	2	3	0	0	3
19MFX20	Ultrasonics and Applications	I,II,III	1,5,6,7,8	2	3	0	0	3

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Dept. of Mech Engg. - ESEC

Department	MECHANICAL ENGINEERING					R 2019	Semester I	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MF101	PROBABILTY AND STATISTICS	3	1	0	4	60	100	

Course Objective (s): The purpose of learning this course is:

- To introduce the advanced Statistical skills required for engineering students that are imperative for effective understanding of engineering subjects.
- To basic tools for specialized studies in many engineering fields.

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

- Get an in-depth knowledge in the recent growth of statistic and, in particular, its applications to problems of engineering.
- Become much more effective in all phases of work relating to research, development, or production.
- Understand phenomena subjects to variation and to effectively predict or control them.

Unit I	PROBABILITY AND RANDOM VARIABLES	14

Probability and Random variables-Moments-Moment generating function-standard distributions (Gaussian, Gamma, Weibull & Normal distributions)-functions of random variables-Two dimensional random variables-Correlation and Regression.

Unit II	MARKOV CHAIN AND RELIABILITY	12

Markov chain-Transition Probabilities-Chapman-Kolmogrov equations-Limiting distributions-Concepts of Reliability-Hazard function-Series and Parallel Systems-Reliability and Hazard rate for exponential distribution-Markov analysis-Mean time to failure and mean time between failure-problems (related to them)

Unit III	SAMPLING DISTRIBUTIONS AND TESTING OF HYPOTHESIS	12

Testing of hypothesis-Sampling distributions-Test based on Normal, t-distribution, chi square and F-distribution-small and large samples-One way and two way classifications.

Unit IV	ANALYSIS OF VARIANCE	12

Design of experiments-Completely Randomized Design-Randomized Block Design-Latin Square Design-2 Square Factorial Design.

Unit V	TIME SERIES	10

Time series-characteristics and Representation- Moving averages –Exponential Smoothing-Auto Regressive processes.

REFERENCE(S):

1. Fruend John, E. and Miller Irwin, "Probability and Statistics for Engineering" 5th edition. Prentice Hall (2005).
2. Jay, L. Devore, " Probability and Statistics for Engineering and Sciences", Brooks/Cole Publishing Company, Monterey California (2008)
3. Montgomery d.C and Johnson, L.A, "Forecasting and Time Series", McGraw-Hill (2005)
4. Anderson, O.D., "Time Series Analysis: Theroy and Practice", I. North-Holland, Amsterdam (1982).
5. Gupta, S.C. and Kapoor V.K., "Fundamentals of Mathematical Statistics". Sultan Chand and Sons, New Delhi (2000).
6. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications, Prentice-Hall, Inc., Englewood Cliffs, New Jercy (2003)

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Department	MECHANICAL ENGINEERING					R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MF102	ADVANCES IN MANUFACTURING TECHNOLOGY	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is:

- To produce useful research output in machining of various materials
- To use this knowledge to develop hybrid machining techniques
- To apply this knowledge to manage shop floor problems
- To apply creativity in the design of systems, components or processes appropriate to Micro & Nano fabrication.
- To apply rapid prototyping and surface modification techniques in manufacturing.

Course Outcome(s): At the end of this course, learners will be able to:

- Produce useful research output in machining of various materials
- Use this knowledge to develop hybrid machining techniques
- Apply this knowledge to manage shop floor problems
- Apply creativity in the design of systems, components or processes appropriate to Micro & Nano fabrication.
- Apply rapid prototyping and surface modification techniques in manufacturing.

Unit I	UNCONVENTIONAL MACHINING	9

Introduction-Bulk processes - surface processes- Plasma Arc Machining- Laser Beam Machining-Electron Beam Machining-Electrical Discharge Machining – Electro chemical Machining-UltrasonicMachining- Water Jet Machining-Electro Gel Machining-Anisotropic machining-Isotropic machining-Elastic Emission machining – Ion Beam Machining.

Unit II	PRECISION MACHINING	9

Ultra precision turning and grinding: Chemical Mechanical Polishing (CMP) - ELID process – Partial ductile mode grinding-Ultra precision grinding- Binderless wheel – Free form optics. A spherical surface generation Grinding wheel- Design and selection of grinding wheel-High-speed grinding-High-speed milling- Diamond turning.

Unit III	ADVANCES IN METAL FORMING	9

Orbital forging, Isothermal forging, Warm forging, Overview of Powder Metal techniques –Hot and Cold isostatic pressing - high speed extrusion, rubber pad forming, Hydroforming, Superplastic forming, Peen forming-micro blanking –Powder rolling – Tooling and process parameters.

Unit IV	MICRO MACHINING AND NANO FABRICATION	9

Theory of micromachining-Chip formation-size effect in micromachining-microturning, micromilling, microdrilling-Micromachining tool design-Micro EDM-Microwire EDM-Nano fabrication:LIGA, Ion beam etching, Molecular manufacturing techniques –Atomic machining- Nano machining techniques – Top/Bottom up Nano fabrication techniques - Sub micron lithographic technique, conventional film growth technique, Chemical etching, Quantum dot fabrication techniques – MOCVD – Epitaxy techniques.

Unit V	RAPID PROTOTYPING AND SURFACE MODIFICATION TECHNIQUES	9

Introduction – Classification – Principle advantages limitations and applications- Stereo lithography – Selective laser sintering –FDM, SGC, LOM, 3D Printing-Surface modification Techniques: Sputtering-CVD-PVD-Diamond like carbon coating-Plasma Spraying Technique.-Diffusion coatings-Pulsed layer deposition.

REFERENCE(S):

1. Benedict,G.F.,"Non Traditional manufacturing Processes",CRC press,2011
2. Madou, M.J., Fundamentals of Micro fabrication: The Science of Miniaturization, SecondEdition, CRC Press (ISBN: 0849308267), 2006.

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Dept. of Mech Engg. - ESEC

Department	MECHANICAL ENGINEERING					R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MF103	COMPUTER INTEGRATED MANUFACTURING SYSTEMS	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To gain knowledge about the basic fundamental of CAD.
- To gain knowledge on how computers are integrated at various levels of planning and manufacturing
- To study the concepts of group technology and computer aided process planning.
- To understand the methods of shop floor control and FMS.
- To understand computer aided planning and control and computer monitoring.

Course Outcome(s): At the end of this course, learners will be able to:

- Apply knowledge about the basic fundamental of CAD.
- Apply knowledge on how computers are integrated at various levels of planning and manufacturing
- Apply the concepts of group technology and computer aided process planning.
- Apply the methods of shop floor control and FMS.
- Apply the idea of computer aided planning and control and computer monitoring.

Unit I	COMPUTER AIDED DESIGN	9

Concept of CAD as drafting and designing facility, desirable features of CAD package, drawing features in CAD – Scaling, rotation, translation, editing, dimensioning, labeling, Zoom, pan, redraw and regenerate, typical CAD command structure, wire frame modeling, surface modeling and solid modeling (concepts only) in relation to popular CAD packages.

Unit II	COMPONENTS OF CIM	10

CIM as a concept and a technology, CASA/Sme model of CIM, CIM II, benefits of CIM, communication matrix in CIM, fundamentals of computer communication in CIM – CIM data transmission methods – seriel, parallel, asynchronous, synchronous, modulation, demodulation, simplex and duplex. Types of communication in CIM – point to point (PTP), star and multiplexing. Computer networking in CIM – the seven layer OSI model, LAN model, MAP model, network topologies – star, ring and bus, advantages of networks in CIM

Unit III	GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING	9

History Of Group Technology – role of G.T in CAD/CAM Integration – part families- classification and coding – DCLASS and MCLASS and OPTIZ coding systems – facility design using G.T – benefits of G.T – cellular manufacturing. Process planning - role of process planning in CAD/CAM Integration – approaches to computer aided process planning – variant approach and generative approaches – CAPP and CMPP systems.

Unit IV	SHOP FLOOR CONTROL AND INTRODUCTION TO FMS	8

Shop floor control – phases – factory data collection system – automatic identification methods – Bar code technology – automated data collection system. FMS – components of FMS – types – FMS workstation – material handling and storage system – FMS layout- computer control systems – applications and benefits.

Unit V	COMPUTER AIDED PLANNING AND CONTROL AND COMPUTER MONITORING	9

Production planning and control – cost planning and control – inventory management – material requirements planning (MRP) – shop floor control. Lean and Agile Manufacturing. Types of production monitoring systems – structure model of manufacturing – process control and strategies – direct digital control.

REFERENCE(S):

1. Chris McMahon and Jimmie Browne, "CAD CAM Principles, Practice and Manufacturing Management", Pearson Education second edition, 2005.Ranky, Paul G., "Computer Integrated Manufacturing", Prentice hall of India Pvt. Ltd.,2005.
2. James A. Regh and Henry W. Kreabber, "Computer Integrated Manufacturing", Pearson Education second edition, 2005.

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Dept. of Mech Engg. - ESEC

Department	MECHANICAL ENGINEERING					R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MF104	METAL CUTTING THEORY AND PRACTICE	3	1	0	4	60	100	

Course Objective(s): The purpose of learning this course is:

- To make the students familiar with the various principles of metal cutting, cutting tool materials and its wear mechanisms during the machining operation.

Course Outcome(s): At the end of this course, learners will be able to:

- Impart the knowledge and train the students in the area of metal cutting theory and its importance.

Unit I	INTRODUCTION	12

Need for rational approach to the problem of cutting materials-observation made in the cutting of metals-basic mechanism of chip formation-thin and thick zone modes-types of chips-chip breaker-orthogonal Vs oblique cutting-force velocity relationship for shear plane angle in orthogonal cutting-energy consideration in machining-review of Merchant, Lee and Shafter theories-critical comparison.

Unit II	SYSTEM OF TOOL NOMENCLATURE	12

Nomenclature of single point cutting tool-System of tool nomenclature and conversion of rake angles-nomenclature of multi point tools like drills, milling-conventional Vs climb milling, mean cross sectional area of chip in milling-specific cutting pressure.

Unit III	THERMAL ASPECTS OF MACHINING	12

Heat distribution in machining-effects of various parameters on temperature-methods of temperature measurement in machining-hot machining-cutting fluids.

Unit IV	TOOL MATERIALS, TOOL LIFE AND TOOL WEAR	12

Essential requirements of tool materials-development in tool materials-ISO specification for inserts and tool holders-tool life-conventional and accelerated tool life tests-concept of mach inability index-economics of machining.

Unit V	WEAR MECHANISMS AND CHATTER IN MACHINING	12

Processing and Machining – Measuring Techniques – Reasons for failure of cutting tools and forms of wear-mechanisms of wear-chatter in machining-factors effecting chatter in machining-types of chatter-mechanism of chatter.

REFERENCE(S):

1. Bhattacharya.A., Metal Cutting Theory and practice, Central Book Publishers, India, 1984.
2. Boothroid D.G. & Knight W.A., Fundamentals of machining and machine tools, Marcel Dekker, Newyork, 1989.
3. Shaw.M.C.Metal cutting principles, oxford Clare don press, 1984.

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Dept. of Mech Engg

Department	MECHANICAL ENGINEERING					R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MF105	CAD / CAM LABORATORY	0	0	4	2	30	100	

Course Objective(s): The purpose of learning this course is:

- To teach the students about the drafting of 3D components and analyzing the same using various CAD packages and programming of CNC machines
- To train them to use the various sensors

Course Outcome(s): At the end of this course, learners will be able to:

- To impart the knowledge on training the students in the area of CAD/CAM

Exp No.	Name of Experiments
1	Exercise on CNC Lathe: Plain Turning, Step turning, Taper turning, Threading, Grooving canned cycle
2	Exercise on CNC Milling Machine: Profile Milling, Mirroring, Scaling & canned cycle. Study of Sensors, Transducers & PLC: Hall-effect sensor, Pressure sensors, Strain gauge, PLC, LVDT, Load cell, Angular potentiometer, Torque, Temperature & Optical Transducers.
3	2D modeling and 3D modeling of components such as 1. Bearing 2. Couplings 3. Gears 4. Sheet metal components 5. Jigs, Fixtures and Die assemblies.

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Dept. of Mech Engg. - ESEC

Department	MECHANICAL ENGINEERING					R 2019	Semester I	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX01	ADVANCES IN CASTING AND WELDING	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To study the metallurgical concepts and applications of casting and welding process.
- To acquire knowledge in CAD of casting and automation of welding process.

Course Outcome(s): At the end of this course, learners will be able to:

- Impart knowledge on basic concepts and advances in casting and welding processes.

Unit I	CASTING DESIGN	8

Heat transfer between metal and mould — Design considerations in casting – Designing for directional solidification and minimum stresses - principles and design of gating and risering

Unit II	CASTING METALLURGY	8

Solidification of pure metal and alloys – shrinkage in cast metals – progressive and directional solidification — Degasification of the melt-casting defects – Castability of steel , Cast Iron, Al alloys, Babbit alloy and Cu alloy.

Unit III	RECENT TRENDS IN CASTING AND FOUNDRY LAYOUT	8

investment casting, CO2 moulding, centrifugal casting, Die casting, 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	10

Heat affected Zone and its characteristics – W eldability of steels, cast iron, stainless steel, aluminum, Mg , Cu , Zirconium and titanium alloys – Carbon Equivalent of Plain and alloy steels Hydrogen embrittlement – Lamellar tearing – Residual stress – Distortion and its control . Heat transfer and solidification - Analysis of stresses in welded structures – pre and post welding heat treatments – weld joint design – welding defects – Testing of weldment.

Unit V	RECENT TRENDS IN WELDING	11

Friction welding, friction stir welding – explosive welding – diffusion bonding – high frequency induction welding – ultrasonic welding – electron beam welding – Laser beam welding –Plasma welding – Electroslag 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.

REFERENCE(S):

1. ASM Handbook vol.6, welding Brazing & Soldering, 2003
2. ASM Handbook, Vol 15, Casting, 2004
3. Carrry B., Modern Welding Technology, Prentice Hall Pvt Ltd., 2002
4. CORNU.J. Advanced welding systems – Volumes I, II and III, JAICO Publishers, 1994
5. HEINELOPER & ROSENTHAL, Principles of Metal Casting, Tata McGraw Hill, 2000.
6. IOTROWSKI – Robotic welding – A guide to selection and application – Society of mechanical Engineers, 1987.
7. Jain P.L., Principles of Foundry Technology, Tata McGraw Hill Publishers, 2003
8. LANCASTER.J.F. – Metallurgy of welding – George Alien & Unwin Publishers, 1980
9. Parmer R.S., Welding Engineering and Technology, Khanna Publishers,2002
10. SCHWARIZ, M.M. – Source book on innovative welding processes – American Society for Metals (OHIO), 1981
11. Srinivasan N.K., Welding Technology, Khanna Tech Publishers, 2002

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Dept. of Mech Engg. - ESEC

Department	MECHANICAL ENGINEERING					R 2019	Semester I	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX02	INDUSTRIAL ROBOTICS AND MACHINE VISION	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To provide the advanced features of robots, its components and industrial applications of robotics.
- To give details about automation and machine vision

Course Outcome(s): At the end of this course, learners will be able to:

- Widen the understanding of students in robotics application, utilization of robotics in industry and escalates to the design of robotics system.
- Get a direct impact in e – manufacturing applications.
- Improve the understanding in manufacturing automation and design optimization

Unit I	ROBOTICS AND ITS COMPONENTS	9

Robotics – Introduction–Basic Structure– Classification of robot and Robotic systems –laws of robotics – robot motions – work space, precision of movement. Drives and control systems: Hydraulic systems, power supply – servo valve – sump – hydraulic motor – DC servo motors – stepper motors – operation. Mechanical Components of Robots: Power transmission systems: Gear transmission. Belt drives, cables, Roller Chains, Link – Road Systems, Rotary to linear motion conversion, Ract and pinion drives, ball bearing screws, speed reducers, Harmonic drives.

Unit II	KINEMATICS OF ROBOT	9

Introduction, Matrix Representation, Homogeneous transformation, forward and inverse Kinematics, Inverse Kinematics Programming, Degeneracy, dexterity, velocity and static forces, velocity transformation force control systems, Basics of Trajectory planning.

Unit III	ROBOT END EFFECTORS	9

Types of end effectors – Mechanical grippers – Types of Gripper mechanisms – Grippers force analysis – Other types of Grippers – Vacuum cups – Magnetic Grippers – Adhesive Grippers–Robot end effector interface. Sensors: Position sensors – Potentiometers, encoders – LVDT, Velocity sensors, Acceleration Sensors, Force, Pressure and Torque sensors, Touch and Tactile sensors, Proximity, Range and sniff sensors, RCC, VOICE recognition and synthesizers.

Unit IV	MACHINE VISION	9

Introduction – Image processing Vs image analysis, image Acquisition, digital Images – Sampling and Quantization –Image definition, levels of Computation. Image processing Techniques: Data reduction – Windowing, digital conversion. Segmentation – Thresholding, Connectivity, Noise Reduction, Edge detection, Segmentation, Region growing and Region Splitting, Binary Morphology and grey morphology operations.

Unit V	FEATURE EXTRACTION	9

Geometry of curves – Curve approximation, Texture and texture analysis, Image resolution – Depth and volume, Color processing, Object recognition by features, Depth measurement, and specialized lighting techniques. Segmentation using motion – Tracking. Image Data Compression, Real time Image processing, Application of Vision systems.

REFERENCE(S):

1. M.P. Groover, Industrial Robotics – Technology, Programming and Applications, McGraw-Hill, USA, 2004.
2. Ramesh Jam, Rangachari Kasturi, Brain G. Schunck, Machine Vision, Tata McGraw-Hill, 1991.
3. Yoremkoren, Robotics for Engineers, McGraw-Hill, USA, 1997.
4. P.A. Janaki Raman, Robotics and Image Processing, Tata McGraw-Hill, 2001.

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Dept. of Mech Engg. - ESEC

Department	MECHANICAL ENGINEERING					R 2019	Semester I	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX03	MANUFACTURING INFORMATION SYSTEMS	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To earn the production planning and control system, the databases required to handle records and their maintenance, various methods of collecting data from the shop floor in order to analyze and improve the performance of the manufacturing system.
- To understand the importance of information system along with scheduling techniques for customer requirement. They are also exposed to different case studies.

Course Outcome(s): At the end of this course, learners will be able to:

- Design the database using various models and approaches.
- Maintain and analyze the database in manufacturing industries.
- Solve the problems of sequencing and scheduling in the real time production shop floor.

Unit I	INTRODUCTION - PRODUCTION MANAGEMENT SYSTEM	7

This subject has been introduced to the students with an idea to impart to the students the knowledge on various manufacturing activities such as Materials Requirement Planning and Manufacturing Resources Planning so that they get to know about the role of information and communication in product manufacture besides understanding the importance of data, database and database management system. They also learn about the various techniques used to collect data from the shop floor in a way to analyze the performance of manufacturing system. They are also introduced to the concept of Part Based Manufacturing Information System that is widely used in modern manufacturing industries. Introduction - the evolution of order policies from MRP to MRP II, the role of production organization control.

Unit II	DATABASE	7

Database-Terminologies-Entities & Attributes - Data Models, Schema & Subschema-Data Independence-ER Diagram - Trends in Database

Unit III	DATABASE MANAGEMENT SYSTEMS AND MODELS	10

Designing database-Hierarchical Model-Network Approach-Relational Data Model-Concepts, Principles, Keys, Relational Operations-Functional Dependence-Normalization and Types - Query Languages.

Unit IV	MANUFACTURING SHOP FLOOR CONTROL SYSTEM	11

Manufacturing Consideration-Product and its structure, Inventory and Process Flow-Shop Floor Control-Data Structure and Procedure-Various Model- Order Scheduling Module, Input/Output Analysis Module, Stock Database- IOM Database.

Unit V	MANUFACTURING INFORMATION SYSTEM	10

Information system for manufacturing- Parts Oriented Production Information System-Concepts and structure-Computerized Production Scheduling, Online Production Control System, Computer Based Production Management System-Case Study.

REFERENCE(S):

1. Luca G. Sartori,"Manufacturing Information Systems", Addision-Wesley Publishing Company, 2003.
2. Date.C.J, "An Introduction to Database Systems", Narosa Publishing House, 2004
3. Orlicky.G, "Material Requirements Planning", McGraw-hill Publishing & Co., 2002.
4. Kerr.R, "Knowledge Based Manufacturing Management", Addison Wesley, 2003.

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Dept. of Mech Engg. - ESEC

Department	MECHANICAL ENGINEERING					R 2019	Semester I	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX04	ADVANCES IN CNC SYSTEMS	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To learn the elements involved in CNC Machines and Mechanism for converting program of instructions to machine tool action.
- To generate program using various techniques and study of special type CNC machines

Course Outcome(s): At the end of this course, learners will be able to:

- Understand the CNC and PLC programming techniques, the working of CNC machines and various commands used for 3D model building.
- Write programs for product manufacture on CNC machines.

Unit I	INTRODUCTION	8

Classification – Construction details of CNC machines – machine structure, guideways, feed drives – spindle,measuring systems –Drivers and controls – Spindle drives, feed drives, D.C.drives - A.C.drives

Unit II	CNC SYSTEM	10

Introduction – Configuration of CNC system –interfacing – Monitoring – Diagnostics- Machine data – Compensations for machine accuracies – PLC programming – Adaptive control CNC systems.

Unit III	PROGRAMMING OF CNC MACHINES	12

Various programming techniques – APT – Programming for various machines in ISO and FANUC – CAM packages for CNC Machines such as Uni graphics, LDEAS, Pro-Engineer, CATIA, ESPIRIT, MASTERCAM, etc.,

Unit IV	TOOLING FOR CNC MACHINES	8

Interchangeable tooling system – present and qualified tools – coolant fed tooling system – Modular fixture – quick change system – Automatic head changers – tooling requirements for turning and machining centres – Tool assemblies – tool magazines –ATC mechanisms – tool management.

Unit V	SPECIAL TYPES OF CNC MACHINES	7

CNC grinding machines, EDM, Wire cut EDM, CNC Gear Hobbing machine – Installation, Maintenance- Testing and performance, Evaluation of CNC Machines

REFERENCE(S):

1. Radhakrishnan,P "Computer Numerical Control Machines", New Academic sciences limited, 2nd Revised Edition, 2014
2. Sehrawat,M.S and NarangJ.S "CNC Mchines", Dhanpat Rai and Co., 2008
3. "Mechatronics", HMT Ltd, TATA McGraw Hill, Publishing Company Ltd., 1998
4. Thyer,G.E "Computer Numerical Control of Machine Tools", B.H.Newberg,1991
5. Krar.S "CNC Technology and programming", McGraw Hill, 1990
6. Peter Smid, "CNC Programming Hand Book", Industries Press Inc, 2000

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Department	MECHANICAL ENGINEERING					R 2019	Semester I	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX05	ADVANCED METROLOGY AND NON DESTRUCTIVE TESTING	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To provide an insight for the need of quantifying the physical parameters and their techniques in evaluating them.
- To provide an insight to principles of latest metrological systems used in industries.
- To provide fundamental knowledge on non destructive testing methods.

Course Outcome(s): At the end of this course, learners will be able to:

- Demonstrate techniques used to quantify and comparison of products to required standards.
- Conversant with the newer technologies used in metrology.
- Design procedures which will incorporate quality in the product as per the customer's needs.
- Demonstrate his or her knowledge in developing control mechanism to check variation in attributes and variables.
- Select suitable ND testing method for the contemporary issues.

Unit I	INTRODUCTION	9

Measuring Machines - Tool Maker's microscope - Co-ordinate measuring machines - Universal measuring machine - Laser viewers for production profile checks - Images shearing microscope- Use of computers- Machine vision technology - Microprocessors in metrology.

Unit II	STATISTIAL QUALITY CONTROL	9

Statistical Quality Control - Data presentation - Statistical measures and tools - Process capability - Confidence and tolerance limits - Control charts for variables and for fraction defectives - Theory of probability - Sampling - ABC standard - reliability and life testing.

Unit III	BASIC NDT TESTS	9

Liquid penetrants and magnetic particle tests - characteristics of liquid penetrants - different washable systems - Developers - applications - method of production of magnetic fields - Principles of operation of magnetic particle test - applications -Advantages and limitations.

Unit IV	RADIOGRAPY	9

Radiography - Sources of ray - x- ray production - properties of d and x rays - film characteristics – exposure chart contrasts-operational characteristics of x ray equipment - applications.

Unit V	ULTRASONIC TESTING METHODS	9

Ultrasonic and acoustic emission techniques - Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method -A, B, C scans -Principles of acoustics emission technique - Advantage and limitations - Instrumentation - applications

REFERENCE(S):

1. Jain,R.K."Engineering Metrology ", Khanna Publishers, 2009.
2. Barry Hull and Vernon John ," Non Destructive Testing ", Mac Millan, 2009
3. American Society for Metals ,"Metals Hand Book ", Vol II ,1976.
4. Progress in Acoustics Emission, " Proceedings of 10th International Acoustics Emission Symposium ", Japanese Society for NDI,1990.

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Department	MECHANICAL ENGINEERING					R 2019	Semester I	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX06	PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To provide an understanding of production management and re-engineering concepts, their applications to manufacturing system.
- To deal with managerial, strategic and technological dimensions of productivity management and re-engineering.
- To understand the improvement tools and techniques, so as to deal with business challenges from a leadership and management perspective globally.

Course Outcome(s): At the end of this course, learners will be able to:

- Understand the approach and obligations of the professional systems analyst and the analogies between software and other branches of engineering.
- Knowing the need for quality assurance, students apply in the industry with engineering standards like ISO 9000-2000
- Use a variety of analysis and design techniques to document existing systems, to propose alternative new systems, and to specify required information systems.
- Produce the key deliverable's of the product life cycle.
- Apply the project management tools.

Unit I	INTRODUCTION	5

Introduction - Productivity concepts - Macro and Micro factors of productivity, Productivity benefit model, productivity cycle.

Unit II	PRODUCTIVITY MEASURES	12

Productivity Models - Productivity measurement at International, National and Organizational level, Total Productivity models. Productivity management in manufacturing and service sector. Productivity evaluation models, Productivity improvement models and techniques.

Unit III	ORGANIZATIONAL TRANSFORMATION AND REENGINEERING	8

Organizational Transformation - Principles of organizational transformation and re-engineering, fundamentals of process re-engineering, preparing the workforce for transformation and re-engineering, methodology, guidelines, DSMCQ and PMP model.

Unit IV	PROCESS IMPROVEMENT	10

Re-engineering - Process Improvement Models, PMI models, Edosomwan model, Moen and Nolan strategy for process improvement, LMICIP model, NPRDC model.

Unit V	TOOLS AND TECHNIQUES	10

Re-engineering Tools and implementation - Analytical and process tools and techniques - Information and communication technology - Enabling role of IT, RE opportunities, process redesign - cases. Software methods in BPR - specification of BP, case study - Order, processing, user interfaces, maintainability and reusability

REFERENCE(S):

1. Edosomwan, J.A., "Organisational transformation and process re-engineering", British Library cataloging in pub. data, 2005.
2. Sumanth, D.J., "Productivity engineering and management", Tata McGraw Hill, New Delhi, 1984.
3. Rastogi, P.N. "Re-engineering and Re-inventing the enterprise", Wheeler pub. New Delhi, 2006.
4. Premvrat, Sardana, G.D. and Shahay, B.S., "Productivity Management - A systems approach", Narosa Pub. New Delhi, 2007.
5. Lawrence Leemis. , "Reliability: Probabilistic models and Statistical methods", Prentice hall , 1995.

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Department	MECHANICAL ENGINEERING					R 2019	Semester I	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX07	SUPPLY CHAIN INFORMATION SYSTEMS	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To provide visibility about the role played by information system in supply chain enhancement.
- To provide a detailed knowledge about e-business and e-commerce application in real World supply chains.
- To develop knowledge & role of databases in SCM, along with the knowledge on future projected SC information system.

Course Outcome(s): At the end of this course, learners will be able to:

- Students will have better understanding on the integral relationship between supply chain and information system.
- Students will be able to project the role played by information in triggering the material flow, and the role played by different databases and Internet in processing supply chain.

Unit I	INTRODUCTION	6

World Wide Web – Web search elements – Web fundamentals – new technologies and innovations – Security protocols – Networks and numbers – Zones and domain names - Packets and protocols – OSI reference model – Intranet and its applications – Types of client server architecture – Extranet Role of IT in network design - forecasting – planning – transportation – sourcing – coordination

Unit II	E -BUSINESS	10

e – Business – Evolution of e-business – Types of e-business– Benefits of e-business - Dimensions of e-business and e-com – e-business infrastructure – ERP system – Enterprise structure modeling (Oracle application)– CRM – Selling chain management – infrastructure of selling chain – e-business servers – client connectivity - e-business case studies – e-business relationships with the stake holders – Internal & Internet based requisition development (Access / SQL)

Unit III	E -COMMERCE	9

The concept of e-commerce - e-commerce activities – Advantages and issues of e-com – Building blocks of electronic commerce – e-commerce business models – Value chain in e-commerce – Electronic auctions - Forward, reverse & Internet Auction – Intermediary Oriented B2B – EDI - Business to Business (B2B)– Kaplan – Sawhney B2B matrix.

Unit IV	APPLICATION OF E-COMMERCE	10

Features and challenges of B2B exchanges – Buyer oriented B2B – Supplier oriented B2B – Business to Consumer (B2C) –Online retailing vs traditional retailing – Product suitability for online retailing – Alternative models of e-retailing: Amazon vs Webvan – elements of successful B2C strategy – Marketing on the internet – Consumer to Business (C2B) - Consumer to Consumer (C2C) – Case studies on e-commerce – m – commerce.

Unit V	ADVANCED SUPPLY CHAIN INFORMATION SYSTEMS	10

SC information flows – A map of SCM Systems – Drivers of new SC systems & applications – ERP systems – E-sourcing/supply & web based systems– Types of systems – Reverse auctions – Evolving E-sourcing vendors - E-sourcing and fully integrated systems – Information visibility – Benefits of information visibility – e-supply chain fusion – The continuing evolution of E-Supply chains.

REFERENCE(S):

1. Agarwala, N. K., Lal, A. and Agarwala, D. (2000), Business on the Net – An Introduction to the 'Whats' and 'Hows' of e-commerce, Macmillan India Ltd.
2. Awad, E.M. (2007), Electronic Commerce from Vision to Fulfillment, Prentice Hall India, 3rd Edition.
3. Burt, N.D., Dobler, W.D. and Starling, L.S. (2005), World Class Supply Chain Management, The Key to Supply Chain Management, Tata McGraw Hill Publishing Company Limited
4. Chakrabarti, R. and Kardile, V. (2002), The Asian Managers Handbook of e -commerce, McGraw Hill Publishing Company Limited.

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Department	MECHANICAL ENGINEERING					R 2019	Semester I	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX08	DESIGN OF CELLULAR MANUFACTURING SYSTEM	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To learn various approaches involved in Cellular Manufacturing system.
- To understand the design aspects of CMS
- To Study about Machine Cell Layout and its performance in detail.

Course Outcome(s): At the end of this course, learners will be able to:

- Identify the role of advanced manufacturing technology in improving the productivity, design a cellular manufacturing system and the suitable layout in a manufacturing organization whether big or small.
- Optimize various parameters using non-traditional techniques thereby reducing the total production cost.

Unit I	INTRODUCTION	5

Introduction-Introductionof Group Technology, Limitations of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT.

Unit II	CELLULAR MANUFACTURING SYSTEM DESIGN AND APPROACH	12

CMS planning and design - Problems in GT/CMS - Design of CMS - Models , traditional approaches and non-traditional approaches - Genetic Algorithms, Simulated Annealing, Neural networks.

Unit III	MACHINE CELL LAYOUT	10

Implementation of GT/CMS - Inter and Intra cell layout, cost and non-cost based models, establishing a team approach, Managerial structure and groups, batch sequencing and sizing, life cycle issues in GT/CMS.

Unit IV	PERFORMANCE MEASUREMENT	10

Performance Measurement and Control - Measuring CMS performance - Parametric analysis - PBC in GT/CMS, cell loading, GT and MRP - framework.

Unit V	COMPARITIVE STUDIES	8

Economics of GT/CMS - Conventional Vs group use of computer models in GT/CMS, Human aspects of GT/CMS - cases.

REFERENCE(S):

1. Burbidge, J.L., "Group Technology in Engineering Industry", MECHANICAL ENGINEERING pub. London, 1979.
2. Askin, R.G. and Vakharia, A.J., "G.T - Planning and Operation in the automated factory" Hand Book: Technology and Management", Cleland, D.I. AND Bidananda, B(Eds), TAB Books, NY, 1991
3. Irani, S.A,. "Cellular Manufacturing Systems Hand Book".
4. Kamrani, A.K. Parsaei, H.R. and Liles, D.H.(Eds), "planning, design and analysis of cellular manufacturing systems ", Elsevier, 1995.

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Department	MECHANICAL ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MF201	OPTIMIZATION TECHNIQUES IN MANUFACTURING	3	1	0	4	60	100	

Course Objective(s): The purpose of learning this course is:

- To make use of the above techniques while modeling and solving the engineering problems of different fields.

Course Outcome(s): At the end of this course, learners will be able to:

- Introduce the various optimization techniques and their advancements.

Unit I	INTRODUCTION	14

Optimization – Historical Development – Engineering applications of optimization – Statement of an Optimization problem – classification of optimization problems.

Unit II	CLASSIC OPTIMIZATION TECHNIQUES	10

Linear programming - Graphical method – simplex method – dual simplex method – revised simplex method – duality in LP – Parametric Linear programming – Goal Programming.

Unit III	NON-LINEAR PROGRAMMING	14

Introduction – Lagrangeon Method – Kuhn-Tucker conditions – Quadratic programming – Separable programming – Stochastic programming – Geometric programming.

Unit IV	INTEGER PROGRAMMING AND DYNAMIC PROGRAMMING AND NETWORK TECHNIQUES	12

Integer programming - Cutting plane algorithm, Branch and bound technique, Zero-one implicit enumeration – Dynamic Programming – Formulation, Various applications using Dynamic Programming. Network Techniques – Shortest Path Model – Minimum Spanning Tree Problem – Maximal flow problem.

Unit V	ADVANCES IN SIMULATION	10

Genetic algorithms – simulated annealing – Neural Network and Fuzzy systems

REFERENCE(S):

1. Hamdy A. Taha, Operations Research – An Introduction, Prentice Hall of India, 1997
2. J.K.Sharma, Operations Research – Theory and Applications – Macmillan India Ltd., 1997
3. P.K. Guptha and Man-Mohan, Problems in Operations Research – Sultan chand & Sons, 1994
4. R. Panneerselvam, "Operations Research", Prentice Hall of India Private Limited, New Delhi 1 – 2005
5. Ravindran, Philips and Solberg, Operations Research Principles and Practice, John Wiley & Sons, Singapore, 1992

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Department	MECHANICAL ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MF202	ADVANCES IN METROLOGY AND INSPECTION	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To teach the students basic concepts in various methods of engineering measurement techniques and applications, understand the importance of measurement and inspection in manufacturing industries
- To make the students capable of learning to operate and use advanced metrological devices with ease in industrial environments.

Course Outcome(s): At the end of this course, learners will be able to:

- Understand the advanced measurement principles with ease.
- Operate sophisticated measurement and inspection facilities.
- Design and develop new measuring methods.

Unit I	CONCEPTS OF METROLOGY	8

Terminologies – Standards of measurement – Errors in measurement – Interchangeability and Selective assembly – Accuracy and Precision – Calibration of instruments – Basics of Dimensional metrology and Form metrology.

Unit II	MEASUREMENT OF SURFACE ROUGHNESS	9

Definitions – Types of Surface Texture: Surface Roughness Measurement Methods- Comparison, Contact and Non Contact type roughness measuring devices, 3D Surface Roughness Measurement, Nano Level Surface Roughness Measurement – Instruments.

Unit III	INTERFEROMETRY	8

Introduction, Principles of light interference – Interferometers – Measurement and Calibration – Laser Interferometry.

Unit IV	MEASURING MACHINES AND LASER METROLOGY	10

Tool Makers Microscope – Microhite – Coordinate Measuring Machines – Applications – Laser Micrometer, Laser Scanning gauge, Computer Aided Inspection techniques - In-process inspection, Machine Vision system-Applications.

Unit V	IMAGE PROCESSING FOR METROLOGY	10

Overview, Computer imaging systems, Image Analysis, Preprocessing, Human vision system, Image model, Image enhancement, gray scale models, histogram models, Image Transforms - Examples.

REFERENCE(S):

1. "ASTE Handbook of Industries Metrology", Prentice Hall of India Ltd., 1992
2. Bewoor, A.K. and Kulkarni,V.A.,"Metrology and Measurement", Tata Mc Graw-Hill, 2009.
3. Galyer, F.W. and Shotbolt, C.R., "Metrology for engineers", ELBS, 1990.
4. Gupta, I.C., "A Text Book of engineering metrology", Dhanpat Rai and Sons, 1996
5. Jain ,R.K.,"Engineering Metrology", Khqanna Publishers, 2008.
6. Rajput,R.K., "Engineering Metrology and Instrumentations", Kataria & Sons Publishers, 2001.
7. Smith,G.T., "Industrial Metrology", Springer, 2002
8. Sonka,M., Hlavac,V. and Boyle.R., "Image Processing, Analysis, and Machine Vision", Cengage-Engineering, 2007.
9. Whitehouse,D.J., "Surface and their measurement", Hermes Penton Ltd, 2004

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Department	MECHANICAL ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MF203	THEORY OF METAL FORMING	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To study the basic concepts of metal forming techniques and to develop force calculation in metal forming process.
- To study the thermo mechanical regimes and its requirements of metal forming

Course Outcome(s): At the end of this course, learners will be able to:

- Upgrade their knowledge on plasticity, surface treatment for forming of various types of metal forming process.

Unit I	THEORY OF PLASTICITY	9

Theory of plastic deformation – Yield criteria – Tresca and Von-mises – Distortion energy – Stress-strain relation – Mohr's circle representation of a state of stress – cylindrical and spherical co-ordinate system – upper and lower bound solution methods – Overview of FEM applications in Metal Forming analysis.

Unit II	THEORY AND PRACTICE OF BULK FORMING PROCESSES	9

Analysis of plastic deformation in 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.

Unit III	SHEET METAL FORMING	9

Formability studies – Conventional processes – H E R F techniques – Superplastic forming techniques – Hydro forming – Stretch forming – Water hammer forming – Principles and process parameters – Advantage, Limitations and application.

Unit IV	POWDER METALLURGY AND SPECIAL FORMING PROCESSES	9

Overview of P/M 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 – Rubber pad forming – Fine blanking – LASER beam forming

Unit V	SURFACE TREATMENT AND METAL FORMING APPLICATIONS	9

Experiment techniques of evaluation of friction in metal forming selection – influence of temperature and gliding velocity – Friction heat generation – Friction between metallic layers – Lubrication carrier layer – Surface treatment for drawing, sheet metal forming, Extrusion, hot and cold forging. Processing of thin Al tapes – Cladding of Al alloys – Duplex and triplex steel rolling – Thermo mechanical regimes of Ti and Al alloys during deformation – Formability of welded blank sheet – Laser structured steel sheet - Formability of laminated sheet.

REFERENCE(S):

1. Altan T., Metal forming – Fundamentals and applications – American Society of Metals, Metals park, 2003
2. ALTAN.T, SOO-IK-oh, GEGEL, HL – Metal forming, fundamentals and Applications, American Society of Metals, Metals Park, Ohio, 1995.
3. ASM Hand book, Forming and Forging, Ninth edition, Vol – 14, 2003
4. Dieter G.E., Mechanical Metallurgy (Revised Edition II) McGraw Hill Co., 1988
5. Helmi A Youssef, Hassan A. El-Hofy, Manufacturing Technology: Materials, Processes and Equipment, CRC publication press, 2012.
6. Marciniak,Z., Duncan J.L., Hu S.J., 'Mechanics of Sheet Metal Forming', Butterworth-Heinemann An Imprint of Elesevier, 2006
7. Nagpal G.R., Metal Forming Processes- Khanna publishers, 2005.
8. Proc. Of National Seminar on "Advances in Metal Forming" MIT, March 2000

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Dept. of Mech Engg. - ESEC

Department	MECHANICAL ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MF204	TOOLING FOR MANUFACTURING	3	1	0	4	60	100	

Course Objective(s): The purpose of learning this course is:

- To study the various design considerations for tooling.
- Develop knowledge in tooling and work holding devices.

Course Outcome(s): At the end of this course, learners will be able:

- State of Art in Tooling in Manufacturing and Inspection
- Design and Develop tooling for Flexible Manufacturing

Unit I	INTRODUCTION	12

Manufacturing Processes-objectives of manufacturing processes-classification of manufacturing process-Objectives of Tool design-tool design process-Nature and scope of Tool engineering-principles of economy for tooling-problems of economy in tooling-planning and tooling for economy-Manufacturing principles applicable to process and tool planning-tool control-tool maintenance-tool materials and its selection

Unit II	TOOLING FOR METAL REMOVAL PROCESSES	12

Traditional machining processes -work and tool holding devices-tool nomenclatures-Mechanism of machining-force temperature and tool life of single point tool-multipoint tools -tool design-tool wear-special processes-capstan and turret lathe-tooling layout of automats-tooling in NC and CNC machines-tooling for machining centres-CAD in tool design-Jigs and fixtures-design-Non-traditional material removal processes-mechanical, electrical thermal and chemical energy processes-principles-operation-equipment-tooling parameters and limitations

Unit III	TOOLING FOR METAL FORMING PROCESSES	12

Classification of Forming processes-Types of presses-design of -blanking and piercing dies-simple, compound, combination and progressive dies-Drawing dies-Bending dies-forging dies-plastic moulding dies.

Unit IV	TOOLING FOR METAL CASTING AND METAL JOINING PROCESSES	12

Tools and Equipment for moulding-patterns –pattern allowances – pattern construction-die casting tools-mechanization of foundries. Tooling for Physical joining processes Design of welding fixtures – Arc welding, Gas welding, Resistance welding, laser welding fixtures-Tooling for Soldering and Brazing Tooling for Mechanical joining processes.

Unit V	TOOLING FOR INSPECTION AND GAUGING	12

Survey of linear and angular measurements-standards of measurement-design and manufacturing of gauges-measurement of form-Inspection bench centre-co-ordinate measuring machine-tooling in CMM.

REFERENCE(S):

1. Cyril Donaldson Tool Design, Tata McGraw Hill, 1976
2. Hoffman E.G Fundamentals of tool design SME 1984.
3. Kalpak Jian S., Manufacturing Engineering and Technology Addison Wesley 1995.
4. L E Doyle Tool Engineering Prentice Hall 1950
5. Wellar, J Non-Traditional Machining Processes, SME, 1984

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Department	MECHANICAL ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
19ME205	AUTOMATION AND METAL FORMING LABORATORY	L	T	P	C			
		0	0	4	2	30	100	

Course Objective(s): The purpose of learning this course is:

- To train the students to have an hands on having the basic concepts of metal forming processes and to determine some metal forming parameters for a given shape.

Course Outcome(s): At the end of this course, learners will be able to:

- impart practical knowledge on bulk metal forming and sheet metal forming processes

Exp No.	Name of Experiments
1	Determination of strain hardening exponent
2	Determination of strain rate sensitivity index
3	Construction of formability limit diagram
4	Determination of efficiency in water hammer forming
5	Determination of interface friction factor
6	Determination of extrusion load
7	Study on two high rolling process
8	Simulation of single and double acting cylinder circuits
9	Simulation of Hydraulic circuit
10	Simulation of electro pneumatic circuits
11	Simulation of electro hydraulic circuits
12	Simulation of PLC circuits
13	Software simulation of fluid power circuits using Automation studio.

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Department	MECHANICAL ENGINEERING					R 2019	Semester II	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MF206	Technical Seminar	0	0	2	0	30	100	

Course Objective(s): The purpose of learning this course is:

- To develop self-learning skills of utilizing various technical resources to make a technical presentation
- To promote the technical presentation and communication skills.
- To impart the knowledge on intonation, word and sentence stress for improving communicative competence, identifying and overcoming problem sounds.
- To promote the ability for Interacting and sharing attitude.
- To engarauge the commitment-attitude to complete tasks.

Course Outcome(s): At the end of this course, learners will be able to:

- Refer and utilize various technical resources available from multiple fields
- Improve the technical presentation and communication skills
- Analyze the importance of intonation, word and sentence stress for improving communicative competence, identifying and overcoming problem sounds.
- Interact and share their technical knowledge to enhance the leadership skills
- Prepare report and present oral demonstrations

METHOD OF EVALUATION:

In this course. A student has to present three technical papers or recent advanced in engineering/technology that will be evaluated by a committee constitutes by the head of the department.

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Department	MECHANICAL ENGINEERING					R 2019	Semester II	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX09	PRECISION ENGINEERING	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To understand the concepts of Nano technology and its applications.
- To study about the various machining techniques used in industries and to give first level introduction to micro machining techniques.

Course Outcome(s): At the end of this course, learners will be able to:

- Get perspective knowledge on latest trends in Nano field.
- Able to apply various precision concepts of modern manufacturing systems for real life application.

Unit I	INTRODUCTION	9

Concepts of accuracy-Introduction- Concepts of accuracy of machine tools –spindle and displacements accuracies –Accuracy of numerical control systems –Errors due to numerical interpolation – displacement measurement system and velocity lags

Unit II	DIMENSIONING AND TOLERRANCING	9

Geometric dimensioning and tolerancing –Tolerance zone conversions –Surfaces, features of size, datum features –datum, oddly configured and curved surfaces as datum features ,equalizing datum –datum features of size representation-form controls, orientation controls –logical approach to tolerance

Unit III	NANOTECHNOLOGY – AN INTRODUCTION	9

Fundamentals of nanotechnology and measuring–Processing system of nanometer accuracies–mechanism of metal processing–nano physical processing of atomic-bit-units nano chemical and electrochemical atomic-bit processing. IN processing in-situ measurement position of processing point –post process and on-machine measurement of dimensional feature and surface – Mechanical and optional measuring system.

Unit IV	POSITIONING SYSTEMS	9

Nano-positioning systems of nanometer accuracy and repeatability –Guide systems for moving elements –Servo control systems for tool positioning –Computer aided digital and ultra-precision position control

Unit V	MANUFACTURING METHODS	9

Application and future trends in nano technology –nano-Grating systems –Nano lithography, photolithography, and electron beam lithography –machining of soft materials, diamond turning , mirror grinding of ceramics – development of intelligent products –Nano processing of materials for super high density ICs-Nano-mechanical parts and micro nano machines.

REFERENCE(S):

1. Murthy,R.L.," Precision Engineering in manufacturing ", Tata Mcgraw Hill (P) limited publishers ,2007.
2. James D.Meadows, "Geometric dimensioning and tolerancing ", Marcel Dekker Inc., 1995.
3. Norio Tanigichi,"Nano Technology", oxford university press, 2003.

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Dept. of Mech Engg. - ES

Department	MECHANICAL ENGINEERING					R 2019	Semester II	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX10	RELIABILITY AND TOTAL PRODUCTIVE MAINTENANCE	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To study the reliability concepts, failure data analysis, reliability prediction and management and the concepts of total productive maintenance.
- To enable the students to understand the concepts of reliability and total productive maintenance and to make them apply these in the industries.

Course Outcome(s): At the end of this course, learners will be able to:

- Achieve a good understanding of the basic technologies as related to reliability and maintenance engineering, their scope and limitations.
- Student should able to use the theories and methods that form the basis for these areas.

Unit I	INTRODUCTION	5

Introduction - Reliability function - MTBF - MTTF - morality curve -availability - Maintainability.

Unit II	DISTRIBUTIVE FUNCTIONS	10

Failure Data Analysis - Repair time distributions - exponential, normal, log normal, gamma, and Weibull - reliability data requirements - Graphical evaluation.

Unit III	RELIABILITY PREDICTION	10

Reliability Prediction - Failure rate estimates - Effect of environment and stress - Series and Parallel systems - RDB analysis - Standby Systems - Complex Systems

Unit IV	RELIABILITY MANAGEMENT	10

Reliability Management - Reliability demonstration tests - Reliability growth testing - Duane curve - Risk assessment - FMEA, Fault tree - Reliability Improvement - Analysis of downtime - Repair time distribution - System repair time - Maintainability prediction - Measures of maintainability

Unit V	TOTAL PRODUCTIVE MAINTENANCE	10

Total Productive Maintenance - Causes of Machine Failures - Downtime - Maintenance policies - TPM pillars - Autonomous maintenance - Restorability predictions - Replacement models - Spares provisioning - Maintenance management - Cleanliness and House Keeping - TPM implementation

REFERENCE(S):

1. Paul Kales, "Reliability for technology, Engineering and Management", Prentice Hall, New Jersey, 2000.
2. Modarres, " Reliability and Risk analysis ", Meral Dekker Inc., 2005.
3. O'CONNOR, P.D.T', "Practical Reliability Engineering ", John Wiley-1994.
4. NAKAJIMA.S...,"Introduction to TPM - Total Productive Maintenance", Productivity Press-1995.
5. Gopalakrishnan.P, and Banerji A.K., "Maintenance and Spare Parts Management ", Prentice Hall of India, New Delhi, 2005.
6. Dhillon B.S., " Engineering maintainability: How to design for reliability and easy maintenance ", Prentice Hall of India, New Delhi, 2005.
7. Ebeling, " An Introduction to reliability and maintainability Engineering ", Waveland Pr Limited, 2nd Edition, 2009.

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Department	MECHANICAL ENGINEERING					R 2019	Semester II	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX11	COMPUTER AIDED PROCESS PLANNING	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is to

- To study the Process Planning concepts, Part Design Representation, Process engineering and planning and Computer Aided Process Planning Systems, Integrated Process Planning Systems, part family generation.
- To make them apply these in the industries, process planning sheet preparations

Course Outcome(s): At the end of this course, learners will be able to:

- Adopt the process planning procedure after generating part families.
- Adopt these techniques to improve the production efficiency.
- Able to make use of certain CAPP related software packages in order to construct operation instruction sheet.
- Know the shortest way of executing machining techniques.

Unit I	INTRODUCTION	5

Introduction - The Role of Process Planning in the manufacturing cycle - Process Planning and Production Planning - Process Planning and Concurrent Engineering, CAPP, Group Technology

Unit II	GROUP TECHNOLOGY	10

Part Design Representation - Design Drafting - Dimensioning - Conventional tolerancing - Geometric tolerancing - CAD - input/output devices - topology - Geometric transformation - Perspective transformation - Data Structure - Geometric modeling for process planning - GT coding - The OPITZ system - The MICLASS system- CODE system.

Unit III	PROCESS PLANNING	10

Process engineering and process planning - Experience based planning - Process capability analysis - Process Planning - Forward and Backward planning & scheduling, software for studying, Input format, AI.

Unit IV	COMPUTER AIDED PROCESS PLANNING	10

Computer Aided Process Planning Systems - Logical Design of a Process Planning - Implementation considerations - manufacturing system components, production volume, No. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP. – Process planning Software's.

Unit V	PROCESS PLAN SYSTEMS	10

An Integrated Process Planning Systems - Totally integrated process plans systems - An overview – Modulus structure - Data Structure, operation - Report generation, Expert Process Planning.

REFERENCE(S):

1. Gideon Halevi and Roland D.Weill," Principles of Process planning, A logical approach", Chapman Hall, 1995.
2. Tien - Chien Chang, Richard A.Wysk," An introduction to automated process planning systems ",Prentice Hall,1985
3. Chang, T.C.,"An Expert process planning system", Prentice Hall, 1985
4. Nanua singh, "Systems approach to Computer Integrated Design and Manufacturing", John Wiley & Sons,1996
5. Rao, " Computer Aided Manufacturing",Tata McGraw Hill Publising CO.,2000

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Department	MECHANICAL ENGINEERING					R 2019	Semester II	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX12	FLEXIBLE COMPETITIVE MANUFACTURING SYSTEM	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To gather the information about Flexible manufacturing system concept in detail.
- To understand modern manufacturing methodology
- To learn the recent trends in Scheduling and Simulation

Course Outcome(s): At the end of this course, learners will be able to:

- Implement the concepts of group technology, know the techniques of part family generation and improve the performance of manufacturing system.
- Apply newer techniques in real time manufacturing environment methodologies in order to reduce total manufacturing lead time and down time in the production shop floor.

Unit I	INTRODUCTION	9

Manufacturing in a competitive environment - Automation of manufacturing process – types of automation - material handling and movement - industrial robots - Sensor technology - flexible, fixturing - Design for assembly, disassembly and services.

Unit II	GROUP TECHNOLOGY AND CELL DESIGN	9

Group technology - Part families generation - classification and coding - Production flow analysis - Machine cell design – Benefits

Unit III	FLEXIBLE MANUFACTURING SYSTEM AND APPLICATIONS	9

Flexible Manufacturing System - Introduction - Components of FMS - Application work stations - Computer control and functions - Planning, scheduling and control of FMS - Scheduling – Knowledge based scheduling – Agile manufacturing.

Unit IV	SOFTWARE INTEGRATION WITH FMS	9

Computer software, simulation and database of FMS - System issues - Types of software - specification and selection Trends - Application of simulation software - Manufacturing data system - data flow - CAD/CAM considerations - Planning FMS database.

Unit V	LEAN MANUFACTURING	9

Just in time - Characteristics of JIT – batch size concepts - work station loads - close supplier ties - flexible work force - line flow strategy. Total productive maintenance - Kanban system - strategic implications - implementation issues - MRD JIT - Lean manufacturing.

REFERENCE(S):

1. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", Prentice-Hall of India Pvt Ltd., New Delhi, 2010
2. Jha, N.K."Handbook of Flexible Manufacturing Systems",Academic Press Inc., 1991.
3. Kalpakjain, "MECHANICAL ENGINEERING and Technology", Addision-Wesley Publishing Co.1995.
4. Talichi Ohno, Toyoto, "Production System Beyond Large-Scale production", Productivity Press (India) Pvt Ltd.,1992.

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Department	MECHANICAL ENGINEERING					R 2019	Semester II	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX13	ADVANCED TOOL ENGINEERING AND DESIGN	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To enable the students to understand the analysis, planning, design, construction and application of tools, methods and procedures necessary to increase manufacturing productivity.
- To provide an exposure to the recent trends in the field of tool engineering.

Course Outcome(s): At the end of this course, learners will be able to:

- Work on thermal related software's and its applications.
- Get knowledge on designing the machine tools.
- Select proper tools for appropriate applications considering type of process.

Unit I	MECHANISM OF CHIP FORMATION, TYPES OF CHIPS AND FORCES IN METAL CUTTING	9

Mechanism of chip formation, Types of chip, techniques for the study of chip form formation, chip tool interface, built- up edge, chip breakers etc – problems Stress on the shear plane, Shear angle relationship in thin plane analysis. Minimum energy theory - stresses on the tool. Measurement of tool Forces - virtual tool dynamometers – evaluation of cutting forces, tool failures, work piece failure etc. with various real time problems

Unit II	THERMAL ASPECTS OF METAL CUTTING AND THERMAL ANALYSIS WITH CFD SOFTWARE	9

Heat in metal cutting, Flow of heat, Methods of tool temperature measurement, significance of cutting tool temperature. Cutting fluids - Types and selection – evaluation of heat flow in both the tool and work piece Introduction to CFD - various tools and techniques in CFD – various features of CFD – Applications of CFD – Comparisons of CFD with ANSYS and NISA – CFD in thermal analysis of metal cutting.

Unit III	CUTTING TOOL MATERIAL AND TOOL WEAR	9

Cutting tool materials - classification, application, heat treatment. Mechanisms of tool wear, Tool failure, Methods of tool wear Measurement. Tool life, Machinability index, Tool life equations, Universal machinability index, Economics of turning.

Unit IV	JIGS & FIXTURES	9

Fundamental ideas and principles of Jigs and Fixtures. Design of drill jigs and fixtures for turning, drilling, milling, broaching and grinding operations. Locating and clamping devices of jigs and fixtures. Indexing devices and types. Different types of jigs & fixtures. Design of a jig and fixtures for the given component by using Computer Aided Design (CAD).

Unit V	PRESS TOOLS & ECONOMIC ASPECTS OF TOOLING	9

Dies, punches, types of presses, clearances, types of dies, strip layout, calculation of press capacity, center of pressure. Design consideration for die elements. Economics of tooling – Tool selection and tool replacement with respect to small tools.

REFERENCE(S):

1. Amerego.E.J and Brown.R.H., "The Machining of Metals".Prentice hall, 1969.
2. ELBS "Principles of jig and Tool design: Published by English Universities Michigan,1969.
3. "P.S.G Design Data Book", PSG college of Technology, DPV printers, coimbatore, 2005.
4. Production Tooling Equipment - S.A.J.Parsons, published by Macmillan, 1966

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Department	MECHANICAL ENGINEERING					R 2019	Semester II	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX14	PLASTICS AND COMPOSITE MATERIALS	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To import knowledge about different types of plastics and composites and their fabrication methods.
- To acquire details about the effects machining and joining parameters on its quality
- To gain knowledge about the different types of reinforcements and its corresponding fabrication methods of composites.

Course Outcome(s): At the end of this course, learners will be able to:

- Select suitable plastics and composite materials for the required applications and its corresponding fabrication method.
- Identify service requirements and how to relate materials to those requirements.
- Identify the various properties of composites and plastics.

Unit I	INTRODUCTION	5

Introduction – Chemistry and classification of Polymers – Properties of Thermo plastics Properties of Thermosetting plastics – Applications –Merits and Demerits.

Unit II	PLASTICS PROCESS	17

Processing of plastics – Extrusion – Injection Moulding -Blow Moulding – Compression And transfer Moulding – casting – Thermo Forming. Machining and joining of plastics – General Machining Properties of Plastics – Machining Parameters and their effect – joining of Plastics- Mechanical Fasteners – Thermal bonding – Press Fitting.

Unit III	COMPOSITE MATERIALS	5

Introduction to Composite Materials – Fibers – Glass, Boron , Carbon , Organic , Ceramic and Metallic Fibers – Matrix Materials – Polymers, Metals and Ceramics.

Unit IV	POLYMER MATRIX COMPOSITES	9

Processing of Polymer Matrix Composites – Open Mould Processes, Bag Moulding, Compression Moulding With BMS and SMS - Filament winding – Pultrusion - Centrifugal Casting – Injection Moulding – Application of PMC`s

Unit V	METAL MATRIX COMPOSITES	9

Processing of metal matrix composites – Solid State Fabrication Techniques – Diffusion Bonding – Powder Metallurgy Techniques – Plasma Spray, Chemical and Physical Vapour Deposition of Matrix on Fiber – Liquid State Fabrication Method – Infiltration – Squeeze Casting – Rheo Casting – Compocasting – Application of MMC`s.

REFERENCE(S):

1. Harold Belofsky, "Plastics: Product Design and Process Engineering", Hanser Publishers, 1995.
2. Hensen.F, "Plastics Extrusion Technology", Hanser Publishers, 1988.
3. Johnnaber F, "Injection Moulding Machines", Hanser Publishesr, 1983.
4. Rosatao,D.V., "Blow Moulding Handbook", Hanser Publishers, 1989.
5. Rauwendaal, C, "Polymer Extrusion", Hanser Publishers, 1990.
6. A.K.B hargava, "Engineering Materials: Polymers, Ceramics and Composites", Prentice-Hall of India Limited, New Delhi, 2005.
7. Bera, E and Moet, A, "High Performance Polymers", Hanser Publisners ,1991

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Department	MECHANICAL ENGINEERING					R 2019	Semester II	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX15	TOTAL QUALITY SYSTEM AND ENGINEERING	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To provide the concepts of TQM, SQC and Acceptance sampling.

Course Outcome(s): At the end of this course, learners will be able to:

- Design a better system in manufacturing and implement the appropriate processes.
- Apply the basic concepts of sampling problems in real world applications.
- Demonstrate his ability in solving industrial problems using SQC methods.

Unit I	PRINCIPLES OF TQM	9

Introduction - Principles of Quality Management - Pioneers of TQM - Quality costs - Quality system Customer Orientation - Benchmarking - Re-engineering - concurrent engineering.

Unit II	LEADERSHIP AND QUALITY AUDITING	9

Practices of TQM - leadership - organizational structure - Team building - Information systems and documentation - Quality Auditing - ISO 9000 – QS 9000.

Unit III	TQM TECHNIQUES	9

Techniques of TQM - Single vendor concept - JIT- Quality Function Deployment - Quality circles - KAIZEN - SGA - POKA - YOKE - Taguchi Methods.

Unit IV	STATISTICAL QUALITY CONTROL	9

Statistical Quality control - Methods and Philosophy of Statistical process control - Control Charts for variables and Attributes - Cumulative sum and exponentially weighted moving average control charts – Other SPC Techniques - Process Capability Analysis - Six Sigma accuracy.

Unit V	SAMPLING	9

Acceptance sampling - Acceptance sampling problem - Single sampling Plans for attributes - double, multiple and sequential sampling, Military standards - The Dodge & Romig sampling plans.

REFERENCE(S):

1. .Mohamed Zairi, "Total Quality Management for Engineers", Woodhead Publising Limited 1991.
2. Harvid noori and russel, "Production and operations management - Total Quality and Responsiveness", McGraw-Hill Inc, 1995
3. Douglus C Montgomery,"Introduction to Statistical Quality Control", McGraw Hill, 1984
4. Grant E.L and Leavensworth, "Statistical Quality control", McGraw hill, 1984
5. Suganthi. L and Anand A Samuel, "Total Quality Management", Prentice - Hall of India, New Delhi, 2005.
6. Howard Gitlow, Alan Oppenheim and Proa Oppenheim, "Quality Management", McGraw-Hill Inc, 2005.
7. Dale H. Besterfield, and Etc, "Total Quality Management ", 3rd Edition, Pearson Education - Prentice Hall, 2007

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Department	MECHANICAL ENGINEERING					R 2019	Semester II	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX16	ADVANCES IN FOUNDRY TECHNOLOGY	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To know about the casting metallurgy and design aspects of moulding, gating and riser.
- To learn about the special casting processes and foundry mechanization.
- To understand about the computer applications in foundry technology

Course Outcome(s): At the end of this course, learners will be able to:

- Perform casting design with the acquired knowledge on runner, riser, gates materials and components for the desired product.
- Apply computer design for the casting and select suitable foundry technique for the desired product.
- Design a better foundry layout in order to increase the productivity by implementing mechanization techniques and computers.

Unit I	INTRODUCTION AND CASTING METALLURGY AND DESIGN	10

Basics of casting techniques – Various aspects of advances inn foundry technology – Scope of the study Casting metallurgy & design - Solidification of pure metals and alloys - Fluidity- Shrinkage in cast metals - Absorption of gases - Degassing methods - Progressive solidification - Directional solidification - Hot spot & Junction - Design for moulding-Design for core support.

Unit II	PRINCIPLE OF GATING AND RISER	9

Principle of gating and riser - Improvement of yield efficiency - Simple problems in gating and risening for steels and cast irons

Unit III	SPECIAL CASTING PROCESSES	11

Special casting processes - Shell moulding, investment casting, Carbon - Dioxide moulding, Centrifugal casting, Die casting, Continous casting, Squeeze casting, Vaccum casting, Full mould processes, Semi-Solid metal casting,Thixocasting and Rheocasting process, Compo casting.

Unit IV	FOUNDRY MECHANIZATION	9

Foundry mechanization – Layout of mechanized foundry – Sand reclamation – Material handling in foundry – Pollution control in foundry – Casting defects – Identification, Analysis and Remedies.

Unit V	COMPUTER AIDED DESIGN AND CASTINGS	6

Computer aided design and castings – Computer aided pattern making and use of rapid prototyping technology in foundry, Feeder design and solidification analysis, Gating design and mould filling analysis, Rapid tooling fabrication, Implementing rapid casting development technologies, Case study from industry.

REFERENCE(S):

1. Jain "Principles of Foundry Technology", Tata Mc Graw Hill 3rd edition 2005.
2. "ASM Metals Hand book on Casting", Revised edition 1995.
3. Heine.R.W.Loper and Rosenthal "Principles of Metal Casting" Tata Mc Graw Hill, 1997.
4. Peter Beelay "Foundry Technology" Butterworth, Second edition, 2001.
5. Ravi.B "Metal Casting Computer aided Design and Analysis" Prentice Hall, 2005.
6. Srinivasan.N.K "Foundry Engineering" Khanna Tech pub co, New Delhi, 2000.

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Department	MECHANICAL ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MF301	RESEARCH METHODOLOGY	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To impart scientific, statistical and analytical knowledge for carrying out research work effectively.

Course Outcome(s): At the end of this course, learners will be able to:

- Able to get knowledge about the different research techniques and research report.

Unit I	INTRODUCTION TO RESEARCH	9

The hallmarks of scientific research – Building blocks of science in research – Concept of Applied and Basic research – Quantitative and Qualitative Research Techniques – Need for theoretical frame work – Hypothesis development – Hypothesis testing with quantitative data. Research design – Purpose of the study: Exploratory, Descriptive, Hypothesis Testing.

Unit II	EXPERIMENTAL DESIGN	9

Laboratory and the Field Experiment – Internal and External Validity – Factors affecting Internal validity. Measurement of variables – Scales and measurements of variables. Developing scales – Rating scale and attitudinal scales – Validity testing of scales – Reliability concept in scales being developed – Stability Measures.

Unit III	DATA COLLECTION METHODS	9

Interviewing, Questionnaires, etc. Secondary sources of data collection. Guidelines for Questionnaire Design – Electronic Questionnaire Design and Surveys. Special Data Sources: Focus Groups, Static and Dynamic panels. Review of Advantages and Disadvantages of various Data-Collection Methods and their utility. Sampling Techniques – Probabilistic and non-probabilistic samples. Issues of Precision and Confidence in determining Sample Size. Hypothesis testing, Determination of Optimal sample size.

Unit IV	MULTIVARIATE STATISTICAL TECHNIQUES	9

Data Analysis – Factor Analysis – Culster Analysis -Discriminant Analysis – Multiple Regression and Correlation – Canonical Correlation – Application of Statistical (SPSS) Software Package in Research.

Unit V	RESEARCH REPORT	9

Purpose of the written report – Concept of audience – Basics of written reports. Integral parts of a report – Title of a report, Table of contents, Abstract, Synopsis, Introduction, Body of a report – Experimental, Results and Discussion – Recommendations and Implementation section – Conclusions and Scope for future work.

REFERENCE(S):

1. C.R.Kothari, Research Methodology, WishvaPrakashan, New Delhi, 2001.
2. Donald H.McBurney, Research Methods, Thomson Asia Pvt. Ltd. Singapore, 2002
3. Donald R. Cooper and Ramela S. Schindler, Business Research Methods, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2000
4. G.W.Ticehurst and A.J.Veal, Business Research Methods, Longman, 1999.
5. Ranjit Kumar, Research Methodology, Sage Publications, London, New Delhi, 1999.
6. Raymond-Alain Thie'tart, et.al., Doing Management Research, Sage Publications, London, 1999
7. Uma Sekaran, Research Methods for Business, John Wiley and Sons Inc., New York, 2000.

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Department	MECHANICAL ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MF302	MATERIALS TESTING AND CHARACTERIZATION TECHNIQUES	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To impart knowledge on various techniques of material characterization.

Course Outcome(s): At the end of this course, learners will be able to:

- Be knowledgeable in microstructure evaluation, crystal structure analysis, electron microscopy, Chemical Thermal Analysis, static and dynamic mechanical testing methods.

Unit I	MICRO AND CRYSTAL STRUCTURE ANALYSIS	10

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials - Elements of Crystallography – X- ray Diffraction – Bragg's law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction.

Unit II	ELECTRON MICROSCOPY	9

Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF & DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction & working of SEM – various Imaging Techniques – Applications-Atomic Force Microscopy-Construction & working of AFM - Applications .

Unit III	CHEMICAL AND THERMAL ANALYSIS	9

Basic Principles, Practice and Applications of X-Ray Spectrometry, Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra Red Spectroscopy (FTIR)-Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC) And Thermo Gravitymetric Analysis (TGA).

Unit IV	MECHANICAL TESTING – STATIC TESTS	8

Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test – Tensile Test – Stress – Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy & Izod – DWTT - Fracture Toughness Test, Codes and standards for testing metallic and composite materials.

Unit V	MECHANICAL TESTING – DYNAMIC TESTS	9

Fatigue – Low & High Cycle Fatigues – Rotating Beam & Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – AE Tests-modal analysis - Applications of Dynamic Tests.

REFERENCE(S):

1. ASM Hand book-Materials characterization, Vol – 10, 2004.
2. Culity B.D., Stock S.R& Stock S., Elements of X ray Diffraction, (3rd Edition). Prentice Hall, 2001.
3. Davis J. R., Tensile Testing, 2nd Edition, ASM International, 2004.
4. Davis, H.E., Hauck G. & Troxell G.E., The Testing of engineering Materials, (4th Edition), McGraw Hill, College Divn., 1982.
5. Grundy P.J. and Jones G.A., Electron Microscopy in the Study of Materials, Edward Arnold Limited, 1976.
6. Dieter G.E., Mechanical Metallurgy, (3rd Edition), ISBN: 0070168938, McGraw Hill, 1988.
7. Morita.S, Wiesendanger.R, and Meyer.E, "Non-contact Atomic Force Microscopy" Springer, 2002.

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Dept. of Mech Engg. - ESEC

Department	MECHANICAL ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MF303	PROJECT WORK (PHASE I)	0	0	12	6	180	100	

Course Objective(s): The purpose of learning this course is:

- To develop the skill of students for analyzing safety problems to control the hazard.
- To expose the students to identify and evaluate the hazards in an industry under study.
- To expose the students to assess the Compliance level of safety norms and procedures.

Course Outcome(s): At the end of this course, learners will be able to:

- This course would make students to train themselves to conduct hazard analysis and suggest solutions to control risks.
- Course would be helpful for the students to know the norms and standards for an Industry.
- Students can recognize hazards and assess or evaluate them by using various techniques.
- Students would be able to suggest suitable measures to prevent hazards by referring the literature and comprehensive hazard analysis.

Methodology of Evaluation:

- The student will identify and select a problem based on comprehensive literature survey.
- The student should submit a proposal and get it approved by the Head of the department.
- Three reviews will be conducted by Project review committee.
- Students will be evaluated by the committee during the review and suggestions will be offered by members.
- The report for PHASE - I should be submitted by the students at the end of course.

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Dept. of Mech Engg. - ESEC

Department	MECHANICAL ENGINEERING					R 2019	Semester III	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX17	FINITE ELEMENT ANALYSIS IN MANUFACTURING ENGINEERING	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To gain fundamental knowledge and techniques of FEM for solving boundary value problems and manufacturing process.
- To gain exposure to commercial FE analysis packages.

Course Outcome(s): At the end of this course, learners will be able to:

- Solve boundary value problems using classical as well as finite element methods.
- Demonstrate his/her ability in selection of appropriate elements.
- Understand various manufacturing processes with the application of finite element techniques.
- Solve simple practical problems using commercial FE analysis packages.

Unit I	INTRODUCTION	10

Introduction –Basic of FEM – Initial value and boundary value problems – weighted residual Galerkin and Raleigh –Ritz methods – Review of variational formulation.

Unit II	ONE DIMENSIONAL ANALYSIS	8

One dimensional analysis – Steps in FEA – Discretization, interpolation, derivation of elements characteristic matrix, shape function, assembly and imposition of boundary conditions-solution and post processing-one dimensional analysis in solid mechanics and heat transfer.

Unit III	TWO DIMENSIONAL ANALYSIS	8

Shape functions and higher order formulations – Global and Natural co-ordinates – Shape functions for one and two dimensional elements- three noded triangular and four noded quadrilateral element – non-linear analysis – Isoparametric elements – Jacobian matrices and transformations – basic of two dimensional axi-symmetric analysis.

Unit IV	ANALYSIS OF PRODUCTION PROCESSES	10

Analysis of production processes-FEA of metal casting-Special considerations, latent heat incorporation, gap element-Time stepping procedures-Crank-Nicholson algorithm-Prediction of grain structure. Basic concepts of plasticity-Solid and flow formulation-Small incremental deformation formulation-FEA of metal cutting, chip separation criteria, incorporation of strain rate dependency.

Unit V	COMPUTER IMPLEMENTATION IN FEA	9

Computer implementation-Preprocessing, Mesh-generation, element connecting, boundary conditions, input of material and processing characteristics-Solution and post processing-Overview of application packages such as ANSYS and Abaqus FEA. Development of code for one dimensional analysis and validation.

REFERENCE(S):

1. Reddy, J.N. "An Introduction to Finite Element Method", McGraw-Hill, 2005.
2. Rao, S.S, "Finite Element Method in Engineering", Elsevier, 2012.
3. K. J. Bathe, "Finite Element Procedures", Cambridge, MA: Klaus-Jürgen Bathe, 2006
4. SHIRO KOBAYASHI, SOO-IK-oh-ALTAN, T, "Metal forming and Finite Element Method" Oxford University Press, 1989.
5. Lewis R.W., Morgan K. Thomas, H.R. and Seetharaman K.N., "The Fintie Element Method in Heat Transfer Analysis", John Wiley, 1996.
6. Lars-Erik Lindgren., "Computational Weld Mechanics – Thermomechanical and microstructural simulations", Woodhead Publishing Ltd., Cambridge England, 2007.
7. P Seshu, "Textbook of Finite Element Analysis",PHI Learning Private Limited ,2003

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Department	MECHANICAL ENGINEERING					R 2019	Semester III	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX18	ADVANCED AGILE AND LEAN MANUFACTURING SYSTEM	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To teach the students about E manufacturing concepts i.e.,
- To know the use of IT in the manufacturing sector and advanced manufacturing systems like Lean manufacturing, Agile manufacturing etc.

Course Outcome(s): At the end of this course, learners will be able to:

- Implement the concepts of E-manufacturing in the manufacturing industries.
- Decide the fundamental principle in transforming conventional manufacturing organisation into E-manufacturing systems.
- Apply the knowledge of various e-manufacturing technologies and their possible implementation.
- Identify the considerations and paradigms needed when selecting, evaluating, and adopting the E-manufacturing concept in the manufacturing industries.

Unit I	INTRODUCTION	5

Introduction – Manufacturing operations – Manufacturing Industries and products – Manufacturing Support systems – E- manufacturing concept.

Unit II	MANUFACTURING STRATEGY	12

Manufacturing strategy and supply chain – Forecasting systems – Dimensions of manufacturing strategy – Supply chain management concepts – Aggregate planning – Single stage inventory control.

Unit III	LEAN MANUFACTURING	8

Lean Manufacturing – Principles of lean manufacturing – Lean flow- Two paths of implementing lean manufacturing – methodologies for change- environment change – Pitfalls in implementing lean manufacturing.

Unit IV	AGILE MANUFACTURING	10

Agile manufacturing – Meaning and definition of Agility – Force pulling towards Agility – Three consequences converging physical products, information and services – Empowerment -Enterprise Integration – Concurrent operations – Planning internal alignment of company – Role of strategic planning departments.

Unit V	E-MANUFACTURING	10

E-Manufacturing – Concepts of E-Manufacturing – Use of internet in manufacturing industries – E-business technology in manufacturing industry – Scope of applications - Implementation Methodology – Benefits of E-Manufacturing.

REFERENCE(S):

1. Mikell P. Groover., "Automation , Production systems and Computer – Integrated Manufacturing ", Pearson – Prentice Hall, 2007.
2. Ronald G.Askin, " Design and Analysis of Lean Production System ", John Wiley and sons, 2002 .
3. Bedwprth D D, " Integrated Production control systems Management,Analysis, Design ", John Wiley and sons, Newyork , 2002
4. Vollman T E ," Manufacturing Planning and control Systems", Galgotia publication , New Delhi ,1998.
5. Paul Kenneth wright , " 21st Century manufacturing" , Prentice hall , 2001

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Department	MECHANICAL ENGINEERING					R 2019	Semester III	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX19	SMART MATERIALS & SYSTEMS	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is to

- To gain fundamental knowledge on different types of smart materials and systems and to understand the applications of smart materials in various domains.

Course Outcome(s): At the end of this course, learners will be able to:

- Demonstrate and analyze the various types of smart materials and systems.
- Evaluate the characteristics of smart material with different domains.
- Analyze and select a piezoelectric composite material according to the requirement.
- Determine the characteristics of shape memory alloys.
- Apply smart materials and systems to various real-world problems

Unit I	INTRODUCTION AND HISTORICAL PERSPECTIVE	9

Classes of materials and their usage – Intelligent /Smart materials – Evaluation of materials Science – Structural material – Functional materials – Polyfunctional materials – Generation of smart materials – Diverse areas of intelligent materials – Primitive functions of intelligent materials – Intelligent inherent in materials – Examples of intelligent materials, structural materials, Electrical materials, biocompatible materials etc. – Intelligent biological materials – Biomimetics – Wolff's law – Technological applications of Intelligent materials.

Unit II	SMART MATERIALS AND STRUCTURAL SYSTEMS	9

The principal ingredients of smart materials – Thermal materials – Sensing technologies – Micro sensors – Intelligent systems – Hybrid smart materials – An algorithm for synthesizing a smart material – Passive sensory smart structures– Reactive actuator based smart structures – Active sensing and reactive smart structures – Smart skins – Aero elastic tailoring of airfoils – Synthesis of future smart systems.

Unit III	ELECTRO-RHEOLOGICAL (FLUIDS) SMART MATERIALS	9

Suspensions and electro-rheological fluids – Bingham-body model – Newtonian viscosity and non-Newtonian viscosity – Principal characteristics of electro rheological fluids – The electrorheological phenomenon – Charge migration mechanism for the dispersed phase – Electrorheological fluid domain – Electrorheological fluid actuators – Electro-rheological fluid design parameter – Applications of Electrorheolgoical fluids.

Unit IV	PIEZOELECTRIC SMART MATERIALS	9

Background – Electrostriction – Pyroelectricity – Piezoelectricity – Industrial piezoelectric materials – PZT – PVDF – PVDF film – Properties of commercial piezoelectric materials – Properties of piezoelectric film (explanation) – Smart materials featuring piezoelectric elements – smart composite laminate with embedded piezoelectric actuators – SAW filters.

Unit V	SHAPE – MEMORY (ALLOYS) SMART MATERIALS	9

Background on shape – memory alloys (SMA) Nickel – Titanium alloy (Nitinol) – Materials characteristics of Nitinol – Martensitic transformations – Austenitic transformations – Thermoelastic martensitic transformations – Cu based SMA, chiral materials – Applications of SMA – Continuum applications of SMA fastners – SMA fibers – reaction vessels, nuclear reactors, chemical plants, etc. – Micro robot actuated by SMA – SMA memorisation process (Satellite antenna applications) SMA blood clot filter – Impediments to applications of SMA – SMA plastics – primary molding – secondary molding – Potential applications of SMA plastics.

REFERENCE(S):

1. 1M.V.Gandhi and B.S. Thompson, Smart Materials and Structures Chapman and Hall, London, First Edition, 1992
2. T.W. Deurig, K.N.Melton, D.Stockel and C.M.Wayman, Engineering aspects of Shape Memory alloys, Butterworth –Heinemann, 1990
3. C.A.Rogers, Smart Materials, Structures and Mathematical issues, Technomic Publising Co., USA, 1989

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Department	MECHANICAL ENGINEERING					R 2019	Semester III	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MFX20	ULTRASONICS AND APPLICATIONS	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is:

- To gain fundamental knowledge on ultrasonic transducers and determine the velocity of propagation and absorption in different mediums and to use this principle to solve various real life

Course Outcome(s): At the end of this course, learners will be able to:

- Demonstrate and analyze the various types of transducers and its components.
- Evaluate the absorption of ultrasonic radiation in different domains.
- Compute the propagation of ultrasonic waves in different medium.
- Determine the velocity of propagation of ultrasound.
- Apply ultrasonic principle to various real-world problems.

Unit I	ULTRASONIC TRANSDUCERS	9

Piezoelectric and Magnetostrictive transducers - equivalent circuits – Efficiency - Transducer mounting Mechanical and Electronics, linear and sector transducers - variable frequency systems.

Unit II	ABSORPTION OF ULTRASONIC RADIATION	9

Classical absorption due to viscosity - Absorption due to thermal conductivity - Relaxation process - Evaluation of dispersion and absorption curves - structural relaxation - relation between collision frequency and relaxation time - Ultrasonic attenuation in solids.

Unit III	ULTRASONIC PROPAGATION IN SOLIDS AND LIQUIDS	9

Propagation of Ultrasonic waves in solids - Plane wave propagation – Relation between velocity of sound and elastic properties - Adiabatic and Isothermal elastic constants - Ultrasonic propagation in liquids – Internal pressure and free volume calculations.

Unit IV	DETERMINATION OF VELOCITY OF PROPAGATION OF ULTRASOUND	9

Transit time method - Pulse Echo methods - Acoustic Interferometry - Measurements at high pressure and high temperature - Transducer coupling materials.

Unit V	APPLICATION OF ULTRASONICS	9

Industrial applications - Medical Applications - Acoustic microscope - Acoustic hologram – ultrasonic trans axial tomography.

REFERENCE(S):

1. G.L.Gooberman, Ultrasonics - Theory and Applications, - The English Universities Press Ltd., London, 1968.
2. Schreiber, Anderson and Soga, Elastic Constants and Their Measurement, Mc Graw Hill Book Co., New Delhi, 1973.
3. R.A.Lerski (Editor), Practical Ultrasound, IRL Press, Oxford,1988. 4. Robert T.Beyer and Stephen V. Letcher, Physical Ultrasonics, Academic Press, London, 1969.

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Department	MECHANICAL ENGINEERING					R 2019	Semester IV	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MF401	PROJECT WORK (PHASE II)	0	0	24	12	360	100	

Course Objective(s): The purpose of learning this course is:

- To develop the skill of students for analyzing safety problems to control the hazard.
- To expose the students to identify and evaluate the hazards in an industry under study.
- To expose the students to assess the Compliance level of safety norms and procedures.

Course Outcome(s): At the end of this course, learners will be able to:

- This course would make students to train themselves to conduct hazard analysis and suggest solutions to control risks.
- Course would be helpful for the students to know the norms and standards for an Industry.
- Students can recognize hazards and assess or evaluate them by using various techniques.
- Students would be able to suggest suitable measures to prevent hazards by referring the literature and comprehensive hazard analysis.

Methodology of Evaluation: (It is the continuation of Phase I project)

- Three reviews will conducted by Project review committee.
- Students will be evaluated by the committee during the review and suggestions will be offered by members.
- At least one paper should be published by the student in international / national conference.
- The report should be submitted by the students at the end of course.

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