M.Tech Mechanical Engineering (Manufacturing Technology)

Course Description

Title: Analysis and Design of Machine Tools Code: 14M11ME111

L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Students must have already studied course, "*Manufacturing Technology*".

Objective:

[1] To provide fundamental knowledge and principles in material removal processes.

[2] To provide the knowledge of different drives and mechanisms used in machine tools, The design of gear boxes & feed boxes, structures, guide ways, spindles and various control systems used in machine tools.

[3] To demonstrate the fundamentals of machining processes. Vibrations induced in machine tools.

[4] To apply knowledge of basic mathematics to calculate the machining parameters for different machining processes.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the machine tools, cutting tool geometry, mechanism of chip formation and mechanics of orthogonal cutting.
CO2	Describe the concepts of design of machine tools and machine tools drives, design and analysis of machine tool structures, columns, beds, spindles, slide ways and bearings.
CO3	Develop newer concepts of designing CNC Machine tool.
CO4	Identify machine tool vibrations, different theories of vibration in machine tools.
CO5	Apply Modal analysis, vibrations induced in machine tools and calculate the values of various forces involved in the machining operations.
CO6	Demonstrate the inter-relationship between cutting parameters and machining performance measures like power requirement, cutting time, tool life and surface finish.

Course Content:

Unit-1: Metal cutting : Mechanics of metal cutting, Geometry of tool and nomenclature, Tool materials, Orthogonal vs oblique cutting. Mechanics of chip formations, types of chips, tools angles, shear angle, Merchant's force circle diagram, Cutting forces, power required, Cutting fluids/lubricants, Tools wear and tool life.

Unit-2: Design and Analysis of Machine Tool Structures, Columns, Beds, Spindles, Slide ways and Bearings.

Unit-3: Design of Kinematic Schemes of Machine Tools, Design of kinematic schemes used in modern machine tools drives**,** Concepts of design of machine tools, Design of Machine tool drives.

Unit-4:Computer controlled manufacturing process: NC, CNC, DNC, part programming, Introduction to computer aided manufacturing and robotics.

Unit-5: Machine Tool Vibrations, different theories of vibration in machine tools, Modal analysis, Vibration isolation, Static and dynamic testing of machine tools.

Teaching Methodology:

This course is introduced to help students to understand Machine tools,the various parts of machine tools, the forces which act on them. Students will gain advanced knowledge of machining process modeling as well as vibration analysis of machine tools.

Course will equip students to diagnose machining process related issues, and will motivate practical solutions for some industrial problems in the machine tool.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1& Unit-2
Test-2	25 Marks	Based on Unit-3& Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 and around 30% from coverage of Test-1 & Test-2.
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Course-related resources will be provided on JUET server. This can include eBook, lecture material, supplementary course notes.

Text Book:

[1] Manufacturing Automation by Y. Altintas.

[2] Machining Dynamics by T. Schmitz & K. Smith;

Reference Books/Material:

[1] Machine Tool Structures by Koenigsberger & Tlusty

Web References:

[1] https://www.youtube.com/watch?v=orKAv91M0Uo

Journals References:

[1] International Journal of Machine Tools and Manufacture: Elsevier

Course Description

Title: Metal Machining Code: 14M11ME112

L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: It is a foundation course of machining

Objectives:

1. To study the basics of metal machining and mechanics of metal machining
2. To study the different cutting tool materials and types & geometry of cutting tools
3. To learn introductory concepts of various advanced machining processes

Learning Outcomes:

CO1	Outline various machining processes such as turning, milling, shaping, drilling, grinding
CO2	Describe various machining processes its mechanism, mechanics
CO3	Develop the knowledge of heat generation in machining and its impact on M-F-T and its regulation
CO4	Identify and use the proper technique required for the machining process of any metallic product
CO5	Apply various advanced machining processes where conventional are not suitable
CO6	Demonstrate the practical exposure of various conventional and nonconventional machining techniques

COURSE CONTENT

Unit 1:

Mechanics of Metal Cutting, Thermal Aspects of Machining

Unit 2:

Cutting fluids, Tool Wear, Tool Life

Machinability, Economics of Machining

Unit 3:

Abrasive Processes, Vibrations in Cutting

Unit 4:

Introduction to Modern Machining Processes

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit 1
Test-2	25 Marks	Based on Unit 2 & 3 and Unit 1 (20%)
Test-3	35 Marks	Based on Unit 3 & 4, Unit 2 (15%) and Unit 1 (15%)
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Lecture notes on Metal Machining (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:

1. G. K. Lal (2007), Introduction to Machining Science, New Age International Publisher, New Delhi.
2. **A. Ghosh** and A. K. Malik (2010) Manufacturing Science, East West Press Private Limited New Delhi.
3. V.K. Jain (2005), Advanced Machining Processes, Allied Publishers Private Limited, India.

Reference Books:

1. P.C. Pandey and H. S. Shan (1996), Modern Machining Processes, TMH Publishing Limited, New Delhi.
2. R.K Jain (2005), Production Technology, Khanna Publisher, New Delhi.
3. S. Kalpakjian and S. Schemid (2001), Manufacturing, Engineering and Technology, Addison Wesley.

Web References:

1. www.youtube.com/user/nptelhrd

Journals References:

1. International Journal of Advanced Manufacturing Technology
2. International Journal of Machine Tools and Manufacture

Course Description

Title: Metal Machining Lab Code: 14M17ME172

L-T-P scheme: 0-0-1 **Credit: 1**

Prerequisite: Basics of workshop

Objectives:

1. To determine the shear plane angle and shear strain during the cutting of single point cutting tool of mild steel sheet
2. To study the different cutting tool materials and types & geometry of cutting tools
3. To learn introductory concepts of roughness during the metal cutting

Learning Outcomes:

CO1	Outline different conventional and nonconventional machining processes
CO2	Describe each process with their practical aspects
CO3	Develop the practical knowledge to manufacture products using machining technology
CO4	Identify the required machining process for a product
CO5	Apply the knowledge to improve the methods
CO6	Demonstrate the skill of metal machining for practical use in the industry

Contents:

S.No.	Name of Experiments
1.	Determine the shear plane angle and shear strain of a work piece on shaper
2.	To determine the roughness in a specimen
3.	Optimization of current to overcome the taper obtains during EDM drilling process
4.	To study the geometry of single point cutting tool
5.	To prepare single point cutting tool as per given tool signature

Evaluation Scheme:

Exams		**Marks**	**Coverage**
P-1		15 Marks	**Based on Lab Exercises: 1-3**
P-2		15 Marks	**Based on Lab Exercises: All**
Day-to-Day Work	Viva	20 Marks	**70 Marks**
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

Learning Resources:

Digital copy of study material and videos will be available on the JUET server.

Books:

1. R.K Jain (2005), Production Technology, Khanna Publisher, New Delhi.
2. **A. Ghosh** and A. K. Malik (2010) Manufacturing Science, East West Press Private Limited New Delhi.
3. G. K. Lal (2007), Introduction to Machining Science, New Age International Publisher, New Delhi.

Web References:

1. www.youtube.com/user/nptelhrd

Journals References:

1. International Journal of Advanced Manufacturing Technology
2. International Journal of Machine Tools and Manufacture

Course Description

TITLE	CODE	CREDITS
Casting and Welding	14M11ME113	3

Scope and Objective:

- To understand basic manufacturing processes like casting and welding
- To learn various aspects of different manufacturing techniques such as various casting methods and welding methods
- To have a broad knowledge to design a casting process for a product and design of welded joints

Learning Outcome:

Course Outcome	Description
CO1	Outline scope of various casting and welding processes
CO2	Describe various terminologies used in various casting and welding processes. Designing of the pattern and the gating system. Describe solid solutions, phase diagram, phase transformation, heat treatment processes.
CO3	Develop skills of sand preparation, making pattern,mould, core, gating system, arc welding, resistance welding, gas welding and brazing processes.
CO4	Identify casting and welding processes suitable for different materials. To analyze and compare the processes to choose the appropriate process.
CO5	Identify various defects in casting and welding processes, the causes for their occurrence and the remedies.
CO6	Apply testing and measuring equipments and methods used in casting and welding processes.

COURSE CONTENT

Casting:

Mechanism of Solidification: Design Principles of Gates, Runners and Risers.

Design of Casting, Introduction to ferrous and non-ferrous foundry practice.

Iron-Carbon Equilibrium Diagram, TTT Curves, Heat treatment of Metals, Melting Furnaces**(8)**

Recent developments in Casting. Casting defects, Inspection and testing of Castings.

Welding:

Theory of fusion and pressure welding, flow and distribution of heat in welding, Weldability, Welding of various materials, Non conventional welding processes

TEXT BOOKS:

1. Jain P L, Principles Foundry Technology, Tata McGraw Hill
2. Parmar R.S., Welding Process and Technology, Khanna Publishers.

REFERENCES:

1. Pandey P. C. and Singh C. K., Production Engineering Sciences, Standard Publisher.
2. De Garmo, E. P., Black, J. T. and Kohser, R.A., Materials and Processes in Manufacturing, Prentice Hall of India Pvt. Ltd.
3. Ghosh A. and Mallik A. K., Manufacturing Science, EWP Pvt. Ltd.
4. William D. Callister and David G. Rethwisch, Materials Science and Engineering: An Introduction, Wiley

Course Description

TITLE	CODE	CREDITS
Casting and Welding Lab	14M17ME173	1

Scope and Objective:

1. To study different testing methods for silica sand, moulding sand and design of pattern
2. To study SMAW, GMAW, GTAW, Oxy-acetylene welding and resistance spot welding processes

Learning Outcome:

Course Outcome	Description
CO1	Skills to use sand testing equipments used in the foundry viz. GFN test, Moisture content test, Clay content test, Permeability test, Tensile and Compression strength test.
CO2	Skills to use sand testing equipments used in the welding viz. dye penetrant test, ultrasonic test etc.
CO3	Skill to use welding processes viz. SMAW, GMAW, GTAW, Oxy-acetylene welding and Resistance spot welding.
CO4	Skill to prepare edge for making different joints.
CO5	Skill to set the flame in gas welding for welding and cutting operations

CONTENTS

S No	Name of Experiment
1	To design a wooden pattern for casting of cast iron
2	Making a wooden pattern designed in Experiment No. 1.
3	Preparing butt joint of two steel plates using manual Metal Arc Welding (MMAW)
4	Preparing lap joint of steel plates using Oxy Acetylene Gas welding.
5	To cut steel sheets of different thicknesses with the help of an oxy-acetylene gas cutting torch
6	To determine the hardness of Heat Affected Zone produced by welding and cut steels using oxy acetylene flame by Rockwell hardness tester.

TEXT BOOKS:

1. Jain P L, Principles Foundry Technology, Tata McGraw Hill
2. Parmar R.S., Welding Process and Technology, Khanna Publishers.

REFERENCES:

1. Rao P. N., Manufacturing Technology I, Tata McGraw Hill.
2. Jain R.K., Production Technology, Khanna Publisher.
3. Kalpakjian S., Schemid S., Manufacturing, Engineering and Technology, Addison Wesley.

Course Description

Title: Mechatronics **Code:** 14M11ME214

L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Basic of electrical and electronics engineering, fluid mechanics, kinematics, thermodynamics

Objective:

1. To develop an ability to identify, formulate, and solve engineering problems.
2. To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.
3. To develop ability to Integrate and use systems or devices incorporating modern microelectronics, information technologies and modern engineering tools for product design, development and manufacturing.

Learning Outcomes:

CO1	Outline of mechatronics system to understand the requirement in the society and industry
CO2	Describe various sensors, microcontrollers, signal processing, actuators
CO3	Develop the knowledge of mechatronics to improve the performance of manufacturing, maintenance, assembly units and society
CO4	Identify the type of sensors, microcontrollers, communication methods and actuators required for specific problem requirement
CO5	Apply the knowledge to develop and maintain various automated systems
CO6	Demonstrate the skill in the field of requirement

Learning outcomes:

1. Students will be able to model and analyze electrical and mechanical systems and their interconnection.
2. Students will be able to integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems.
3. Students will be able to demonstrate knowledge of electrical circuits and logic design.

COURSE CONTENT

Unit 1: Introduction To Mechatronics System: Key elements-Mechatronics Design Process-Types of Design-Traditional and Mechatronics Designs-Advanced Approaches in Mechatronics-Real Time Interfacing –Elements of Data Acquisition System.

Actuators, Sensors & Transducers: Fluid Power and Electrical Actuators-Piezoelectric Actuator; Sensors for position, motion, force and temperature-Flow sensors-Range sensors-Ultrasonic sensors-Fibre Optic Sensors-Magnetostrictive transducer-Selection of Sensors.

Unit 2: Signals, System & Controllers: Introduction to Signals, system and Controls-System representation-Linearisation-Time Delays-Measures of System performance; Closed loop Controllers-PID Controller, Digital Controllers-Controller tuning, adaptive Control-

Introduction to Microprocessors, Micro-controllers and Programmable Logic Controllers-Components-PLC programming.

Unit 3: Advanced Applications in Mechatronics: Sensors for Condition Monitoring-Mechatronics Control in Automated Manufacturing-Artificial Intelligence in Mechatronics-Fuzzy Logic Application in Mechatronics-Microsensors in Mechatronics-Case Studies of Mechatronics Systems

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit 1
Test-2	25 Marks	Based on Unit 2 and Unit 1 (20%)
Test-3	35 Marks	Based on Unit 3, Unit 2 (15%) and Unit 1 (15%)
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Lecture notes on Mechatronics (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:

1. K.P. Ramachandran., G.K. Vijayaraghvan and M.S. Balasundram, Mechatronics: Integrated mechanical electronics system, Willey India Edition.
2. David G. Alciatore and Michel BiHistand, Introduction to Mechatronics and Measurement Systems, Tata McGraw-Hill Publishing, Third edition.
3. G.S. Hegde, Mechatronics, Jones & Bartlett learning, 2010.

Reference Books:

1. W. Bolton, Mechatronics: Electronic control systems in mechanical and electrical engineering, Pearson publication, fourth edition.

Web References:

1. www.youtube.com/user/nptelhrd

Journals References:

1. Mechatronics: The Science of Intelligent Machines
2. International Journal of Mechatronics and Automation

Course Description

Title: Hydraulic and Pneumatic Control System Code: 14M14ME331

L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Basic of electrical engineering, fluid mechanics, kinematics, thermodynamics

Objectives:

1. To acquaint students about the various sources of hydraulic and pneumatic power
2. To know about the hydraulic and pneumatic control devices and components
3. To familiarize students about the pneumatic and fluid power circuits

Learning outcome:

CO1	Outline of hydraulic and pneumatic system to understand the requirement of automation
CO2	Describe various sensors, direction control valves, signal processing, actuators for the pneumatic and hydraulic systems
CO3	Develop the knowledge of automation to improve the performance of manufacturing, maintenance and assembly units
CO4	Identify the type of sensors, direction control valves and actuators required for specific problem of automation
CO5	Apply the knowledge to develop and maintain various automation systems
CO6	Demonstrate the skill in the field of requirement

COURSE CONTENT

Unit 1: Introduction to oil hydraulics and pneumatics, their advantages and limitations.ISO Symbols and standards in Oil Hydraulics and Pneumatics. Recent developments, applications Basic types and constructions of Hydraulic pumps and motors. Ideal pump and motor analysis. Practical pump and motor analysis, Performance curves and parameters

Unit 2: Hydraulic control elements – direction, pressure and flow control valves. Valve configurations, General valve analysis, valve lap, flow forces and lateral forces on spool valves. Series and parallel pressure compensation flow control valves. Flapper valve analysis and Design. Analysis of valve controlled and pump controlled motor. Electro-hydraulic servo valves – specification, selection and use of servo valves.

Electro hydraulic servomechanisms – Electro hydraulic position control servos and velocity control servos. Nonlinearities in control systems (backlash, hysteresis, dead band and friction nonlinearities). Basic configurations of hydraulic power supplies – Bypass Regulated and Stroke Regulated Hydraulic Power Supplies. Heat generation and dissipation in hydraulic systems. Design and analysis of typical hydraulic circuits. Use of Displacement – Time and Travel-Step diagrams; Synchronization circuits and accumulator sizing. Meter-in, Meter-out and Bleed-off circuits; Fail Safe and Counter balancing circuits.

Unit 3: Components of a pneumatic system; Direction, flow and pressure control valves in pneumatic systems. Development of single and multiple actuator circuits; Valves for logic functions; Time delay valve; Exhaust and supply air throttling; Examples of typical circuits using Displacement – Time and Travel-Step diagrams. Will-dependent control, Travel dependent control and Time-dependent control, Combined Control, Program Control,

Sequence Control, Electro-pneumatic control and air-hydraulic control. Applications in Assembly, Feeding, Metalworking, materials handling and plastics working.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit 1
Test-2	25 Marks	Based on Unit 2 and Unit 1 (20%)
Test-3	35 Marks	Based on Unit 3, Unit 2 (15%) and Unit 1 (15%)
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Lecture notes on Hydraulic and Pneumatic Control System (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOKS:

1. Introduction to hydraulics and pneumatics by S. Ilango and V. Sundararajan, PHI Learning, New Delhi, 2nd Edition, 2009
2. Hydraulics and Pneumatics by A. K Upadhyay, S. K. Kataria& Sons, New Delhi

REFERENCES:

1. Fluid Power Control: Hydraulics and Pneumatics by Ahmed Abu Hanieh, Cambridge International Science Publishing
2. Pneumatic and Hydraulic Systems by W. Bolton, Butterworth-Heinemann Ltd, 1997

Web References:

1. www.youtube.com/user/nptelhrd

Journals References:

1. Mechatronics: The Science of Intelligent Machines
2. International Journal of Mechatronics and Automation

Course Description

Title: Unconventional Manufacturing Processes Code: 14M11ME114

L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Students must have already studied courses, "*Conventional Manufacturing Processes and Machining science and Technology*".

Objective:

1. To understand the working principles/mechanisms involved in different unconventional manufacturing processes
2. To learn and know about the applications of hybrid manufacturing processes.
3. To encourage the students for doing their research work in the area of Unconventional Manufacturing Processes

Learning Outcomes:

Course Outcome	Description
CO1	Outline various unconventional manufacturing process based on energy sources and mechanism employed.
CO2	Describe the industrial or real world problems using hybrid manufacturing concepts.
CO3	Develop an idea to fabricate or modify the laboratory setups to find out the solution of industrial problems.
CO4	Identify the most influencing process parameters to manufacture a defect free product.
CO5	Apply most appropriate unconventional technique to manufacture a product economically.
CO6	Demonstrate and deployment the mechanism of unconventional manufacturing processes for solving real-world problems.

Course Content:

Unit-1: Introduction to unconventional manufacturing processes-limitations of conventional manufacturing processes, introduction to hybrid machining process.

Unit-2: Modern machining processes: classification, selection, mechanics, design, economics, accuracy and applications of modern mechanical energy based processes-abrasive jet machining (AJM), water jet machining (WJM), ultrasonic machining (USM).

Unit-3: Thermo-electric processes: Electro discharge machining (EDM), electron beam machining (EBM), laser beam machining (LBM), plasma arc machining (PAM), ion beam machining (IBM).

Unit-4: Chemical Energy based unconventional Machining Processes: chemical machining (CHM), photo chemical machining (PCHM), electrochemical machining (ECM), and electrochemical grinding (ECG).

Unit-5: Electro-discharge grinding (EDG), electro-chemical discharge grinding (ECDG), super finishing processes.

Unit-6: High Velocity Forming Process: Explosive forming processes, Propellant forming, Gas forming, Electro-hydraulic forming, Electromagnetic forming, Pneumatic/mechanical forming, Formability criteria.
Unit-7: Advanced welding processes: ultrasonic welding, laser beam welding, electron beam welding, and plasma arc welding processes.

Teaching Methodology:

This course is introduced to help students to understand the various unconventional manufacturing processes with their industrial applications. The entire course is broken down into six separate units: Introduction, Unconventional machining processes, Hybrid machining processes, unconventional finishing processes, unconventional welding processes, unconventional forming processes, and powder metallurgy. Students are motivated to do their research work in the domain of unconventional manufacturing processes.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 & Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 to Unit-7 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Referred video lectures and lecture notes on Unconventional Manufacturing Processes are available on JUET server.

Text Book:

[1] Ghosh and Mallik, Manufacturing Science, EWP Private Ltd.
[2] Jain V. K., Advance Machining Processes, Allied Publisher.
[3] Pandey P. C., Modern Machining Processes, TMH Publication.
[4] Benedict G.F., Non Traditional Manufacturing Processes, Marcel Dekker.

Reference Books/Material:

[1] El-Hofy, H., Advanced Machining Processes-Non-traditional and Hybrid Machining Processes, McGraw-Hill, NewYork.
[2] McGough J. A., Advanced Methods of Machining, Chapman and Hall Ltd., London.
[3] Kochan D., Solid Freeform Manufacturing, Elsevier Science.
[4] Groover M.P., Fundamentals of Modern Manufacturing Processes, Prentice Hall.
[5] Chryssolouris, G., Laser Machining - Theory and Practice (Mechanical Engineering Series), Springer - Verlag, NewYork.

Web References:

[1] www.nptel.com
[2] https://nptel.ac.in/courses/112/107/112107077/

Journals References:

[1] Journal of Manufacturing Processes: Elsevier
[2] Materials and Manufacturing Processes: Taylor & Francis
[3] Journal of Materials Processing Technology: Elsevier
[4] Advances in Manufacturing: Springer

Course Description

TITLE: Industrial Inspection and Quality Control CODE: 14M14ME131
L-T-P scheme: 3-0-0 **Credit: 3**

SCOPE AND OBJECTIVE:
Induatrial inspection and quality control is a collection of tools that when used together can result in process stability and variance reduction. Objective of course is

1. Satisfactory level of quality must be achieved with a minimum cost
2. Eliminating assignable (special) sources of variation product outcome, so that the process is stable.
3. Monitoring the ongoing production process, assisted by the use of control charts, to detect significant changes of mean or variation.

Learning Objectives:

CO1	Understand the role of statistical tools in quality improvement and inspection of industrial process & products
CO2	Able to interpret and implement Inspection Planning, Inspection & Quality Control, Quality Assurance and Evaluation
CO3	Understand the different types of variability, rational subgroups, and how a control chart is used to detect assignable causes
CO4	Construct and interpret control charts for variables and numbers
CO5	Able to find the process capabilities and interpreting different indexes of process capability
CO6	Able to demonstrate the applications and implementation of TQM, ISO 9000

COURSE CONTENT

Quality

Concept of Quality, Quality Function, Quality Traits, Quality Characteristics, Quality Management, Quality Principles, Quality Policy, Quality System, Quality Planning, Organizing for Quality, Quality of Design, Quality Circles.

Inspection

Definition of Inspection, Inspection Planning, Measurement Errors, Objectives of Inspection, Floor / Patrol Inspection, Centralized Inspection, Process Inspection, Final Inspection, Difference between Inspection & Quality Control. Quality Assurance Importance, Total Quality Assurance, Management Principles in Quality Assurance, Forms of Quality Assurance, Evaluation of Quality Assurance, Quality Assurance Programme, Quality Assurance Aspects, Quality Assurance Departments.

Quality Control

Total Quality Control, Objectives of Quality Control, Principles of Quality Control, Quality Control Tools, Statistical Quality Control, Control Charts, Construction of Control Charts for Variables (R, X - bar Chart) and Attributes (p, np, C, U Charts), Acceptance Sampling by Attributes, AOQ & OC Curves, Types of Sampling Plans, Analysis of Process Capability, Use of Dodge Roming and Military Standards Sampling Tables.

Quality Management System

Quality Management systems- origin of ISO 9000 series (ISO 9001,9002,9003,9004) ISO 9001:2000, clauses of ISO 9001:2000, overview of QS 9000 series.

Text Book

1. D.C. Montgomery, Introduction to Statically quality control, John Wiley & Sons, Inc.
2. A.M. Badhade, Metrology and Quality control

Reference Books

1. Suganthi, L and Samuel, A Anand , TOTAL QUALITY MANAGEMENT , Phi Learning Pvt. Ltd.
2. R. P. Mohanty, TOTAL QUALITY MANAGEMENT, Jaico

Course Description

Title: Welding Metallurgy Code: 17M14ME131

L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Students must have already studied courses, “Material science”, “Welding Engineering”.

Objective:

1. To learn and be able to analyze and design welded structural members subjected to different loading and environmental condition.
2. To learn and be able to perform engineering work in accordance with ethical and economic constraints related to the design of welded structures and apply mathematical approaches to the analysis of numerical information.

Learning Outcomes:

COURSE OUTCOME	**DESCRIPTION**
CO1	UNDERSTAND AND SELECT THE FILLER MATERIALS FOR A GIVEN BASE MATERIAL AND WELDING PROCESS
CO2	DETERMINE WELDING MATERIALS, PROCESSES AND INSPECTION TECHNIQUES BASED ON APPLICATION, FABRICATION AND SERVICE CONDITIONS
CO3	APPLY KNOWLEDGE OF WELD METAL CHEMISTRY FROM THE FILLER METAL AND BASE PLATE COMPOSITIONS
CO4	UNDERTAKE PROBLEM IDENTIFICATION AND PREDICT THE HOT CRACKING AND COLD CRACKING SUSCEPTIBILITY.
CO5	EVALUATE EFFECTS OF WELDING HEAT ON THE TRANSFORMATIONS IN THE WELD METAL AND HAZ OF WELDS.
CO6	ANALYZE AND DESIGN WELDED STRUCTURES AND COMPONENTS TO MEET APPLICATION REQUIREMENTS.

Course Content:

Unit-1: Introduction to welding and joining processes: Introduction to consolidation processes, Classification of welding processes, some common concerns, types of fusion welds and types of joints, physics of welding arc, Arc maintenance and arc characteristics, arc efficiency, welding power source.Heat flow - temperature distribution-cooling rates - influence of heat input, joint geometry, plate thickness, preheat, significance of thermal severity number

Unit-2: Fundamentals of physical metallurgy: Need, phase diagrams: Fe-C, Al-Cu, Cu-Zn system, phase transformations in Fe-C system, TTT diagram, CCT diagram, carbon equivalent, Schaffer diagram, relevance of above in welding..

Unit-3: Solidification of weld metal: Principle of solidification of weld metal, modes of solidification, effect of welding parameters on weld structure, grain refinement principle of weld metal, method of weld metal refinement, inoculation, arc pulsation, external excitation.

Unit-4: Heat affected zone and weld metal: Transformations in HAZ of steel, factors affecting changes in microstructure and mechanical properties of HAZ, reactions in weld pool- gas metal reaction, slag metal reaction.

Unit-5: Metallurgical issue in weld joint: Mechanisms, causes and remedy of cold cracking, solidification cracking, nonmetallic inclusions, lamellar tearing, hydrogen damage, banding, segregation.

Teaching methodology:

This course covers the metallurgical aspects of the welding of common engineering metals such as plain carbon, alloy and stainless steels, aluminum and cast iron. The selection of filler metals, transfer and recovery of alloying elements and design of preheating and post heating cycles is also emphasized.

Evaluation Scheme:

EXAMS	**MARKS**	**COVERAGE**
TEST-1	15 MARKS	BASED ON UNIT-1
TEST-2	25 MARKS	BASED ON UNIT-2, UNIT-3 AND AROUND 30% FROM COVERAGE OF TEST-1
TEST-3	35 MARKS	BASED ON UNIT-4 TO UNIT-5 AND AROUND 30% FROM COVERAGE OF TEST-2
ASSIGNMENT	10 MARKS	
TUTORIALS	5 MARKS	
QUIZ	5 MARKS	
ATTENDANCE	5 MARKS	
TOTAL	**100 MARKS**	

Learning Resources:

Tutorials and referred video lecture on Welding metallurgyis available on JUET server.

Text Book:

1. Sindokou, “Welding metallurgy”, John Wiley & Sons, INC., Publication
2. Parmer R. S., ‘Welding Engineering and Technology’, Khanna Publishers, 1997

Reference Books:

1. “Welding Handbook”, Volumes 1, 2 and 3, 9th edition, American Welding Society.
2. Lancaster J F, “Metallurgy of welding”, Allen and Unwin Co.
3. Larry J and Jeffus L, “Welding Principles and Applications”, 5th edition, Delmer Publications

Course Description

Title: Tool and Die Design Code: 14M14ME133

L-T-P scheme:3-0-0 **Credit: 3**

Prerequisite: Students must have already studied course, "*Manufacturing Technology*".

Objective:

1. To know different reference systems used in single point tools, drill bits and milling cutters.
2. To know the forces in different tools while material removal or plastic deformation on the job.
3. To select proper material for the design of the tool and dies and to design of those as per the requirements.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the tool used in machining and dies in metal formingprocesses.
CO2	Describe the concepts of geometry of cutting tool: ASA, ORS,NRS and WRS systems for a single point cutting tool and multipoint tools i.e. milling cutters. SRS,DRS and WRS for a twist drill and conversion equations from one system to the other.
CO3	Develop mechanics of machining: different forces in turning, milling and drilling, MCD for conversion of forces from one reference to the other and equipment used to measure forces in turning, milling, drilling and grindingprocesses
CO4	Identify heat generation in machining: source, cause and effect of heat generation in machining.
CO5	Explain tool failure methods tool life and tool materials; types of chips and control of chip while machining usingdifferent possible chip breakers in the tools.
CO6	Describe the different dies required in metal forming, a brief knowledge on metal forming will beestablished. According to requirement in the process the design considerations are to be taken anddifferent dies are designed with proper selection of the die material.

Course Content:

Unit-1: Broad Classification of Tools-Cutting tools, Dies, Holding and measuring tools.

Unit-2: Design of Cutting Tools: Single Point and multi-pint cutting tools. Single Point Cutting Tools:Classification, Nomenclature, geometry, design of single point tools for lathes, shapers, planers etc.Chip breakers and their design.

Unit-3: Multipoint Cutting Tools: Classification and specification,nomenclature, Design of drills, milling cutters, broaches, taps etc. Design of Form Tools: Flat andcircular form tools, their design and application.

Unit-4:Design of Dies: Classification of dies, Design of Dies for Bulk metal Deformation-Wire Drawing,Extrusion, Forging and Rolling.

Unit-5: Design of Dies for Sheet metal: Blanking and Piercing, Bending andDeep-drawing; Design of Dies used for Casting and Moulding, Powder Metallurgy die design.

Teaching Methodology:

This course is introduced to help students To know different reference systems used in single point tools, drill bits and milling cutters. It helps to understand the forces in different tools while material removal or plastic deformation on the job.Course will equip students to select proper material for the design of the tool and dies and to design of those as per therequirements.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1& Unit-2
Test-2	25 Marks	Based on Unit-3& Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 and around 30% from coverage of Test-1 & Test-2.
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Course-related resources will be provided on JUET server. This can include eBook, lecture material, supplementary course notes.

Text Book:

1. Donaldson, Tool Design,Mcgraw Hill Education
2. Chattopadhyay A B, Machining and Machine Tools, Wiley India
3. Pandey P. C. and Singh C. K., Production Engineering Sciences, Standard Publisher

Reference Books/Material:

1. HMT, Production Technology, Tata McGraw Hill.
2. Serope Kalpakjian, Steven R Schmid, Manufacturing Engineering and Technology, Pearson
Education
3. Roy A. Lindberg, Materials and manufacturing technology, Allyn and Bacon**Web References:**

https://www.esict.com/tool-die-making/

Journals References:

International Journal of Machine Tool Design and Research

Course Description

Title: Operations and Supply Chain Management Course Code: 14M14ME334
L-T Scheme: 3-0 **Course Credits: 3**

Scope and Objectives:
Operation and Supply Chain Management applied successfully in many different areas of engineering, production and business activities for better & scientific decision making.
Role of Operations and Supply Chain Management

1. Better control on operations and supply chain system
2. Better coordination among the organizations departments
3. Better decisions and quantitative decision.

Learning Outcome:

COURSE OUTCOME	DESCRIPTION
CO1	OUTLINE SCOPE, IMPORTANCE AND EVOLUTION OF OPERATIONS AND SUPPLY CHAIN MANAGEMENT. DESCRIBE VARIOUS MRHODS OF FORECASTING AND THEIR APPLICATIONS.
CO2	DESCRIBE VARIOUS CONCEPTS RELATED TO FACILITIES, INVENTORY, FACILITY LAYOUT, CAPACITY PLANNING ETC. IN DETAIL
CO3	DEVELOP UNDERSTANDING ON SEQUENCING AND SCHEDULING AND THEIR APPLICATIONS IN INDUSTRIES.
CO4	IDENTIFY SCOPE OF SUPPLY CHAIN AND STUDY ABOUT VARIOUS CONCEPTS OF SUPPLY CHAIN MANAGEMENT.
CO5	APPLY THE VARIOUS CONCEPTS OF OPERATIONS AND SUPPLY CHAIN MANAGEMENT IN PRACTICES AND CONCEPTS UTILIZING CASE PROBLEMS AND PROBLEM-BASED LEARNING SITUATIONS.
CO6	DEMONSTRATE THE USE OF AND USE OF IT, EFFECTIVE WRITTEN AND ORAL COMMUNICATIONS, CRITICAL THINKING, TEAM BUILDING AND PRESENTATION SKILLS AS APPLIED TO BUSINESS PROBLEMS.

CONTENTS
FORECASTING: Introduction, different methods of forecasting, errors in forecasting
FACILITY LAYOUT AND LOCATION: Introduction, different models of layout, decision making
CAPACITY AND AGGREGATE PLANNING:Capacity measurement, long-term and short term strategies, aggregate planning
INVENTORY MANAGEMENT: Various costs in inventory management and need, deterministic models and discounts, probabilistic inventory management
SCHEDULING MODELS AND APPLICATIONS: Scheduling in MRP system, sequencing rules and applications, batch production sequencing and scheduling .
INTRODUCTION TO SUPPLY CHAIN: Definition, complexity, key issues, centralized vs. decentralized systems, bullwhip effect, push-based, pull based systems
OUTSOURCING AND TRANSPORTATION: Make or buy decisions, drivers of the decisions, network design decisions, cross-docking, and transshipment.
DISTRIBUTION AND LOGISTICS IN SUPPLY CHAINS: Direct shipment/intermediate storage policies, vehicle routing models, third-party logistics.
INFORMATION TECHNOLOGY IN SUPPLY CHAIN: Enabling supply chain through IT, ERP vendor platforms, Service oriented architecture (SOA), RFID

Text Book
1. Supply Chain Management by *Chopra and Meindl*
2. Operations research by Sharma J.K., Trinity press

References:
1. Operations Management by *Evans and Collier*
2. Operations Management by *Heizer and Render*

Course Description

Title of Course: Seminar-I Course Code: 14M19ME391

L-T-P Scheme: 0-0-4 **Credit: 2**

Prerequisite: Students must have already studied the all basic courses, "*Manufacturing Technology Theory and Lab"* and "*Unconventional Manufacturing Processes*".

Objective:

Students will be able to understand the identification of different areas and new technologies related to manufacturing of real life components

Learning Outcomes:

Course Outcome	Description
CO1	Outline the seminar topics with respect to their needs for the society.
CO2	Description of usefulness of the work in the context of present application
CO3	Development of the literature survey in chronological order
CO4	Identification of the problem in current areas of mechanical engineering
CO5	Application and usefulness to the society.
CO6	Demonstration and deployment of basic manufacturing steps of the methods.

Course Content:

Unit 1: Motivation about Seminar Topic

Unit 2: Usefulness of the work in the context of present application

Unit 3: Literature survey in chronological order.

Unit 4: Problem identification

Unit 5: Study / Analysis of different existing methods based on adequate performance parameters.

Unit 6: Mathematical formulation of the method.

Teaching Methodology:

This course is introduced to help students the basic fundamental areas of manufacturing engineering. It also introduces knowledge of new technologies to grow in this field.

Evaluation Scheme:

Exams	Marks	Coverage

Presentation-1		20 Marks	**Unit 1-Unit 3**
Presentation-2		30 Marks	**Unit 4-Unit 6**
Day to Day Work	Attendance and Discipline	15 Marks	**50 Marks**
	Sincerity and Regularity	20 Marks	
	Report	15 Marks	
Total		**100 Marks**	

Learning Resources:
After discussion with the concerned faculty members, Student will develop some new areas in the field of Manufacturing technology (Mechanical Engineering) and related information.

Text Books & Reference Books/Material: Related to Area of Seminar

Web References:
[1] https://www.sciencedirect.com
[2] https://www.springer.com

Journals References:
[1] Journal of Materials Processing Technology
[2] Materials and Manufacturing Processes
[3] Composite
[4] International Journal of Machine Tools and Manufacturer

Course Description

Title of Course: Dissertation Part-I Course Code: 14M19ME392

L-T-P Scheme: 0-0-24 **Credit: 12**

Prerequisite: Students must have already studied the courses like, "*Advanced Manufacturing Processes*", "*Materials Science and Composites*" etc.

Objective:

To study of literature survey, formulate the research problem and develop necessary methodology related to research problem. The first part of the Dissertation should be to determine the interest of students and broadly identify the area of work, finalize the research problem based on literature survey. The students should have familiarity with the concepts, tools, techniques required to carry out the Dissertation work. Student is expected to start the research work

Learning Outcomes:

Course Outcome	Description
CO1	Outline the dissertation topics with respect to their needs for the society.
CO2	Description of usefulness of the work in the context of present application
CO3	Development of the literature survey in chronological order
CO4	Identification of the problem in current areas of manufacturing technology
CO5	Application and usefulness to the society.
CO6	Demonstration and deployment of manufacturing techniques requires to complete the work

Course Content:

Unit 1: Motivation about dissertation Topic

Unit 2: Usefulness of the work in the context of present application

Unit 3: Literature survey in chronological order.

Unit 4: Problem formulation.

Unit 5: Study / Analysis of different existing methods based on adequate performance parameters.

Unit 6: Mathematical formulation of the proposed method.

Teaching Methodology/Guidelines:

Each student will decide his Dissertation topic in consultation with his/her supervisor on which he/she will work towards the fulfillment of Master's Dissertation. In the first mid-term seminar, the researcher will present a literature review and define the problem. In the final

viva-voce, the researcher is expected to give the problem formulation in detail. By the end of the first semester of the dissertation, the experimental techniques, analysis and/or synthesis procedure should come out clearly. Progress of the work should also be presented. The viva-voce will be based on your work, thesis report and presentation. Finally a report will be submitted towards the end of the semester.

Evaluation Scheme:

Exams		Marks	Coverage
Presentation-1		15 Marks	**Unit 1-Unit 2**
Presentation-2		15 Marks	**Unit 3-Unit 4**
Presentation-3		20 Marks	**Unit 5-Unit 6**
Day to day work	Attendance	10 Marks	**50 Marks**
	Sincerity	10 Marks	
	Report	15 Marks	
	Performance	15 Marks	
Total		**100 Marks**	

Learning Resources:
After discussion with the concerned faculty members, Student will develop some new areas in the field of Manufacturing technology (Mechanical Engineering) and related information.

Text Books & Reference Books/Material: Related to Area of Research work

Web References:
[1] https://www.sciencedirect.com
[2] https://www.springer.com
[3]] https://www.taylorandfrancis.com

Journals References:
[1] Journal of Materials Processing Technology
[2] Materials and Manufacturing Processes
[3] Composite Journals
[4] International Journal of Machine Tools and Manufacturer
[5] Optics and Laser Technology

Course Description

TITLE	CODE	CREDITS
COMPUTER INTEGRATED MANUFACTURING	14M11ME211	3

Objectives:

- This course introduces students with computer assisted modern manufacturing technologies.
- The topics covered in this course include basics of automation, NC programming (manual and APT), concepts of group technology, Flexible Manufacturing system, CIM and robotics.
- The objective of this course is to make students learn the important theoretical concepts, and the state-of-the-art technological developments in the area of modern manufacturing.

Learning Outcome:

COURSE OUTCOME	DESCRIPTION
CO1	OUTLINE BASIC CONCEPTS RELATED TO CIM LIKE TYPES OF PRODUCTION, PLANT LAYOUT, SEQUENCING AND SCHEDULING, GROUP TECHNOLOGY, TYPES OF AUTOMATION AND FMS.
CO2	DESCRIBE NC, CNC AND DNC, COMPUTER AIDED PROCESS PLANNING (CAPP) AND AUTOMATED INSPECTION.
CO3	DEVELOP ABILITY TO CLASSIFY PARTS INTO FAMILIES VIA GT CONCEPTS, CLASSIFICATION AND CODING SCHEMES, PFA ETC.
CO4	IDENTIFY THE SEQUENCE OF OPERATION, GENERATE PROCESS PLAN AND SIMULATE AND WRITE PART PROGRAMS FOR CNC MILLING AND LATHE; FMS INTRODUCTION, COMPONENT AND LAYOUTS.
CO5	APPLY ACQUIRED KNOWLEDGE TO PERFORM MACHINING, INSPECTION AND ASSEMBLY OPERATIONS ON FLEXIBLE MANUFACTURING SYSTEM AVAILABLE IN CIM LAB OF THE DEPARTMENT.
CO6	DEMONSTRATE ABILITY TO WORK IN A FLEXIBLE MANUFACTURING SYSTEM IN AN ORGANIZATION.

COURSE CONTENT

Introduction: Automation, Need for Automation, Types of automation systems, Automation strategies, levels of automation, Introduction to NC, CNC and DNC and Computer integrated manufacturing, CIM wheel, components of CIM

Part programming: Introduction, NC coordinate system, fixed and floating zero machines, NC motion control systems, part programming methods, Manual part programming for milling and lathe using G and M codes, various canned cycles

Group Technology: part families, part classification and coding, production flow analysis, composite part concept, benefits of GT.

Flexible Manufacturing System: Definition of FMS, components of FMS, types of flexibilities, classification of FMS, primary and secondary material handling systems, FMS layout configurations, computer control system, FMS applications and benefits.

Automated Material Handling and AS/RS: Introduction, types of material handling equipment, automated guided vehicle system (AGVs), applications, vehicle guidance and routing, traffic control and safety system management, Basic components of AS/RS, types of AS/RS, AS/RS controls, special features.

Robotics: Definition, robot anatomy and related attributes, robot configuration, work volume, types of control systems, end effectors, industrial applications of robot, introduction to robot programming.

Automated Inspection & Testing: Automated inspection principles, off-line and on-line inspection, contact and noncontact inspection techniques, Co-ordinate measuring machine (CMM): Introduction and types of CMM.

Manufacturing Support System: Product design and CAD, concurrent engineering and Computer aided process planning (CAPP).

TEXT BOOK:

1. Groover M. P., Automation, Production Systems And Computer-integrated Manufacturing, PHI.
2. Miller R. K., FMS/CIM Systems Integrated Handbook, Prentice Hall

REFERENCES:

1. Parrish D. J, “Flexible manufacturing”, Butterworth – Heinemann Ltd, 1990
2. Rao, P.N., CAD / CAM Principles and Applications, McGraw Hill Publishers, New Delhi
3. Jha, N. K., Handbook of Flexible Manufacturing Systems, Academic Press Inc.

Course Description

Title: Mechanics of Metal Forming Code: 14M11ME212

L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Students must have already studied courses, "Material science", and "Manufacturing process".

Objective:

1. To learn the importance metal forming processing routes fordifferent materials and its importance for advanced materials manufacturing
2. To learn and be able to perform engineering work in accordance with ethical and economic constraints related to metal forming processes.

Learning Outcomes:

Course Outcome	Description
CO1	Understands the stress and strain at an inclined plane from the given three dimensional stresses
CO2	Determine the forming load estimation during different metal forming processes
CO3	Apply knowledge of types of modelling technique
CO4	Undertake problem identification and identify different forms of metal forming techniques
CO5	Evaluate the properties of different forming operation
CO6	Analyze design and processing in metal forming like strain, strain rate and thermal effects in metal forming

Course Content:

Unit-1: Elasticity - Analysis of Stress and Strain, General Equations of Elasticity,
Unit-2: Plasticity - Plastic deformations, Theories ofPlasticity.
Unit-3: Modeling Techniques: slip line slab, Upper Bound and FEM.
Unit-4: Mechanics of Manufacturing Processes: Rolling, Forging, Wire Drawing, Extrusion, Deep Drawing, Bending and other miscellaneous forming operations.
Unit-5: Analysis of Manufacturing Processes: Rolling, Forging, Wire Drawing, Extrusion, Deep Drawing, Bending and other miscellaneous forming operations.
Unit-6: Analysis of Die failure: in Metal Forming, Strain, Strain rates and thermal effects in metal forming.

Teaching methodology:

This course covers the design aspects of the different metal forming operation such as rolling, drawing, extrusion, and many more. The load calculations in actual and ideal condition are also emphasized for each and every metal forming processes.

Evaluation Scheme:

EXAMS	MARKS	COVERAGE
TEST-1	15 MARKS	BASED ON UNIT-1
TEST-2	25 MARKS	BASED ON UNIT-2, UNIT-3 AND AROUND 30% FROM COVERAGE OF TEST-1
TEST-3	35 MARKS	BASED ON UNIT-4 TO UNIT-5 AND AROUND 30% FROM COVERAGE OF

		TEST-2
ASSIGNMENT	10 MARKS	
TUTORIALS	5 MARKS	
QUIZ	5 MARKS	
ATTENDANCE	5 MARKS	
TOTAL	**100 MARKS**	

Learning Resources:

Tutorials and referred video lecture on Advanced Materials Technologyis available on JUET server.

Text Book:

1. Dieter George E.,Mechanical Metallurgy, McGraw-Hill, 1988.
2. Timoshenko S.P., Strength of Materials. Advanced Theory and Problems, CBS Publishers andDistributors, New Delhi.

Reference Books:

1. Hearn E. J., Mechanics of Material Vol. I & II, Butterworth-Heinemann Publication.
2. Gere J. M., Mechanics of Materials, Thomson Press.
3. Pytel A. and kiusalaas J., Mechanics of Materials, Thomson Press.

Course Description

Title: Metal Forming Lab Code: 14M17ME272

L-T-P scheme: 0-0-2 **Credit: 1**

Prerequisite: Students must have already studied courses, “Material science”, and “Manufacturing process”.

Objective:

3. To learn the importance metal forming processing routes fordifferent materials and its importance for advanced materials manufacturing
4. To learn and be able to perform engineering work in accordance with ethical and economic constraints related to metal forming processes.

Learning Outcomes:

COURSE OUTCOME	**DESCRIPTION**
CO1	Understands the stress and strain at an inclined plane from the given three dimensional stresses
CO2	Determine the forming load estimation during different metal forming processes
CO3	Apply knowledge of types of modelling technique
CO4	Undertake problem identificationand identifydifferent forms of metal forming techniques
CO5	Evaluate the properties of different forming operation
CO6	Analyze design and processing in metal forming like strain, strain rate and thermal effects in metal forming

Course Content:

Experiment-1: To study the UTM and perform the tensile test on given specimen

Experiment-2: To perform compression test on UTM

Experiment-3: To study the effects of material properties (ductility, types and strength) on the spring back and bending force

Experiment-4: To compare the formability of sheet metals using Erichsen Cupping Test

Teaching Methodology:

This Lab course has been introduced to help a student to learn with hand-on experience on Metal forming processes. This lab course is well complemented by a theory course under the name Mechanics of Metal Forming in the same semester in order to enable the student to get acquainted, learn and discuss the technical details involved in the design and selection of metal forming operations. This Lab course will enable a student to learn with hand-on experience.

Evaluation Scheme:

Exams		**Marks**
P-1		15 Marks
P-2		15 Marks
Day-to-Day Work	Viva	20 Marks
	Demonstration	20 Marks
	Lab Record	15 Marks
	Attendance & Discipline	15 Marks
Total		**100 Marks**

Learning Resources:

Laboratory Manual available in Lab. Study material of Metal Forming Lab (will be added time to time): Digital copy will be available on the JUET server.

Text Book:

1. Dieter George E.,Mechanical Metallurgy, McGraw-Hill, 1988.
2. Timoshenko S.P., Strength of Materials. Advanced Theory and Problems, CBS Publishers andDistributors, New Delhi.

Reference Books/Material:

1. Hearn E. J., Mechanics of Material Vol. I & II, Butterworth-Heinemann Publication.
2. Gere J. M., Mechanics of Materials, Thomson Press.
3. Pytel A. and kiusalaas J., Mechanics of Materials, Thomson Press.

Course Description

Title: Mechatronics **Code:** 14M11ME214

L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Basic of electrical and electronics engineering, fluid mechanics, kinematics, thermodynamics

Objective:

1. To develop an ability to identify, formulate, and solve engineering problems.
2. To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.
3. To develop ability to Integrate and use systems or devices incorporating modern microelectronics, information technologies and modern engineering tools for product design, development and manufacturing.

Learning Outcomes:

CO1	Outline of Mechatronics system to understand the requirement in the society and industry
CO2	Describe various sensors, microcontrollers, signal processing, actuators
CO3	Develop the knowledge of mechatronics to improve the performance of manufacturing, maintenance, assembly units and society
CO4	Identify the type of sensors, microcontrollers, communication methods and actuators required for specific problem requirement
CO5	Apply the knowledge to develop and maintain various automated systems
CO6	Demonstrate the skill in the field of requirement

Learning outcomes:

1. Students will be able to model and analyze electrical and mechanical systems and their interconnection.
2. Students will be able to integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems.
3. Students will be able to demonstrate knowledge of electrical circuits and logic design.

COURSE CONTENT

Unit 1:

Introduction To Mechatronics System: Key elements-Mechatronics Design Process-Types of Design-Traditional and Mechatronics Designs-Advanced Approaches in Mechatronics-Real Time Interfacing –Elements of Data Acquisition System. **(10)**

Actuators, Sensors & Transducers: Fluid Power and Electrical Actuators-Piezoelectric Actuator; Sensors for position, motion, force and temperature-Flow sensors-Range sensors-Ultrasonic sensors-Fibre Optic Sensors-Magnetostrictive transducer-Selection of Sensors.(**10)**

Unit 2:

Signals, System & Controllers: Introduction to Signals, system and Controls-System representation-Linearisation-Time Delays-Measures of System performance; Closed loop Controllers-PID Controller, Digital Controllers-Controller tuning, adaptive Control-Introduction to Microprocessors, Micro-controllers and Programmable Logic Controllers-Components-PLC programming. **(10)**

Unit 3:

Advanced Applications in Mechatronics: Sensors for Condition Monitoring-Mechatronics Control in Automated Manufacturing-Artificial Intelligence in Mechatronics-Fuzzy Logic Application in Mechatronics-Microsensors in Mechatronics-Case Studies of Mechatronics Systems **(10)**

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit 1
Test-2	25 Marks	Based on Unit 2 and Unit 1 (20%)
Test-3	35 Marks	Based on Unit 3, Unit 2 (15%) and Unit 1 (15%)
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Lecture notes on Mechatronics (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:

1. K.P. Ramachandran., G.K. Vijayaraghvan and M.S. Balasundram, Mechatronics: Integrated mechanical electronics system, Willey India Edition.
2. David G. Alciatore and Michel BiHistand, Introduction to Mechatronics and Measurement Systems, Tata McGraw-Hill Publishing, Third edition.
3. G.S. Hegde, Mechatronics, Jones & Bartlett learning, 2010.

Reference Books:

1. W. Bolton, Mechatronics: Electronic control systems in mechanical and electrical engineering, Pearson publication, fourth edition.

Web References:

1. www.youtube.com/user/nptelhrd

Journals References:

1. Mechatronics: The Science of Intelligent Machines
2. International Journal of Mechatronics and Automation

Course Description

TITLE: CIM Lab **CODE :** 14M17ME271
L-T-P : 0-0-2 **Credit:** 1

SCOPE AND OBJECTIVES

- This course is designed to provide practical experience to the students with an opportunity of hands-on training on modern CNC machines and CIM system.
- The topics covered in this course include the basics of automation, NC programming (Manual and APT), concepts of group technology, Flexible Manufacturing system, CIM and robotics etc.
- The objective of this course is to expose the students to practical aspects of automation and the state-of-the-art technological developments in the area of modern manufacturing.

LEARNING OUTCOME:

COURSE OUTCOME	DESCRIPTION
CO1	OUTLINE BASIC CONCEPTS RELATED TO CIM LIKE TYPES OF PRODUCTION, PLANT LAYOUT, SEQUENCING AND SCHEDULING, GROUP TECHNOLOGY, TYPES OF AUTOMATION AND FMS.
CO2	DESCRIBE NC, CNC AND DNC, TYPES AND COMPONENTS OF FMS, PART CLASSIFICATION AND CODING SCHEMES, COMPUTER AIDED PROCESS PLANNING (CAPP) AND AUTOMATED INSPECTION.
CO3	DEVELOP ABILITY TO WRITE CNC PART PROGRAMS, FORMATION OF PART FAMILIES, PICK AND PLACE PROGRAMS FOR ROBOT AND AUTOMATED INSPECTION THROUGH CMM.
CO4	IDENTIFY THE SEQUENCE OF OPERATION, GENERATE PROCESS PLAN AND SIMULATE THE FMS OPERATION IN OFF-LINE MODE.
CO5	APPLY ACQUIRED KNOWLEDGE TO PERFORM MACHINING, INSPECTION AND ASSEMBLY OPERATIONS ON FLEXIBLE MANUFACTURING SYSTEM AVAILABLE IN CIM LAB OF THE DEPARTMENT.
CO6	DEMONSTRATE ABILITY TO WORK IN A FLEXIBLE MANUFACTURING SYSTEM IN AN ORGANIZATION.

COURSE CONTENT

XL Turn Machine

1. Write a manual part program for Linear and Circular Contour (G01, G02, and G03) operation for the component.
2. Write a manual part program for Box Facing (G94) operation for the component.
3. Write a manual part program for Multiple Facing (G72) operation for the component.

4. Write a manual part program for Multiple Turning operation with G71 Cycle for the component.
5. Write a manual part program for Peck Drilling operation with G74 Cycle for the component.
6. Write a manual part program for Turning and Parting OFF operation through subroutines for the component.

XL Mill Machine

7. Write a manual part program for Contouring (G01, G02, and G03) operation (Linear & Circular Interpolation) for the component.
8. Write a manual part program for Contouring (G40, G41) operation with Left cutter diameter compensation for the component.
9. Write a manual part program for Contouring (M98, M99) operation through subprogram for the component.
10. Write a manual part program for Mirroring (M70, M71, M80, and M81) operation for the component.
11. Write a manual part program for Drilling (G73, G83, G98, and G99) operation for the component.
12. Write a manual part program for Pocketing (G170, G171) operation for the component.

5-axis and 6-axis Robot

13. Write a program for pick and place operation for 5-axis robot
14. Write a program for continuous welding operation for 6-axis robot

Coordinate Measuring machine (CMM)

15. Write a program for automatic measurement of various dimensions such as OD, ID, thickness etc. of a part.

Complete CIM System

16. Demonstration and study of CIM system Off-line manual mode.
17. Demonstration and study of CIM system on-line automatic mode

Teaching Methodology:

This course is introduced to help students learn and understand the fundamentals and hands on knowledge of computer integrated manufacturing. Students will make and simulate part programs for CNC Lathe and Milling machines and perform machining on these machines. They will also do Robot programming. Finally, they will be performing automatic operations on FMS and CIM systems. This lab course is well complemented by a theory course under the name Computer Integrated Manufacturing (CIM) that helps students learn with hand-on experience.

Evaluation Scheme:

<table>
<tr><th>EXAMS</th><th>MARKS</th><th>COVERAGE</th></tr>
<tr><td>P-1</td><td>15 MARKS</td><td>BASED ON LAB EXERCISES: 1-7</td></tr>
<tr><td>P-2</td><td>15 MARKS</td><td>BASED ON LAB EXERCISES: 8-14</td></tr>
<tr><td rowspan="4">DAY-TO-DAY WORK</td><td>VIVA</td><td rowspan="4">70 MARKS</td></tr>
<tr><td>DEMONSTRATION</td></tr>
<tr><td>LAB RECORD</td></tr>
<tr><td>ATTENDANCE & DISCIPLINE</td></tr>
<tr><td>TOTAL</td><td colspan="2">100 MARKS</td></tr>
</table>

TEXT BOOK:

1. Groover M. P., Automation, Production Systems And Computer-integrated Manufacturing, PHI.
3. CNC XLTURN Manual by MTAB, Chennai
4. CNC XLMILL Manual by MTAB, Chennai
5. Miller R. K., FMS/CIM Systems Integrated Handbook, Prentice Hall

REFERENCES:

6. Parrish D. J, “Flexible manufacturing”, Butterworth – Heinemann Ltd, 1990
7. Rao, P.N., CAD / CAM Principles and Applications, McGraw Hill Publishers, New Delhi
8. Jha, N. K., Handbook of Flexible Manufacturing Systems, Academic Press Inc.

Course Description

TITLE	CODE	CREDITS
ADDITIVE MANUFACTURING PROCESS	14M11ME213	3

SCOPE AND OBJECTIVES

LEARNING OUTCOME

1. The student will be able to select between a subtractive and an AM process for a particular application. He or she will be able to select a particular AM process.
2. The student will be able to take a career in research or in advanced manufacturing, the AM being a rapidly evolving area and with wide applications.
3. It is aimed at making the students ready for product development of engineering components and for entrepreneurship. He will be able to employ RE for value addition and reproduction of parts.

Objectives:

1. The objective of this first course on additive manufacturing (AM) to the PG students of Manufacturing Technology stream is to make the students aware of rapidly evolving and widely used technology.
2. It is aimed to make the students aware of the technology for conceptual modeling, prototyping and rapid manufacturing. It is also aimed to introduce reverse engineering (RE).
3. It is aimed to impart detailed knowledge of wide applications of AM in industry and society; and in particular, key applications of AM such as rapid tooling, medical AM and rapid manufacturing.

Learning Outcome:

COURSE OUTCOME	DESCRIPTION
CO1	OUTLINE THE ADDITIVE MANUFACTURING PROCESS. INTRODUCTION, DEFINITION, PROCESS CHAIN
CO2	DESCRIBE CLASSIFICATION AND DETAIL DESCRIPTIONS OF VARIOUS RAPID PROTOTYPING, MATRIALS, COMPARISON WITH SUBTRACTIVE MFG. PROCESSES
CO3	DEVELOP UNDERSTANDING OF VARIOUS PROCESSES IN DIFFERENT CIRCUMSTANCES, VARIOUS FILE FORMATS FOR ADDITIVE MANUFACTURING
CO4	IDENTIFY DIFFERENCES AMONG RAPID PROTOTYPING, MANUFACTURING AND RAPID TOOLING. STL FILE CONVERSION, ERRORS AND REPAIR.
CO5	APPLY ACQUIRED KNOWLEDGE IN NEW PRODUCT DEVELOPMENT AND MASS CUSTOMIZATION OF PRODUCTS IN VARIOUS INDUSTRIES SUCH AS AUTOMOBILE, AEROSPACE, MEDICAL, CONSTRUCTION, FASHION, ELECTRONICS ETC.
CO6	DEMONSTRATE SKILL TO BUILD AM PART BY PREPARING CAD MODEL DIRECTLY OR THROUGH REVERSE ENGINEERING, PRE PROCESSING, PART BUILDING AND POST PROCESSING THE PART.

COURSE CONTENT

1. INTRODUCTION

Prototyping, rapid prototyping, Additive Manufacturing (AM), Process chain of additive manufacturing, Advantages of AM.

2. CLASSIFICATION OF AM PROCESSES

Liquid based, solid based, and powder based AM processes; Stereolithography and other liquid based systems, Fused Deposition processes for polymers, ceramics and metals, Laminated Object Manufacturing , Shape Deposition Manufacturing, Laser sintering based technologies, 3D printing, Direct Metal Deposition, LENS, Electron beam melting based process.

3. APPLICATIONS OF AM

Introduction, applications of AM in different categories such as conceptual design, rapid manufacturing, rapid tooling, terrain modeling, medical AM and mass customization (most of things to be discussed in detail in the chapters on Rapid Manufacturing, Medical AM and Rapid Tooling).

4. RAPID MANUFACTURING

Different applications of AM for directly making end-use parts – industrial applications, utilizing porous property, medical applications such as dental, hearing aid and medical devices, terrain modeling, transport, military, architectural, electronics, etc. Mass customization – production of customized products in mass scale.

5. MEDICAL AM

Medical applications of AM for prosthesis and implant; tissue engineering; complex surgical planning and visualization of bio-molecules with several case studies in each category.

6. DATA EXCHANGE FORMATS

Data formats for AM and associated details, Data conversion for AM and associated difficulties, Data validity checks for AM, Data repair procedures for AM, Slicing algorithms and related details, Direct slicing, Standard data formats for translation, Relevant AM file formats, STEP data format and its details.

7. RAPID TOOLING (RT)

Soft tooling and hard tooling, Direct methods of rapid tooling, Indirect methods of rapid tooling processes.

8. INTRODUCTION TO REVERSE ENGINEERING

Definition of Reverse Engineering (RE), Need for RE, Three phases in the generic RE process – scanning (contact and non-contact scanners), point processing and geometric modeling.

TEXT BOOKS:

1. Chua, C K, Leong, K F and Lim CS, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific, 2003.
2. Gibson, I., Rosen, D.W. and Stucker, B., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, New York, 2010.

REFERENCES:

1. Prasad, Hari and Badrinarayan, K.S., *Rapid Prototyping and Tooling*, ISBN: 978-81-923-2065-6, 1st edition, SIP-Page Turners Publications, Surya Infotainment Products Pvt. Ltd., Bangalore, 2013.
2. Hopkinson, N, Hague, R, and Dickens, P, *Rapid Manufacturing: An Industrial Revolution for a Digital Age: An Industrial Revolution for the Digital Age*, Wiley, Jan 2006.
3. Castle Island Co., *Worldwide Guide to RP*, available at: www.additive3d.com.

4. Hilton, P.D. and Jacobs, P.F., *Rapid Tooling – Technologies and Industrial Applications*, Marcel Dekker AG, Basel, Switzerland, 2000.
5. Gibson, Ian, *Advanced Manufacturing Technologies for Medical Application – Reverse Engineering, Software Conversion and Rapid Prototyping*, John Wiley and Sons Ltd, West Sussex, England, 2005

Course Description

Title: Finite Element Analysis Code: 14M14ME431
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Students must have already studied course, " *Strength of Materials, Dynamics of Machine, Design of Machine Elements and Advanced Mechanics of Solids* ".

Objective:

1. The main objective of this subject is to provide a practical training in engineering design using finite element methods. When components have complex construction, shape, and general boundary conditions (loading and restraint) the designer will often use finite element methods to determine their structural integrity.
2. The first half of the module aims at introducing the fundamental principles of the modeling for statics and dynamics analyses.
3. In the second half of the module the students will be taught how to use the method in practice, to critically assess and evaluate the results.

Learning Outcomes:

Course Outcome	**Description**
CO1	Outline of this subject is to provide a practical training in engineering design using finite element methods.
CO2	Describe the use of finite element methods to determine their structural integrity when components have complex construction, shape, and general boundary conditions (loading and restraint).
CO3	Develop the fundamental principles of the modeling for statics and dynamics analyses.
CO4	Identify the important stress analysis technique and how it may be used to design components.
CO5	Apply the finite element methods for small displacement linear elastic analysis,Non-linear analysis, interpret the numerical results in design.
CO6	Demonstrate the method in practice, critically assess, evaluate the results and error analysis.

Course Content:

Unit-1:Fundamental concepts

Introduction, Stresses and equilibrium equations, Boundary conditions, Strain-displacement, Relations, Stress- strain relations, The Rayleigh-Ritz method, Galerkin's method,Application: Axial deformation of bars, Axial spring element, Matrix algebra, Gaussian elimination.

Unit-2: One-dimensional problems

Finite element modeling, Coordinates and a shape functions, Galerkin approach treatment of boundary conditions, Quadratic shape functions, Temperature effects.

Unit-3:Two-dimensional problems

Finite element modeling, Constant strain triangle, Axis symmetric solids subjected to axis symmetric loading, Axis symmetric formulation, Triangular element, Four- node quadrilateral, Numerical integration stress calculations, High order element, Nine-node quadrilateral, Eight-node quadrilateral, Six-node triangle.

Unit-4: Beams, frames & truss element

Introduction, Finite element formulation, Load vector, Boundary considerations, Shear force and bending moment, Beams on elastic supports, Plane frames. 2D & 3D Truss element.

Unit-5:**Three-dimensional problems**

Introduction, Finite element formulation, Stress calculations, Mesh preparation, hexahedral elements and Higher- order elements,

Unit-6: Dynamic considerations

troduction, Formulation, Element mass matrices: Evaluation of Eigen values and Eigenvectors, Heat transfer Problem, Non-linear problems , Finite element error analysis

Teaching Methodology:

This course is introduced to provide a numerical method for solving problems of engineering and mathematical physics, which include structural analysis, heat transfer analysis, thermal analysis etc. This course is introduced to help students to understand a method which can reduce the degrees of freedom from infinite to finite with the help of discretization or meshing. The entire course is broken down into six units: Fundamental concepts, One-dimensional problems, Two-dimensional problems, Beams, frames & truss element, Three-dimensional problems and Dynamic considerations.

Each section helps a student to gain detail knowledge of the subject to solve different types of engineering problems.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 & Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5& Unit-6 and around 30% from coverage of Test-1 & Test-2.
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	

Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Course-related resources will be provided on JUET server. This can include eBook, lecture material, supplementary course notes.

Text Book:

[1] Finite Element Analysis by P.Seshu

Reference Books/Material:

[1] Finite Element Method for Engineering by C.V. Girija Vallabhan

[2] The Finite Element Method for Engineers by Kenneth H. Huebner

Web References:

[1] https://nptel.ac.in/courses/112/104/112104116/

[2] https://ocw.mit.edu/resources/res-2-002-finite-element-procedures-for-solids-and-structures-spring-2010/

Journals References:

[1] Finite Elements in Analysis and Design: Elsevier

[2] Computer-Aided Engineering: IET

Course Description

Title: Hydraulic and Pneumatic Control System Code: 14M14ME331

L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Basic of electrical engineering, fluid mechanics, kinematics, thermodynamics

Objectives:

1. To acquaint students about the various sources of hydraulic and pneumatic power
2. To know about the hydraulic and pneumatic control devices and components
3. To familiarize students about the pneumatic and fluid power circuits

Learning outcome:

CO1	Outline of hydraulic and pneumatic system to understand the requirement of automation
CO2	Describe various sensors, direction control valves, signal processing, actuators for the pneumatic and hydraulic systems
CO3	Develop the knowledge of automation to improve the performance of manufacturing, maintenance and assembly units
CO4	Identify the type of sensors, direction control valves and actuators required for specific problem of automation
CO5	Apply the knowledge to develop and maintain various automation systems
CO6	Demonstrate the skill in the field of requirement

COURSE CONTENT

Unit 1: Introduction to oil hydraulics and pneumatics, their advantages and limitations.ISO Symbols and standards in Oil Hydraulics and Pneumatics. Recent developments, applications Basic types and constructions of Hydraulic pumps and motors. Ideal pump and motor analysis. Practical pump and motor analysis, Performance curves and parameters

Unit 2: Hydraulic control elements – direction, pressure and flow control valves. Valve configurations, General valve analysis, valve lap, flow forces and lateral forces on spool valves. Series and parallel pressure compensation flow control valves. Flapper valve analysis and Design. Analysis of valve controlled and pump controlled motor. Electro-hydraulic servo valves – specification, selection and use of servo valves.

Electro hydraulic servomechanisms – Electro hydraulic position control servos and velocity control servos. Nonlinearities in control systems (backlash, hysteresis, dead band and friction nonlinearities). Basic configurations of hydraulic power supplies – Bypass Regulated and Stroke Regulated Hydraulic Power Supplies. Heat generation and dissipation in hydraulic systems. Design and analysis of typical hydraulic circuits. Use of Displacement – Time and Travel-Step diagrams; Synchronization circuits and accumulator sizing. Meter-in, Meter-out and Bleed-off circuits; Fail Safe and Counter balancing circuits.

Unit 3: Components of a pneumatic system; Direction, flow and pressure control valves in pneumatic systems. Development of single and multiple actuator circuits; Valves for logic functions; Time delay valve; Exhaust and supply air throttling; Examples of typical circuits using Displacement – Time and Travel-Step diagrams. Will-dependent control, Travel dependent control and Time-dependent control, Combined Control, Program Control, Sequence Control, Electro-pneumatic control and air-hydraulic control. Applications in Assembly, Feeding, Metalworking, materials handling and plastics working.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit 1
Test-2	25 Marks	Based on Unit 2 and Unit 1 (20%)

Test-3	35 Marks	Based on Unit 3, Unit 2 (15%) and Unit 1 (15%)
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Lecture notes on Hydraulic and Pneumatic Control System (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOKS:

1. Introduction to hydraulics and pneumatics by S. Ilango and V. Sundararajan, PHI Learning, New Delhi, 2nd Edition, 2009
2. Hydraulics and Pneumatics by A. K Upadhyay, S. K. Kataria& Sons, New Delhi

REFERENCES:

1. Fluid Power Control: Hydraulics and Pneumatics by Ahmed Abu Hanieh, Cambridge International Science Publishing
2. Pneumatic and Hydraulic Systems by W. Bolton, Butterworth-Heinemann Ltd, 1997

Web References:

1. www.youtube.com/user/nptelhrd

Journals References:

1. Mechatronics: The Science of Intelligent Machines
2. International Journal of Mechatronics and Automation

Course Description

Title: Design of Experiments Code: 17M14ME231
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Students must have already studied courses, "Higher Engineering Mathematics (*Probability and Statistics)"*.

Objective:

1. To learn and be able to use the designed matrices for experimentation.
2. To develop the abilities to create a functional relationship between input and output parameters.

Learning Outcomes:

Course Outcome	Description
CO1	Get familiar with various Design of Experiments techniques.
CO2	Have a good foundation of Design of Experiments and analysis methods like response surface methodology, Factorial design.
CO3	Possess demonstrative skills in using statistical software (Minitab, Design expert, and R).
CO4	Identify the influencing parameters of the process using analysis of experiments
CO5	Apply analysis of variance (ANOVA) to obtain the significant variables in the process
CO6	Work as a team on a project.

Course Content:

Unit-1: Basic Concepts: Fundamentals of experimental design, Selection of an appropriate design, Criteria for evaluation, Factors and levels, Importance of optimized design**.**

Unit-2: Single Factor Experiments: Introduction to one parameter at a time study, Analysis of variance (ANOVA), total sum of Squares, mean sum of the square, degree of freedom, calculation of p-value and f-value, physical significance of p-value and f-value, Randomized block design, Randomized incomplete block design

Unit-3: Factorial Design: Introduction to factorial design, types of factorial design, two way analysis of variance, Fixed, Random and Mixed models, Expected mean square rules

Unit-4: Response Surface Methodology (RSM) – Introduction to RSM, Central composite designs (CCD), Central Composite Rotary Design (CCRD), number of experiments required in RSM, Box-Behnken design, The method of steepest ascent, response surface designs, Statistical regression techniques, fitting of regression models

Unit-5: Robust Parameter Design: Steps in designing performance in to a product, Taguchi's definition of quality, Loss functions in quality, Orthogonal arrays, Types of Orthogonal arrays, selection of orthogonal array (OA), Orthogonal arrays vs. classical statistical experiments, Graphic evaluations of main effects, Selecting factors for Taguchi Experiments, Concept of S/N Ratios – its significance in robust design

Unit-6: **Applications:** Applications of RSM in Engineering, Case studies of S/N ratios in optimization, Identifying control and noise factors, Applications of Robust parameter design methodology

Teaching Methodology:

This course is introduced to help students for designing the experiments in scientific way so that they can save the time, money and materials while conducting the experiments. The methods of experiments help them to build an empirical model to predict the process behavior.

The entire course is broken down into six separate units: introductory or fundamentals of design of experiments, factorial design, response surface methodology, Taguchi method, analysis of variance, and the applications of techniques.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 and Unit-6 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on Design of Experiments (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

[1] D. C. Montgomery, "Design and Analysis of Experiments", D. C. Montgomery, John Wiley & Sons.

[2] "Quality Engineering using robust design", M. S. Phadke, Prentice-Hall.

[3] "Taguchi Techniques for quality engineering", P. J. Ross, McGraw-Hill.

Reference Books/Material:

[1] "Fundamental concepts in design of experiments", C. R. Hicks, Holt, Rinehort and Winston.
[2] "Methods Explained: Practical steps to Robust Design", T. P. Bagchi, Prentice-Hall.
[3] "Experimental Designs", W.G. Cochran, and G.M. Cox, Asia Publishing House

Web References:

[1] https://nptel.ac.in/courses/110/105/110105087/
[2] https://nptel.ac.in/courses/102/106/102106051/

Journals References:

[1] Journal of Materials Processing Technology
[2] Materials and Manufacturing Processes

Course Description

Title: Advanced Materials Technology Code: 14M14ME233

L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Students must have already studied courses, “Material science”, “Manufacturing process”.

Objective:

5. To learn the importance non-conventional processing routes fordifferent materials and its importance for advanced materials manufacturing
6. To learn and be able to perform engineering work in accordance with ethical and economic constraints related to the design of metallurgicalstructures.

Learning Outcomes:

COURSE OUTCOME	DESCRIPTION
CO1	UNDERSTANDS THE WORKING PRINCIPLES OF DIFFERENT ADVANCED PROCESSES
CO2	DETERMINE AND SELECT THE TYPE OF DEPOSITION AND SPRAYING TECHNIQUE WITH RESPECT TO THE APPLICATION
CO3	APPLY KNOWLEDGE OF TYPES OF PRE-TREATMENT METHODS TO BE GIVEN TO SURFACE ENGINEERING
CO4	UNDERTAKE PROBLEM IDENTIFICATIONAND IDENTIFYDIFFERENT FORMS OF PROCESSING TECHNIQUES OF SURFACE ENGINEERING MATERIALS.
CO5	EVALUATE THE PROPERTIES OF SURFACE DEGRADATION OF MATERIALS.
CO6	ANALYZE DESIGN AND PROCESSING NEW TYPES OF SURFACE TESTING METHODS AND COMPREHEND THE DEGRADATION PROPERTIES

Course Content:

Unit-1: Review of Mechanical Behavior of Materials: Plastic deformation in poly phase alloys - Strengthening mechanisms - Griffith's theory of failure modes – Brittle and ductile fractures - Damping properties of materials - fracture toughness - Initiation and propagation of fatigue cracks - Creep mechanisms - Hydrogen embrittlement of metals.

Unit-2: Surface Modification of Materials: Mechanical surface treatment and coating - Case hardening and hard facing - thermal spraying – vapour deposition-ion implantation - Diffusion coating - Electroplating and Electroforming - Conversion coating - Ceramic and organic coatings – Diamond coating - Advanced surface modification of steels.

Unit-3: Advanced Heat Treatment of Materials: Unconventional surface hardening techniques-Heat treatment of critical mechanical elements like gears, tools, dies, springs, shafts-Heat treatment of Al, Cu, Ni and Ti alloys-Polymerquenchants.

Unit-4: Modern Materials and Alloys: Super alloys-Refractory materials-Ceramics and their applications-Low melting alloys-shape memory alloys-Metal matrix and ceramic matrix composites.

Unit-5: Applications of Advanced Materials: Ti and Ni based alloys for gas turbine applications-Maraging and Cryogenic steels-Newer materials and their treatment for automobile applications-Materials for Naval and nuclear systems.

Teaching methodology:

This course covers the metallurgical aspects of the welding of common engineering metals such as plain carbon, alloy and stainless steels, aluminum and cast iron. The selection of filler metals, transfer and recovery of alloying elements and design of preheating and post heating cycles is also emphasized.

Evaluation Scheme:

EXAMS	**MARKS**	**COVERAGE**
TEST-1	15 MARKS	BASED ON UNIT-1
TEST-2	25 MARKS	BASED ON UNIT-2, UNIT-3 AND AROUND 30% FROM COVERAGE OF TEST-1
TEST-3	35 MARKS	BASED ON UNIT-4 TO UNIT-5 AND AROUND 30% FROM COVERAGE OF TEST-2
ASSIGNMENT	10 MARKS	
TUTORIALS	5 MARKS	
QUIZ	5 MARKS	
ATTENDANCE	5 MARKS	
TOTAL	**100 MARKS**	

Learning Resources:

Tutorials and referred video lecture on Advanced Materials Technologyis available on JUET server.

Text Book:

1. E Paul Degarmo, J T Black, Ronald A Kohser., Materials and Processing in Manufacturing, Willey Publication, 2006
2. Composite Materials Hand book – M M Schwartz, McGraw Hill.
3. G.E. Totten., Steal heat treatment handbook- Metallurgy and Technologies, CrC press, Taylor and Francis group, second edition.

Reference Books:

4. P K Mallick., Fiber Reinforced Composites- Materials, Manufacturing and Design, CRC press, Taylor and Francis group.
5. Metal Matrix Composites – Minoru Taya, Richard J Arsenault

Course Description

TITLE: MODELLING AND OPTIMIZATION TECHNIQUES IN ENGINEERING — CODE : 15M14ME338

L-T-P SCHEME: 3-0-0 **CREDITS:** 3

Prerequisite: Student must have already studied courses, "Operation research, Manufacturing process, Industrial Engineering at UG-level ".

Objective:

1. To learn the importance of Modelling in Process industries
2. To study the steps in the formulation of a Mathematical Model
3. To learn about the various optimization techniques.
4. To make able to understand process parameter optimization.
5. To learn about the utilization of optimization techniques in process planning

Learning Outcomes:

Course Outcome	Description
CO1	To **describe** the requirement of the optimization techniques
CO2	**Outline** fundamental concept of different classical optimization techniques
CO3	To **develop** optimization models for real case industrial problems
CO4	To **demonstrate** the requirement and utilization of optimization techniques for industrial applications
CO5	To **demonstrate** knowledge of various types of optimization techniques to solve the real case problems.
CO6	To **describe** and Implement the hybrid and meta- heuristics in order to model and solve the engineering problems .

Course Content:

Unit-1: INTRODUCTION: Need for Modelling and Optimization of Manufacturing Processes, Modelling and Optimization, Types of Modelling and Optimization, Design Variables, Constraints, Objective Function, Problem formulation, Single and Multi-objective optimization methods, constrained optimization methods.

Unit-2: DESIGN OF EXPERIMENTS (DOES):Introduction to DOE processes- factorial design, fractional factorial design: two levels and three level design.

Unit-3: RESPONSE SURFACE METHODOLOGY (RSM): Introduction to RSM, Steepest ascent method, central composite design (CCD), Box-Behnken design, central composite rotatable design (CCRD). .

Unit-4: TAGUCHI METHOD (TM):Selection of control factors and levels, parameter design, degree of freedom, selection of orthogonal array (OA), types of characteristics, signal-to-noise (S/N) ratio, analysis of variance (ANOVA), confirmation of result.

Unit-5: Statistical regression techniques, fitting of regression models, Grey relational analysis (GRA), Principal component analysis (PCA), Fuzzy Theory, Artificial Neural Network (ANN).
Unit-6: META-HEURISTICS: Genetic algorithms, Simulated Annealing, Tabu search, Particle Swarm Optimization, Ant colony Optimization and Bee Algorithms.

Unit-7: HYBRID APPROACHES: TMRSM, RSMGA, Taguchi-Fuzzy based approach, GRA-fuzzy, Neuro-fuzzy, NSGA.

Teaching Methodology:
This is introduced to make the student capable of utilizing skills developed as an outcome from their above-mentioned pre-requisite subjects, various constructional parameters of the child parts and their requirement. Course contain deals within this Modelling and Optimization Techniques In Engineering subject is categories in seven different units (viz. Introduction, Design Of Experiments (DOES), Response Surface Methodology (RSM), Taguchi Method (TM), Statistical Regression Techniques, Meta-Heuristics, Hybrid Approaches). A well equipped advance laboratories of advance manufacturing systems will helps student to understand and gives hands on experience.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2 & Unit-3
Test-2	25 Marks	Based on Unit-4 & Unit-5 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-6 to Unit-7 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:
Tutorials and lecture slides of an automobile engineering subject (will be added from time to time): Digital copy will be available on the JUET server.
Text Books
1.Montgomery, D.C. (1997) Design and Analysis of Experiments, New York: John Wiley.
2.Deb, K., "Optimization for Engineering Design", Prentice Hall of India, 1995.**Reference Books/Material:**
1.Klir GJ, Yuan B. Fuzzy sets and fuzzy logic (theory and applications). Third Ed. New Delhi: Prentice Hall of India; 2005.
2.Haykin, S. (2002), Neural Networks, a Comprehensive Foundation, 2nd Edition, Pearson Education Pte. Limited: Delhi, India.
3.Roa, S.S., "Optimization Theory and Application", Wiley Easter, 1984.

4.Phadke, M.S. (1989) Quality Engineering Using Robust Design, NJ: Prentice-Hall, Englewood Cliffs

Web References:

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https://www.springer.com/gp/book/9783030000356
https://www.springer.com/gp/book/9783030196370
http://www.ecs.umass.edu/mie/labs/mda/fea/sankar/chap2.html

Journals References:

https://www.sciencedirect.com/science/article/pii/S2211812814007329/pdf?md5=0352b7f4d93524846504e4404fd68743&pid=1-s2.0-S2211812814007329-main.pdf&_valck=1
https://www.sciencedirect.com/science/article/abs/pii/S1755581720300420
https://www.sciencedirect.com/science/article/abs/pii/S1359836818342057

Course Description

TITLE: Advanced Composite Materials CODE: 14M14ME336

L-**T-P scheme: 3-0-0** **Credit: 3**

Prerequisite: Students must have already studied courses, "Material Science" and "Introduction to Composite Materials".

Objective:

1. To explain the fundamental concepts of mechanical behavior of conventional and advanced composite materials.
2. To explore the basic stress analysis techniques used to determine the material properties such as the modulus of elasticity and the Poisson's ratio.
3. To explain the isotropic and anisotropic composite material behavior.

Course Outcome	Description
CO1	Outline various types of composite materials.
CO2	Describe the fabrication and applications of composite materials.
CO3	Develop an idea to fabricate the advanced composite material using the concept of sustainable manufacturing.
CO4	Identify the most influencing process parameters to fabricate the composites.
CO5	Apply most appropriate processing technique to fabricate the polymer matrix composites.
CO6	Demonstrate the applications of composite materials in real-world.

COURSE CONTENT

Unit-1: General introduction of composites, Historical development, Material properties that can be improved by forming a composite material, classification of composites and advantages of composites materials.

Unit-2: Fibers and matrices, various composites, Fiber-matrix interface properties, unidirectional laminates, Cross-plied laminates, Multi-directional laminates, various geometrical aspects of laminates.

Unit-3: Elastic properties of uni-directional lamina, Random long fiber lamina, Short fiber composites, Stress-strain distribution at fibre ends, Thermal stresses and curing stresses

Unit-4: Laminate theory, Strength of uni-directional laminate, Strength of short fiber composites, Edge effect in angle ply laminates.

Unit-5: Fatigue, Notch sensitivity and fracture energy of composites, Failure modes of fiber composites, Energy absorbing mechanism of fiber composites

Unit-6: Property degradation due to various environmental conditions, Manufacturing techniques of composites, Current and potential applications of composites

Teaching Methodology:

This course is introduced to help students to understand the various types of composite materials and their applications. The entire course is broken down into six separate units: Introduction to composites, Fibers and matrices, Laminates, Elastic properties, laminates theory, Mode of failure, Property degradation, manufacturing techniques and Applications.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 & Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 & Unit-6 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Referred video lectures on Processing of non-metals are available on JUET server.

TEXT BOOKS-

1. Mallick P. K., Fiber reinforced composites: Materials, manufacturing and design, CRC press, 2007
2. Hull, D. and Clyne, T.W., Introduction to composite materials, Cambridge University press, 1996.
3. Kaw.A. K, Mechanics of Composite materials, CRC Press (Taylor & Francis), 2006.

REFERENCE BOOKS-

1. Bunsell, A, R. and Renard, J., Fundamentals of fiber reinforced composite materials, Institute of Physics Pub, 2005.
2. Gibson, Ronald F**., Principles of composite material mechanics,** CRC Press (Taylor & Francis Group), 2012.
3. Luigi Nicolais., Eva Milella, Michele Meo, Composite materials – A vision for future, Springer, 2011.

Web References:

[1] www.nptel.com

[2] https://nptel.ac.in/courses/112/104/112104229/

Journals References:

[1] Journal of Manufacturing Processes: Elsevier

[2] Materials and Manufacturing Processes: Taylor & Francis

[3] Journal of Materials Processing Technology: Elsevier

[4] Composite Part A: Elsevier

[5] Composite Part B: Elsevier

Course Description

Title: Laser Beam Machining Code: 14M14ME335

L-T Scheme: 3 **Credits: 3**

Objectives

1. To make acquainted the various types of lasers, applications of lasers and generation of laser
2. To understand mechanisms of material removal in laser beam machining (LBM) process
3. To encourage the students for doing research in the area of LBM

Course Outcome	Description
CO1	Outline various machining processes
CO2	Describe the lasers for machining and its industrial application
CO3	Develop an idea to machine the difficult to cut materials using different classes of lasers.
CO4	Identify the most influencing process parameters in laser beam machining processes
CO5	Apply most appropriate laser for machining a product economically.
CO6	Demonstrate and deployment different laser machining techniques for solving real-world problems

Course Content

Unit-1: Overview of Machining Processes-Introduction, Conventional Machining Processes, Nonconventional Machining Processes.

Unit-2: Light and Laser – Historical background, Basic Mechanisms in Lasers, Laser Light: Properties, Generation of laser beam, Classification, Laser Equipment Characteristics and application of lasers, Lasers in engineering.

Unit-3:Basics of Laser Machining-Laser processing of materials and process capabilities, Laser Machining as a One, Two and Three –Dimensional Process, Laser Machining Systems, Laser Machining Control, Economics of Laser Systems.

Unit-4: Heat Transfer in Laser Machining-Introduction, Fundamentals of Heat Transfer, Conduction, Convection and Fluid Mechanics, Radiation, Numerical Methods in Heat Transfer (Basic Concepts, Finite Difference Method, Finite Element Method).

Unit-5: Laser Beam Machining-Laser processing of materials and process capabilities, Laser beam machining (LBM), Process principle, Laser Micromachining.

Unit-6: Laser Machining Analysis and Applications-Introduction, Problem Definition for Laser Process Modeling (Drilling, Cutting, Grooving, 3-D Machining), analysis and applications of laser Drilling, Cutting, Turning, and Milling processes.

Teaching Methodology:

This course is introduced to help students to understand the various types of lasers and their applications for machining. The entire course is broken down into six separate units:

Introduction to laser beam machining, laser generation and their types, various configurations of laser machining, laser micromachining, heat transfer in laser machining, Analysis and applications.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 & Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 & Unit-6 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Text Books

1. Steen W. M., Laser Material Processing, Springer, 2003.

2. Chryssolouris G., Laser Machining- Theory and Practice (Mechanical Engineering Series), Springer, 1991.

References:

1. Luxton J.T., Parker D.E, Industrial lasers and their applications, Prentice Hall, 1987.
2. Ion, J.C., *Laser Processing on Engineering Materials (Principles, Procedure and Industrial Application)*, Elsevier Butterworth-Heinemann, Burlington, 2005.
3. Nambiar, K. R., *Lasers-Principles, Types and Applications*, New Age International Publishers, New Delhi, 2004.

Course Description

Title of Course: Seminar-II Course Code: 14M19ME491

L-T-P Scheme: 0-0-4 **Credit: 2**

Prerequisite: Students must have already studied the courses, "*Manufacturing technology theory and lab*" and "*Unconventional manufacturing Processes*".

Objective:

Students will be able to understand the identification of different areas and new technologies related to manufacturing processes.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the seminar topics with respect to their needs for the society.
CO2	Description of usefulness of the work in the context of present application
CO3	Development of the literature survey in chronological order
CO4	Identification of the problem in current areas of mechanical engineering
CO5	Application and usefulness to the society.
CO6	Demonstration and deployment of advanced manufacturing methods

Course Content:

Unit 1: Motivation about Seminar Topic

Unit 2: Usefulness of the work in the context of present application

Unit 3: Literature survey in chronological order.

Unit 4: Problem identification

Unit 5: Study / Analysis of different existing methods based on adequate performance parameters.

Unit 6: Mathematical formulation of the method.

Unit 7: Applications in real world

Teaching Methodology Guidelines:

Each student will choose a broad topic in consultation with his/her supervisor on which he/she will give presentation. Seminar-II is a course requirement wherein under the guidance of a faculty member, a student is expected to do in-depth study in a specialized area by

performing literature survey. He should analyze works of various authors/researchers critically, study concepts and techniques; and present it. The Seminar-II is an independent course, not related to Seminar I and Dissertation Part-II. The researcher is expected to give clear and concise oral presentations in the three evaluations. Finally a report of the work done or state-of-the-art-report in the specialized area is to be submitted towards the end of the semester.

Evaluation Scheme:

Exams		**Marks**	**Coverage**
Presentation-1		20 Marks	**Unit 1-Unit 3**
Presentation-2		30 Marks	**Unit 4-Unit 7**
Day to Day Work	Attendance and Discipline	15 Marks	**50 Marks**
	Sincerity and Regularity	20 Marks	
	Report	15 Marks	
Total		**100 Marks**	

Learning Resources:
After discussion with the concerned faculty members, Student will develop some new areas in the field of Manufacturing technology (Mechanical Engineering) and related information.

Text Books & Reference Books/Material: Related to Area of Seminar

Web References:
[1] https://www.sciencedirect.com
[2] https://www.springer.com
[3]] https://www.taylorandfrancis.com

Journals References:
[1] Journal of Materials Processing Technology
[2] Materials and Manufacturing Processes
[3] Composite Journals
[4] International Journal of Machine Tools and Manufacturer
[5] Optics and Laser Technology

Course Description

Title of Course: Dissertation Part-II Course Code: 14M19ME492

L-T-P Scheme: 0-0-28 **Credit: 14**

Prerequisite: Students must have already studied the courses like, "*Advanced Manufacturing Processes*", "*Materials Science and Composites*" and "Programming and/ or *Simulation Tools"* etc.

Objective:

The objective of Dissertation Part-I is to promote a systematic understanding of the knowledge, critical awareness of current problems, originality in the application of knowledge and the quality of work. The ideal work may be characterized by a new result in design, development and implementation. It should have the potential of industrial/scientific acceptance. Dissertation Part-II should be seen in continuation with Dissertation Part-I. The researcher should continue the research work in the two parts.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the dissertation topics with respect to their needs for the society.
CO2	Description of usefulness of the work in the context of present application
CO3	Development of the literature survey in chronological order
CO4	Identification of the problem in current areas of manufacturing technology
CO5	Application and usefulness to the society.
CO6	Demonstration and deployment of advanced manufacturing techniques requires to complete the work

Course Content:

Unit 1: Motivation about dissertation Topic

Unit 2: Usefulness of the work in the context of present application

Unit 3: Literature survey in chronological order.

Unit 4: Problem formulation.

Unit 5: Study / Analysis of different existing methods based on adequate performance parameters.

Unit 6: Mathematical formulation of the proposed method.

Unit 7: Applications of the proposed work in real world problems for finding the solutions

Teaching Methodology/Guidelines:
Each researcher should present analytical and/or experimental works in consultation with his/her supervisor towards the fulfillment of Master's degree. The researcher will present the progress of his work in the mid-semester evaluation. He/she will present his/her complete work including literature review and introduction. The evaluation will be done based on the work done in both the semesters. In the end-semester evaluation of 4^{th} semester, the researcher will present his/her research work and defend his/her dissertation. Finally a dissertation has to be submitted to the University for Partial Fulfillment of M. Tech. program according to university rules. The students have to submit one copy of the dissertation soft bound/spiral bound before the end-semester evaluation for external examiner to facilitate modification. They should submit three bound copies of the dissertation after the end-semester evaluation, one of which will go to the supervisor. Therefore, a student will get four copies bound (one copy for himself), if he/she has one supervisor. The no. of copies may increase, in case he/she has more than one supervisor.

Evaluation Scheme:

Exams		**Marks**	**Coverage**
Presentation-1		15 Marks	**Unit 1-Unit 2**
Presentation-2		15 Marks	**Unit 3-Unit 4**
Presentation-3		20 Marks	**Unit 5-Unit 6**
Day to day work	Attendance	10 Marks	**50 Marks**
	Sincerity	10 Marks	
	Report	15 Marks	
	Performance	15 Marks	
Total		**100 Marks**	

Learning Resources:
After discussion with the concerned faculty members, Student will develop some new areas in the field of Manufacturing technology (Mechanical Engineering) and related information.

Text Books & Reference Books/Material: Related to Area of Research work

Web References:
[1] https://www.sciencedirect.com
[2] https://www.springer.com
[3]] https://www.taylorandfrancis.com

Journals References:

[1] Journal of Materials Processing Technology
[2] Materials and Manufacturing Processes
[3] Composite Journals
[4] International Journal of Machine Tools and Manufacturer
[5] Optics and Laser Technology
[6] Optics and Lasers in Engineering