Semester- II

COMPUTER CONTROL OF MANUFACTURING SYSTEM			
Course Code	**MMSE201**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To impart knowledge of CIM and Automation and different concepts of automation by developing Mathematical models.
- To make students to understand the Computer Applications in Design and Manufacturing [CAD / CAM) leading to Computer integrated systems. Enable them to perform various transformations of Entities on display devices.
- To expose students to automated flow lines, assembly lines, Line Balancing Techniques, and Flexible Manufacturing Systems.
- To expose students to computer aided process planning, material requirement planning, capacity Planning etc.
- To expose the students to CNC Machine Tools, CNC part programming, and industrial robots.
- To introduce the students to concepts of Additive Manufacturing, Internet of Things, and Industry 4.0 leading to Smart Factory.

Module-1

Introduction to CIM and Automation: Automation in Production Systems, automated manufacturing systems-types of automation, reasons for automating, Computer Integrated Manufacturing, computerized elements of a CIM system, CAD/CAM and CIM. Mathematical models and matrices: production rate, production capacity, utilization and availability, manufacturing lead time, work-in- process, numerical problems.

Automated Production Lines and Assembly Systems: Fundamentals, system configurations, applications, automated flow lines, buffer storage, control of production line, analysis of transfer lines, analysis of flow lines without storage, partial automation, analysis of automated flow lines with storage buffer,fundamentals of automated assembly systems, numericals.

Teaching-Learning Process	Chalk and Talk / White board, Power Point Presentation, Video Demonstration or Simulation.

Module-2

CAD and Computer Graphics Software: The design process, applications of computers in design, software configuration, functions of graphics package, constructing the geometry. Transformations: 2D transformations, translation, rotation and scaling, homogeneous transformation matrix, concatenation, numerical problems on transformations. Computerized Manufacture Planning and Control System: Computer Aided Process Planning, Retrieval and Generative Systems, benefits of CAPP, Production Planning and Control Systems, typical activities of PPCSystem, computer integrated production management system, Material Requirement Planning, inputs to MRP system, working of MRP, outputs and benefits, Capacity Planning, Computer Aided Quality Control, Shop floor control.

Teaching-Learning Process	Chalk and Talk / White board, Power Point Presentation, Video Demonstration or Simulation.

Module-3

Flexible Manufacturing Systems: Fundamentals of Group Technology and Flexible Manufacturing Systems, types of FMS, FMS components, Material handling and storage system, applications, benefits, computer control systems, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RS and Automatic parts identification systems and data capture. Line Balancing: Line balancing algorithms, methods of line balancing, numerical problems on largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights method, Mixed Model line balancing, computerized line balancing methods.

Teaching-Learning Process	Chalk and Talk / White board, Power Point Presentation, Video Demonstration or Simulation.

Module-4

Computer Numerical Control: Introduction, components of CNC, CNC programming, manual part programming, G Codes, M Codes, programming of simple components in turning, drilling and milling systems, programming with canned cycles. Cutter radius compensations. Robot Technology: Robot anatomy, joints and links, common robot configurations, robot control systems, accuracy and repeatability, end effectors, sensors in robotics. Robot programming methods: on-line and offline methods. Robot industrial applications: material handling, processing and assembly and inspection.

Teaching-Learning Process	Chalk and Talk / White board, Power Point Presentation, Video Demonstration or Simulation.

Module-5

Additive Manufacturing Systems: Basic principles of additive manufacturing, slicing CAD models for AM, advantages and limitations of AM technologies, Additive manufacturing processes: Photo polymerization, material jetting, binder jetting, material extrusion, Powder bed sintering techniques, sheet lamination, direct energy deposition techniques, applications of AM. Future of Automated Factory: Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, industrial automation, supply chain optimization, supply-chain & logistics, cyber-physical manufacturing systems.

Teaching-Learning Process	Chalk and Talk / White board, Power Point Presentation, Video Demonstration or Simulation.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Automation, Production Systems and Computer-Integrated Manufacturing Mikell P Groover Pearson Learning. 4th Edition,2015
2. CAD / CAM Principles and Applications P N Rao Tata McGraw-Hill 3rd Edition, 2015
3. CAD/CAM/CIM Dr. P. Radhakrishnan New Age International Publishers, New Delhi. 3rd edition

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Define Automation, CIM, CAD, CAM and explain the differences between these concepts. Solve simple problems of transformations of entities on computer screen	L1, L2, L3
CO2	Explain the basics of automated manufacturing industries through mathematical models and analyze different types of automated flow lines.	L1, L2, L3, L4,L5
CO3	Analyse the automated flow linestoreduce time and enhance productivity.	L1, L2, L3,
CO4	Explain the use of different computer applications in manufacturing, and able to prepare part programs forsimple jobs on CNC machine tools and robot programming.	L, L2, L3, L4,L5
CO5	Visualize and appreciate the modern trends in Manufacturing like additive manufacturing, Industry 4.0 and applications of Internet of Things leading to Smart Manufacturing.	L1, L2, L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	To prepare students to meet the industrial requirements at global level competitiveness.	PO1
2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	PO2
3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	PO3
4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	PO4
5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	PO5
6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	PO6
7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	PO7

Mapping of COS and POs (Note : High - 3, Medium – 2, and Low – 1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**2**	**2**	**3**	**3**	**2**	**2**	**2**
CO2	**3**	**3**	**3**	**2**	**2**	**2**	**1**
CO3	**2**	**2**	**2**	**3**	**3**	**3**	**1**
CO4	**3**	**3**	**3**	**2**	**2**	**1**	**1**
CO5	**2**	**2**	**3**	**3**	**3**	**2**	**2**

Semester- II

PRODUCT DESIGN AND MANUFACTURING			
Course Code	MMSE202	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- Understand modern product development processes.
- Understand and explain the concept of Industrial design and robust design concepts.
- Understand the concept of Design for manufacture and assembly.
- Understand the legal factors, social issues, engineering ethics related to product design

Module-1	
Product Data Management : Product life cycle, Complexity in Product Development, General Description of PDM **Basic functionality of PDM:** Information architecture, PDM System architecture, Applications used in PDM systems. Trends in PDM.	
Teaching-Learning Process	Chalk and Talk / White board, Power Point Presentation, Video Demonstration or Simulation.
Module-2	
Document Management Systems: Document management and PDM, Document life cycle, Content Management, Document management and related technologies, Document management resources on the Internet.	
Teaching-Learning Process	Chalk and Talk / White board, Power Point Presentation, Video Demonstration or Simulation.
Module 3	
Workflow Management in PDM: Structure Management, Engineering Change Management, Release Management, Version Management, Configuration Management.	
Teaching-Learning Process	Chalk and Talk / White board, Power Point Presentation, Video Demonstration or Simulation.
Module-4	
Creating Product Structures: Part centric approach, CAD centric approach, Product Structure configuration, Managing Product Structures, PDM Tools: Matrix One, Team Center, Windchill. Enovia, PDM resources on the Internet.	
Teaching-Learning Process	Chalk and Talk / White board, Power Point Presentation, Video Demonstration or Simulation.
Module-5	
PDM Implementation Case Studies: Sun Microsystems, Inc., Mentor Graphics Corporation, Ericsson Radio Systems AB, Ericsson Mobile Communications AB, ABB Automation Technology Products, SaabTech Electronics AB	
Teaching-Learning Process	Chalk and Talk / White board, Power Point Presentation, Video Demonstration or Simulation.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
   The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Computer Integrated Design and Manufacturing - David Bed worth. Mark Henderson &. Philips Wolfe - McGraw Hill Inc
2. Visual Modeling with Rational Rose and UML - Terry Quatrain –
3. Wind-chill - RS.O Reference manuals - 2000.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=oTqtY8yjUw4
- https://www.youtube.com/watch?v=bxHbP-q9InU
- https://www.youtube.com/watch?v=0XFuRPPkZvA
- https://www.technia.com/blog/cad-data-management-on-the-3dexperience-platform/
- https://www.youtube.com/watch?v=JvQI0jkv89k

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars.

Course outcome

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

Sl. No.	Description	Blooms Level
CO1	Use the Product Design and Development Process, as a means to manage the development of an idea from concept through to production.	L1, L2, L3, L4
CO2	Employ research and analysis methodologies as it pertains to the product design process, meaning, and user experience.	L1, L2, L3, L4,L5
CO3	Apply creative process techniques in synthesizing information, problem-solving and critical thinking.	L1, L2, L3, L4
CO4	Demonstrate and employ hand drawing and drafting principles to convey concepts.	L1, L2, L3, L4,L5
CO5	Use basic fabrication methods to build prototype models for hard-goods and soft-goods and packaging.	L1, L2, L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research/investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	To be able to demonstrate a degree of mastery over the area as per the specialization of the program.	PO3
4	Understand contemporary issues in manufacturing engineering and develop relationship between product design and manufacturability to create safe, reliable, and cost-effective products.	PO4
5	Understand the process of converting customer needs into engineering specifications to create product designs that are sensitive to user needs and robust against unanticipated use and misuse	PO5
6	Employ advanced prototyping methods to shorten design cycles and narrow alternatives without restricting innovation.	PO6
7	Understand and debate the roles and responsibilities of a product designer/manufacturer on society.	PO7

Mapping of COS and POs (Note : High - 3, Medium – 2, and Low – 1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**1**	**1**	**2**	**2**	**3**	**3**	**2**
CO2	**1**	**2**	**2**	**2**	**3**	**3**	**2**
CO3	**1**	**2**	**2**	**2**	**3**	**3**	**2**
CO4	**1**	**2**	**2**	**2**	**3**	**3**	**2**
CO5	**1**	**2**	**2**	**2**	**3**	**3**	**2**

Semester- II

INDUSTRIAL ROBOTICS			
Course Code	**MMSE203**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40hrs+10-12 Labs	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

- The goal of the course is to familiarize the students with the concepts and techniques in robotic engineering,manipulator kinematics, dynamics and control, chose, and incorporate robotic technology in engineeringsystems.
- Make the students acquainted with the theoretical aspects of Robotics
- Enable the students to acquire practical experience in the field of Robotics through design projects and casestudies.
- Make the students to understand the importance of robots in various fields of engineering.

Module-1

Introduction: Automation and Robotics – An over view of Robotics – present and future applications. Components of the Industrial Robotics: common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, Design of end effectors, Precision of Movement: Resolution, Accuracy and Repeatability, Speed of Response and Load Carrying Capacity.

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Motion Analysis: Basic Rotation Matrices, Equivalent Axis and Angle, Euler Angles, Composite Rotation Matrices. Homogeneous transformations as applicable to rotation and translation – problems. Manipulator Kinematics-H notation-H method of Assignment of frames-H Transformation Matrix, joint coordinates and world coordinates, Forward and inverse kinematics – problems on Industrial Robotic Manipulators.

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Differential transformation of manipulators, Jacobians – problems. Dynamics: Lagrange – Euler and Newton – Euler formations – Problems. Trajectory planning and avoidance of obstacles, path planning, Slew motion, joint interpolated motion straight line motion.

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Robot actuators and Feedback components: Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison of Actuators, Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors, Tactile and Range sensors, Force and Torque sensors – End Effectors and Tools

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Robot Application in Manufacturing: Material Transfer – Material handling, loading and unloading- Processing – spot and continuous arc welding & spray painting – Assembly and Inspection. Robotic Programming Methods – Languages: Lead Through Programming, Textual Robotic Languages such as APT, MCL.

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	ASSIGNMENT ON INTRODUCTION TO ROBOT CONFIGURATION
2	DEMONSTRATION OF ROBOT WITH 2 DOF, 3 DOF, 4 DOF etc.
3	TWO ASSIGNMENTS ON PROGRAMMING THE ROBOT FOR APPLICATIONS
4	TWO ASSIGNMENTS ON PROGRAMMING THE ROBOT FOR APPLICATIONS IN VAL II
5	TWO PROGRAMMING EXERCISES FOR ROBOTS
6	TWO CASE STUDIES OF APPLICATIONS IN INDUSTRY
7	EXERCISE ON ROBOTIC SIMULATION SOFTWARE

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

1. Two Tests each of **25 Marks**
2. Two assignments each of **25 Marks/One Skill Development Activity of 50 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

  Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to

50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

Books

1. Industrial Robotics / Groover M P /McGraw Hill
2. Introduction to Industrial Robotics / Ramachandran Nagarajan / Pearson

Web links and Video Lectures (e-Resources):

- https://intelitek.com/fundamentals-of-robotics/
- https://www.youtube.com/watch?v=7Bahzh3rniw
- https://www.electronicsforu.com/technology-trends/tech-focus/sensors-robotics-artificial-intelligence
- https://www.youtube.com/watch?v=QJ1wixdSlRc
- https://www.youtube.com/watch?v=zyOv6rn3X88
- https://www.therobotreport.com/6-robotics-applications-new-markets/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quizzes
- Assignments
- Seminars

Course outcome

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

Sl. No.	Description	Blooms Level
CO1	To understand the basic components of robots.	L1, L2, L3, L4
CO2	Differentiate types of robots and robot grippers.	L1, L2, L3, L4
CO3	Model forward and inverse kinematics of robot manipulators.	L1, L2, L3
CO4	Analyze forces in links and joints of a robot.	L1, L2, L3, L4
CO5	Programme a robot to perform tasks in industrial applications.	L1, L2, L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	To prepare students to meet the industrial requirements at global level competitiveness.	PO1
2	To develop the students analytical skills to enable them to understand real	PO2

	world problems and formulate solutions.	
3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	PO3
4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	PO4
5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	PO5
6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	PO6
7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	PO7

Mapping of COS and POs (Note : High - 3, Medium – 2, and Low – 1)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	**2**	**2**	**3**	**3**	**3**	**2**	**2**
CO2	**2**	**2**	**3**	**3**	**3**	**3**	**3**
CO3	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO4	**3**	**3**	**2**	**2**	**2**	**2**	**2**
CO5	**2**	**2**	**2**	**3**	**3**	**3**	**3**

Professional Elective 3

Semester- II

DIGITAL MANUFACTURING			
Course Code	MMSE214A	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning Objectives:
To make students apply the basic concepts of automation to solve material handling problems and analyze flow lines.

Module-1	
Introduction to Automation: Production System Facilities, Automation in Production Systems: Types of Automation, Computerized Manufacturing Support Systems, and Reasons for automating a production system, Automation Principles and Strategies, Levels of Automation. Basic Elements of an Automated System, Advanced Automation Functions.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-2	
Automated Material Handling and Identification Technology: Overview of Material Handling, Material Transport Equipment, Analysis of Material Transport Systems, Storage Systems. Introduction to Storage Systems, Conventional	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-3	
Analysis of Automated flow lines: Analysis of transfer lines without storage, with storage buffer, single stage, double stage, multistage with problems. Automated assembly systems, design for automated assembly, parts feeding devices, analysis of multi station assembly machine, and analysis of single stage assembly machine.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-4	
Electro-Pneumatics: Introduction, Pressurized Air: Production & Distribution, Pneumatic Devices, Single &Double Acting Cylinders, Calculations, Length of Piston Stroke, Speed of Piston's Translation, Pressurized Air Flow Control Valves, Directional Valves, Valves Actuation. Manual, Mechanical, Electrical, Pneumatic.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-5	
PLCs: Introduction, Modular Construction of a PLC, PLC I/O Components, Digital Input Modules, Digital Output Modules, Communication Modules, Central Processing Unit. PLC Programming: Introduction to Programming of PLCs, The IEC 61131 Standard, Structural Programming, Basic Programming Instructions. The Result of an Instruction Execution, Boolean Logic Instructions, Activation Instructions, Complementary Instructions.	
Teaching-Learning	Chalk and Talk/Use of ICT like Power Point Presentations etc

Process	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Automation Production Systems and CIM – Mikell P Groover, 4th Edition, Pearson, 2016. ISBN: 978-93-325-7249-

2. Introduction to Industrial Automation, StamatiosManesis&George Nikolakopoulos, CRC Press, 2018, ISBN: 978- 1-4987-0540-0

3. Principles of Computer Integrated Manufacturing – S.Kant Vajpayee, PHI, ISBN 13: 978-81203-1476-4

4. Mechatronics – William Bolton, Sixth Edition, Pearson , ISBN-9788131732533

Web links and Video Lectures (e-Resources):

- https://youtu.be/De8MQWbhu3k
- https://youtu.be/v-3TmN4HhLc?list=PLwdnzlV3ogoW31clPN6Dn6c8Ia-n36vXk

Skill Development Activities Suggested

- Individual projects on topics covered in class. Students will choose a real life problems related to the discussed topics and implement the solution by using techniques and strategies discussed in the class. For each project, students have to submit a report and present a seminar.
- Assignments, Quiz and Industrial Visit on relevant topic of the course.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Apply automated material handling and identification technologies to upgrade material handling system in industries	L2
CO2	Analyse the automated flow lines and assembly systems	L2
CO3	Design and analyse pneumatic circuits for various applications.	L4
CO4	Apply the concepts of PLC for industrial applications	L2

Mapping of COS and POs (Note : High - 3, Medium – 2, and Low – 1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**2**	**1**	**2**	**2**	**2**	**1**
CO2	**3**	**2**	**1**	**2**	**1**	**2**	**2**
CO3	**3**	**2**	**1**	**2**	**2**	**1**	**1**
CO4	**3**	**2**	**1**	**2**	**1**	**2**	**2**

Semester II

ADVANCED JOINING PROCESS			
Course Code	**MMSE214B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Introduce the various advanced welding techniques which make the interested to choose a career in the field of welding.
- Understand the advanced welding practices in Industries and their comparative merits and demerits.
- Study the right kind of welding techniques for joining raw materials of various thicknesses.
- Learn the appropriate welding technique suitable for joining various types of metals.
- Understand the Computer-Aided Welding Design and Computer-Aided Welding Analysis.

Module-1	
Distortion-methodstoavoiddistortion.StressesinJointDesign.WeldingandCladdingofdissimilarmaterials, overlaying and surfacing. Advanced soldering and Brazing processes different types, Welding ofplastics	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-2	
Electro Slag, Welding Electron Beam Welding, Plasma arc Welding, Laser Beam Welding, Explosion Welding, Diffusion Welding, Ultrasonic Welding, Friction welding and Thermit welding. Advanced soldering and Brazing processes, Welding of plastics.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-3	
Inspection of Welds: Destructive techniques like Tensile, Bend, Nick break, Impact & Hardness. Non-Destructive techniques like 'X' rays, Ultrasonic, Magnetic particle, Dye Penetrant, Gamma ray inspection. **Welding Symbols**-Need for, Representing the welds, Basic weld symbols, Location of Weld, Supplementary symbols, Dimensions of welds, Examples.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-4	
Welding Design-Introduction, Principles of sound welding design, Welding joint design. Welding positions, Allowable strengths of welds, under steady loads. **Quality Control in Welding** Introduction, Quality assurance v/s Quality control, Weld quality, Discontinuities in welds, their causes and remedies and Quality conflicts.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-5	
Computer-Aided Welding Design- Introduction. Principles of sound welding design, Wilding joint design. Welding positions. Allowable strengths: of welds. Solved and unsolved examples.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks**or**oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **Welding Engineering Handbook**-A.W.S.
2. **Welding Engineering**-Rossi-McGrawHill.
3. **Advanced Welding processes**–Nikodaco & Shansky-MIR Publications

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=lTsvhSYstAE
- https://www.forbes.com/sites/bernardmarr/2018/09/02/what-is-industry-4-0-heres-a-super-easy-explanation-for-anyone/?sh=162dc3409788
- https://professional.mit.edu/news/articles/4-ways-ai-will-change-design-and-manufacturing
- https://www.hpe.com/in/en/what-is/machine-learning.html?jumpid=ps_u8bvx1ziqh_aid-520061736&ef_id=Cj0KCQjwmuiTBhDoARIsAPiv6L9QsMm4otXbOHvIYNeBMp2VcsEEtY3bvg3k77Xbh_JHpT8f4l48jPMaAiuMEALw_wcB:G:s&s_kwcid=AL!13472!3!558204153004!e!!g!!types%20of%20machine%20learning!14386686693!128518518145&
- https://theconversation.com/five-ways- -intelligence-can-help-space-exploration-153664
- https://aibusiness.com/author.asp?section_id=789&doc_id=773741#:~:text=Robotics%20and%20artificial%20intelligence%20are%20two%20related%20but%20entirely%20different,
- https://www.systema.com/automated-material-handling-systems#:~:text=Automated%20material%20handling%20systems%20ensure,even%20in%20two%20separate%20buildings

Skill Development Activities Suggested

- **Quizzes**
- **Assignments**
- **Seminars**

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Explain the various advanced welding techniques in the field of welding.	L2
CO2	Describe the advanced welding practices in Industries and their comparative merits and demerits.	L2
CO3	Select the right kind of welding techniques for joining raw materials of various thicknesses.	L3
CO4	Select appropriate welding technique suitable for joining various types of metals.	L3
CO5	Apply the knowledge to explore the Computer-	L3

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Understand contemporary issues in manufacturing engineering and develop relationship between product design and manufacturability to create safe, reliable, and cost-effective products.	PO4
5	Understand the process of converting customer needs into engineering specifications to create product designs that are sensitive to user needs and robust against unanticipated uses and misuse	PO5
6	Employ advanced prototyping methods to shorten design cycles and narrow alternatives without restricting innovation.	PO6
7	Understand and debate the roles and responsibilities of a product designer/manufacturer on society.	PO7

Mapping of COS and POs (Note : High - 3, Medium – 2, and Low – 1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**2**	**1**	**2**	**3**	**3**	**-**	**2**
CO2	**2**	**2**	**2**	**3**	**3**	**-**	**3**
CO3	**2**	**2**	**2**	**3**	**3**	**-**	**3**
CO4	**1**	**1**	**2**	**3**	**3**	**-**	**2**
CO5	**1**	**3**	**2**	**3**	**3**	**-**	**2**

Semester-II

ADVANCED FOUNDRY TECHNOLOGY			
Course Code	**MMSE214C**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	02

Course objectives:

- Study the concept of solidification and design of gates and riser in casting.
- Learn the design of casting and how to apply quality control techniques.
- Understand the designing of molding for grey cast, malleable cast iron and ductile cast iron.
- Understand the characteristic of design steel, aluminum and copper alloy casting.
- Study on how to modernize the casting techniques for improving the efficient quality.

Module-1

Solidification of Casting: Concept of solidification of metals. Homogenous and heterogeneous nucleation. Growth mechanism. Solidification of pure metals and alloys. Mechanism of columnar and dendritic growth. Coring or Segregation. Solidification time and Chvorinov's rule. Concept of progressive and directional solidifications.

Principles of Casting and Risering: Purpose of the gating system. Components of the gating system and its functions. Design of the gating System, different types of gates, gating ratio and its functions, definition and functions of the riser. Types of risers and their application. Design of the riser - its shape, size and location. Use of insulating material and exothermic compounds in risers.

Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-2

Design of Casting: Factors to be considered in casting design. Design consideration in pattern making, moulding techniques and core making and assembly. Cooling stresses and hot spots in casting and modification in casting geometry to overcome them.

Casting Quality Control: Casting defects and factors responsible for them. Different inspection and testing methods to evaluate the casting. Quality control activities in a foundry. Salvaging methods of defective casting.

Furnace Technology: Study of various furnaces used in foundry, construction and operation of crucible and hearth furnaces. Resistance, Arc and Induction furnaces-their construction, Operation, and application. Heat treatment furnaces and drying ovens used in foundry.

Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-3

Gray Cast - Iron Foundry Practice: Chemical Composition and structure of gray cast iron. Moulding, gating and risering techniques. Melting of gray cast iron in Cupola and induction Furnace. Inoculation of gray cast iron. Application of gray cast iron castings.

Malleable Cast Iron: Chemical composition and structure of White- heart and black-heart Malleable cast iron. Melting malleableizations heat treatment and application of malleable cast-iron.

Ductile Cast Iron: Chemical composition and structure of ductile cast iron. Melting and Spheroidization treatment. Inoculation of ductile iron Properties and application of ductile Iron casting.

Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-4

Steel Casting Practice: Common steel casting, their composition, structure and properties. Melting and refining of steel. Gating and risering of steel castings cleaning of steel castings.
Aluminium Foundry Practice: Composition, properties and application of common aluminium alloy casting. Melting and casting of AI-alloys. Gating and risering of AI-alloy casting.
Copper alloy Foundry Practice: General characteristics of common cast copper alloys. Melting and casting of copper alloys. Gating and risering of cu-alloy castings.

Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-5

Foundry Mechanization and Modernization: Introduction to modernization. Mechanization of foundry and its advantages. Mechanization of sand plant, moulding and core making mechanization in melting, pouring and shakeout units. Material handling equipment's and conveyor systems. Brief sketches and description of layouts of job. Captive and mechanized foundries

Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Assessment Details (both CIE and SEE)
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Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:
Books
FoundryTechnology–O.P.Khana

ReferenceBooks
(1) Principleofmetalcasting-Heine,et.al-Tata-McGraw-HiIIPublication-2003.
(2) AtestbookofFoundryTechnology-Lal,M.Khanna,P.O-DhanpatRai&SonsPublication.
FoundryTechnology-Beelely,P.R.–Butterworth.

Web links and Video Lectures (e-Resources):

- https://intelitek.com/fundamentals-of-robotics/
- https://www.youtube.com/watch?v=7Bahzh3rniw
- https://www.electronicsforu.com/technology-trends/tech-focus/sensors-robotics-artificial-intelligence
- https://www.youtube.com/watch?v=QJ1wixdSlRc
- https://www.youtube.com/watch?v=zyOv6rn3X88
- https://www.therobotreport.com/6-robotics-applications-new-markets/

Skill Development Activities Suggested

- **Quizzes**
- **Assignments**
- **Seminars**

Course outcome (Course Skill Set)
At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Explain the concept of solidification and design of gates and riser in casting.	L2
CO2	Apply the design concepts for the casting and quality control techniques.	L3
CO3	Demonstrate the concepts to design the moulding for grey cast,malleable cast iron and ductile cast iron.	L2
CO4	Demonstrate the concepts to design steel, aluminium and copper alloy casting.	L3
CO5	Modernize the casting techniques improving the efficient quality.	L4

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Understand contemporary issues in manufacturing engineering and develop relationship between product design and manufacturability to create safe, reliable, and cost-effective products.	PO4
5	Understand the process of converting customer needs into engineering specifications to create product designs that are sensitive to user needs and robust against unanticipated uses and misuse	PO5
6	Employ advanced prototyping methods to shorten design cycles and narrow alternatives without restricting innovation.	PO6
7	Understand and debate the roles and responsibilities of a product designer/manufacturer on society.	PO7

Mapping of COS and POs (Note : High - 3, Medium – 2, and Low – 1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**1**	**2**	**3**	**3**	**-**	**2**
CO2	**2**	**1**	**2**	**3**	**3**	**-**	**2**
CO3	**1**	**2**	**2**	**2**	**3**	**-**	**2**
CO4	**2**	**2**	**2**	**3**	**3**	**-**	**2**
CO5	**2**	**2**	**2**	**3**	**3**	**-**	**2**

Semester-II

PRECISION ENGINEERING			
Course Code	**MMSE214D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Study the accuracy, errors and stability of machine tools.
- Learn on stiffness, thermal effects and finish machining.
- Understand the dimensioning principles.
- Understand the micro-machining and micro-fabrication.
- Learn on smart structures, materials and micro actuators

Module-1	
CONCEPTS OF ACCURACY AND MACHINE TOOLS: Part Accuracy – errors, accuracy of machine tools –spindle accuracy – displacement accuracy – errors due to numerical interpolation – definition of accuracy of N.C system– errors in the NC machines – feed stiffness – zero stability.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc
Module-2	
STIFFNESS, THERMAL EFFECTS AND FINISH MACHINING: Over all stiffness of Lathe compliance of workpiece–errors caused by cutting forces–deformation in turning– boring–milling–heat sources –thermal effects–Finish Turning, boring, grinding–Surface roughness.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc
Module-3	
DIMENSIONING: Definition of terms–Key dimension–Superfluous dimension–dimensional stepped shaft– assigning tolerances in the constituent dimensions–dimensional chains.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc
Module-4	
MICRO-MACHINING MICRO-FABRICATION: Micro Machining – Photo resist process – Lithography – LIGA Process – Optical, processing of materials – electron beam machining – beam machining – micro forming, diamond turning – micro positioning devices – etching – physical vapour deposition – Chemical vapour deposition	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc
Module-5	
SMART STRUCTURES, MATERIALS AND MICRO ACTUATORS: Smart structures – Smart materials types and applications – smart sensors – micro valves –MEMS – Micro motors – Micro pumps – micro dynamometer – micro machines – micro optics– micro nozzles.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. MurthyR.L.,"PrecisionEngineeringinManufacturing",NewAgeInternationalPvt,2005.
2. JuliarW.Gardner.VijayK.Varadan,"Microsensors,MEMSandSmartDevices",JohnWileyandsons,2001.
3. StephenA.Campbell,"TheScienceandEngineeringofMicroelectronicFabrication",OxfordUniversityPress, 1996.
4. RaadyFrank,"UnderstandingSmartSensors",Artech.House,Boston,1996.
MEMSHandBook,CRCPress,2001.

Web links and Video Lectures (e-Resources):

- https://intelitek.com/fundamentals-of-robotics/
- https://www.youtube.com/watch?v=7Bahzh3rniw
- https://www.electronicsforu.com/technology-trends/tech-focus/sensors-robotics-artificial-intelligence
- https://www.youtube.com/watch?v=QJ1wixdSlRc
- https://www.youtube.com/watch?v=zyOv6rn3X88
- https://www.therobotreport.com/6-robotics-applications-new-markets/

Skill Development Activities Suggested

- **Quizzes**
- **Assignments**
- **Seminars**

Course outcome

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

Sl. No.	Description	Blooms Level
CO1	Explain the accuracy, errors and stability of machine tools.	L2
CO2	Describe the awareness on stiffness, thermal effects and finish machining.	L2
CO3	Draw and demonstrate the dimensioning principles.	L2
CO4	Infer on the micro-machining and micro-fabrication.	L3
CO5	Apply the knowledge to elicit the smart structures, materials, and micro actuators	L3

Program Outcome of this course

Sl. No.	Description	Pos
1	An ability to independently carry out research/investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	To be able to demonstrate a degree of mastery over the area as per the specialization of the program.	PO3
4	Understand contemporary issues in manufacturing engineering and develop relationship between product design and manufacturability to create safe, reliable, and cost-effective products.	PO4
5	Understand the process of converting customer needs into engineering specifications to create product designs that are sensitive to user needs and robust against unanticipated use and misuse	PO5
6	Employ advanced prototyping methods to shorten design cycles and narrow alternatives without restricting innovation.	PO6
7	Understand and debate the roles and responsibilities of a product designer/manufacturer on society.	PO7

Mapping of COS and POs (Note : High - 3, Medium – 2, and Low – 1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**1**	**2**	**2**	**2**	**3**	**3**	**2**
CO2	**1**	**2**	**3**	**3**	**3**	**3**	**2**
CO3	**2**	**2**	**2**	**2**	**3**	**3**	**2**
CO4	**1**	**2**	**2**	**3**	**3**	**3**	**2**
CO5	**1**	**2**	**2**	**3**	**3**	**3**	**2**

Professional Elective 4

Semester- II

AGILE MANUFACTURING			
Course Code	MMSE215A	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the agile manufacturing and conceptual frame work.
- Study to analyse the four core concept of agile manufacturing.
- Study the implication of advanced manufacturing system.
- Understand and design the agile manufacturing enterprises.
- Learn to develop the design skill and knowledge enhancing technology for agile manufacturing

Module-1	
Introduction-What is agile Manufacturing?-Competitive environment to the future the business case for agile manufacturing conceptual frame work for agile manufacturing.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-2	
Four Core Concepts: Strategy driven approach - integrating organization, people technology inter disciplinary design methodology.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-3	
Agile Manufacturing and Change Management: The change implications. Post failures in advanced manufacturing, changes on the way, traditional management accounting, paradigm, investment appraisal, product costing -performance, measurement and control systems, Traditional organization, control technological and design paradigms traditional problems in workplace- organizational issues - role of technology.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-4	
Agile Manufacturing Enterprise Design: Agile manufacturing - enterprise design, system concepts as the basic manufacturing theory - joint technical & organizational design and a model for the design of agile manufacturing enterprise, enterprise design process insights into design processes, what is interdisciplinary design, Main issues –simple design example.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-5
Skill & Knowledge Enhancing Technologies for Agile Manufacturing: Skill and Knowledge enhancing Technologies - scheduling - technology design Strategic-Design Concepts. Design and Skill of Knowledge enhancing Technologies for machine tool systems - Historical overview, Lessons, problems and Future development.

Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

(1) **Agile manufacturing-Forging new Frontiers**-PaulT.Kidd-AddisonWesleyPublication-1994.
(2) **Agile Manufacturing –Proceedings of International Conference**-Dr. M. P Chowdiah (Editor) –Tata Mc Graw Hill Publications - 1996.
(3) **On agile manufacturing**-TataMcGrawHillPublications-1996

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=_n28vUPJzxM
- https://www.youtube.com/watch?v=HQEkn-mJnas
- https://www.youtube.com/watch?v=7M_uMhxZtC4
- https://www.youtube.com/watch?v=VDz-SS6-P4s
- https://www.youtube.com/watch?v=G_0bl6FHo_c

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome

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

Sl. No.	Description	Blooms Level
CO1	Discuss the agile manufacturing and conceptual frame work.	L2
CO2	Analyse the four core concept of agile manufacturing.	L4
CO3	Analyse the implication of advanced manufacturing system.	L4
CO4	Design the agile manufacturing enterprises.	L4
CO5	Design skill and knowledge enhancing technology for agile manufacturing.	L4

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research/investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	To be able to demonstrate a degree of mastery over the area as per the specialization of the program.	PO3
4	Understand contemporary issues in manufacturing engineering and develop relationship between product design and manufacturability to create safe, reliable, and cost-effective products.	PO4
5	Understand the process of converting customer needs into engineering specifications to create product designs that are sensitive to user needs and robust against unanticipated use and misuse	PO5
6	Employ advanced prototyping methods to shorten design cycles and narrow alternatives without restricting innovation.	PO6
7	Understand and debate the roles and responsibilities of a product	PO7

Mapping of COS and POs (Note : High - 3, Medium – 2, and Low – 1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**1**	**2**	**2**	**2**	**3**	**3**	**2**
CO2	**1**	**2**	**3**	**3**	**3**	**3**	**2**
CO3	**2**	**2**	**2**	**2**	**3**	**3**	**2**
CO4	**1**	**2**	**2**	**3**	**3**	**3**	**2**
CO5	**1**	**2**	**2**	**3**	**3**	**3**	**2**

Semester- II

COMPUTER INTEGRATED MANUFACTURING AND AUTOMATION			
Course Code	**MMSE215B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- Understand the effect of manufacturing automation strategies.
- Learn how to Analyze computer aided quality control methods and techniques.
- Study to gain the knowledge for analyzing CIM planning system and computer network for manufacturing.
- Understand and analyse the flow lines and transfer mechanisms.
- Understand and analyse Automated material Handling Storage system

Module-1	
Production Development Through CIM: Computers in Industrial manufacturing, Product cycle & Production development cycle, Introduction of CAD/CAM & CIM, sequential and concurrent engineering, soft and hard prototyping. **Computer Process Monitoring:** Process control methods, direct digital control, supervisory computer control, steady state optimal control.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc
Module-2	
Computer Aided Quality Control: The computer in Q.C, automated inspection principles and methods, Contact inspection methods, non- contact inspection methods, machine vision system, optical inspection method, sensors, coordinate, measuring machine, Computer-Aided testing, Integration of	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc
Module-3	
Computer Integrated Manufacturing: Fundamentals of CAD/CAM, Computerized Manufacturing planning systems, shop floor control & automatic identification techniques. Computer Network for manufacturing and the future automated factor. **Detroit type of Automation:** Flow lines, Transfer Mechanisms, work pattern transfer, Different methods & Problems.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc
Module-4	
Analysis of Automated flow lines: Analysis of transfer lines without storage with storage buffer single stage, Double stage, Multistage with problems, Automated assembly systems, Design for automated assembly, parts feeding devices, analysis of Multi station assembly machine, Analysis of Single stage assembly machine.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc
Module-5	
Automated Material Handling Storage: Material functions, types of material handling equipment, analysis of material handling systems, design of system, conveyor system, automated guided vehicle systems, automated storage/retrieval systems, caroused storage systems work in process storage,	

interfacing handling & storage with manufacturing.

Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1 **CAD/CAM**-Zimmers & Grover–PHI.
2 **CAD/CAM/CIM**-P.Radhakrishna-NewAgeInternational-2ndedition.
3 **Automation, Production systems & Computer Aided Manufacturing**-M.P.Grover-PrenticeHall- 1984.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=_n28vUPJzxM
- https://www.youtube.com/watch?v=HQEkn-mJnas
- https://www.youtube.com/watch?v=7M_uMhxZtC4
- https://www.youtube.com/watch?v=VDz-SS6-P4s
- https://www.youtube.com/watch?v=G_0bl6FHo_c

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome

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

Sl. No.	Description	Blooms Level
CO1	Explain the effect of manufacturing automation strategies.	L2
CO2	Analyze computer aided quality control methods and techniques.	L4
CO3	Analyse CIM planning system and computer network for manufacturing.	L4
CO4	Analyze the flow lines and transfer mechanisms.	L4
CO5	Apply the knowledge gained to analyse the Automated material Handling Storage system.	L3

Program Outcome of this course

Sl. No.	Description	POs
1	To prepare students to meet the industrial requirements at global level competitiveness.	PO1
2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	PO2
3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	PO3
4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	PO4
5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	PO5
6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	PO6
7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	PO7

Mapping of COS and POs (Note : High - 3, Medium – 2, and Low – 1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**2**	**2**	**3**	**3**	**2**	**2**	**2**
CO2	**3**	**3**	**3**	**2**	**2**	**2**	**1**
CO3	**2**	**2**	**2**	**3**	**3**	**3**	**1**
CO4	**3**	**3**	**3**	**2**	**2**	**1**	**1**
CO5	**2**	**2**	**3**	**3**	**3**	**2**	**2**

Semester- II

CLOUD MANUFACTURING			
Course Code	MMSE215C	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Study the application of cloud computing in manufacturing enabling high level integration of product development phases.
- Learn to get an idea about different tools and methodologies used for cloud-based product management.
- Understand the concept of cloud based distributed environment for collaborative manufacturing.
- Study on how to apply the cloud concepts in a sustainable and global product development

Module-1	
Cloud based manufacturing systems- Introduction to cloud computing - definition- architecture of cloud manufacturing- resource requirements - service oriented manufacturing environment - LaaS, SaaS, PaaS, interoperability of systems, cloud-based systems and interoperability -virtual service layer.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-2	
Distributed Service - definition - application of manufacturing, assembly processes and management of productsforrecyclingofe-waste-customizabledecision-makingmodel.Developmentofcloudcommunityfor small and medium industries. Integrating OEMs and suppliers, out sourcing machining process – Cloud based manufacturing of parts, Vendor selection and supply chain management in cloud environment	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-3	
Factors affecting cloud technology adoption and implementation - Benefits of cloud, Barriers and approaches of cloud adoption, various perspectives of users, developers, and market teams, Data as a service, Business process as a service.	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-4	
Sustainable manufacturing system, product design, manufacturing - Needs of sustainability - adaption of sustainability factors in product development- manufacturing requirement, strategy, domain for production paradigm, Re use, Recycle, Remanufacture for sustainability- Life cycle sustainable information management	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-5	
Cloud based integrated systems for design and manufacturing - collaborative cloud-based systems - visualization information sharing - Designing by service for collaborative product development - Real time work in progress management- modelling for operational information exchange network	
Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. WeidongLi,JornMehnen,'CloudManufacturingDistributedcomputingtechnologiesforglobalandsustainable manufacturing, Springer New York
2. Stark,J.,ProductLifecycleManagement-21stCenturyParadigmforProductRealization, Springer-Verlag, London, 2005.
3. RajkumarBuyya,ChristianVecchiola,S.ThamaraiSelvi 'MasteringCloudComputingFoundations and Applications Programming', MK publications, ISBN: 978-0-12-411454- 8.
4. ThomasErl,ZaighamMahmood,andRicardoPuttini,'CloudComputingConcepts,Technology& Architecture', The Prentice Hall Service Technology, Series ISBN-10 : 9780133387520 ISBN-13: 978-0133387520

Web links and Video Lectures (e-Resources):

www.searchsoa.techtarget.comwww.cimdata.comwww.aberdeen.com

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome

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

Sl. No.	Description	Blooms Level
CO1	Understand the concept of cloud based distributed environment for collaborative manufacturing.	L2
CO2	To apply the cloud concepts in a sustainable and global product development	L2

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Understand contemporary issues in manufacturing engineering and develop relationship between product design and manufacturability to create safe, reliable, and cost-effective products.	PO4
5	Understand the process of converting customer needs into engineering specifications to create product designs that are sensitive to user needs and robust against unanticipated uses and misuse	PO5
6	Employ advanced prototyping methods to shorten design cycles and narrow alternatives without restricting innovation.	PO6
7	Understand and debate the roles and responsibilities of a product designer/manufacturer on society.	PO7

Mapping of COS and POs (Note : High - 3, Medium – 2, and Low – 1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**2**	**3**	**1**	**3**	**2**
CO2	**3**	**3**	**2**	**3**	**3**	**2**	**3**

Semester- II

COMPOSITE MATERIALS			
Course Code	**MMSE215D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Identify, describe and evaluate the properties of fibre reinforcements, polymer matrix materials and commercial composites.
- Identify, describe rule of mixture and failure criteria for composites.
- Learn how to develop competency in one o r more common composite manufacturing techniques, and be able to select the appropriate technique for manufacture of composite materials.
- Understand and analyse fabrication of composites and design of structure of composites.
- Understand and recommend composites for different applications and MMCs

Module-1

Introduction to Composite Materials: Definition, Classification, Types of matrices & reinforcements, characteristics & selection, Fiber composites, laminated composites, particulate composites, prepegs, sandwich construction.

Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-2

Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli – Rule of mixture, Macro mechanics of a lamina: Hooke‟s law for different types of materials, number of elastic constants, Laminate code, Failure criterion.

Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-3

Manufacturing: Lay Up and Curing– open and closed mould processing – Hand layup techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining and joining, tooling, Quality assurance Introduction, material qualification, types of defects, NDT methods.

Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-4

Fabrication of Composites: Cutting, machining, drilling, mechanical fasteners & adhesive bonding joining computer aided design manufacturing tooling fabrication equipment

Design of Fibre Reinforced Composite Structures: Introduction, Composite structural design, Design criteria, Laminate design, Mathematical analysis of the laminate, Design of composite stiffeners.

Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Module-5

Application Developments–Aircrafts, missiles, space hardware, automobile, electrical and electronics, marine, recreational and sports equipment-future potential of composites.

Metal Matrix Composites: Re-inforcement materials, types, Characteristics & Selection, base metals-selection, applications. Powder metallurgy technique, liquid metallurgy technique.

Teaching-Learning Process	Chalk and Talk/Use of ICT like Power Point Presentations etc

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**

to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **CompositeMaterialsHandbook**-MeinSchwartz-McGrawHillBookCompany-1984.
2. **MechanicsofCompositeMaterials**-AutarK.Kaw-CRCPressNewYork-1stedi,1997.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=H1SIpk0h4-Q
- https://www.youtube.com/watch?v=slgtMk8k4lk
- https://www.science.org.au/curious/technology-future/composite-materials
- https://www.spiedigitallibrary.org/conference-proceedings-of-spie/10596/1059603/Current-and-future-needs-and-research-for-composite-materials-NDE/10.1117/12.2291921.full?SSO=1

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome

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

Sl. No.	Description	Blooms Level
CO1	Identify, describe and evaluate the properties of fibre reinforcements, polymer matrix materials and commercial composites.	L3
CO2	Identify, describe rule of mixture and failure criteria for composites.	L2
CO3	Develop competency in one or more common composite manufacturing techniques, and be able to select the appropriate technique for manufacture of composite materials.	L3
CO4	Analyze the fabrication of composites and design of structure of composites.	L4
CO5	Analyse and recommend composites for different applications and MMCs	L4

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	Understand contemporary issues in manufacturing engineering and develop relationship between product design and manufacturability to create safe, reliable, and cost-effective products.	PO4
5	Understand the process of converting customer needs into engineering specifications to create product designs that are sensitive to user needs and robust against unanticipated uses and misuse	PO5
6	Employ advanced prototyping methods to shorten design cycles and narrow alternatives without restricting innovation.	PO6
7	Understand and debate the roles and responsibilities of a product designer/manufacturer on society.	PO7

Mapping of COS and POs (Note : High - 3, Medium – 2, and Low – 1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	3	3	3	3	2
CO2	1	3	3	3	3	3	2
CO3	1	2	2	3	3	3	3
CO4	2	3	3	3	-	3	3
CO5	2	3	3	3	3	-	2

Semester-II

DESIGN FOR MANUFACTURE AND ASSEMBLY			
Course Code	**MMSE206**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the principles of manufacturability and design for manufacture.
- Design casting and weldment for economic production quantity.
- Understand the concept of assembly, its design and true position of datum system.
- Design parts cut to length and screw machine parts of various processes, open and closed die forging.
- Design guidelines and background for powder metallurgy part and reviewing of formed parts.

Mosdule-1	
INTRODUCTION: General design principles for manufacturability, Process Capability, Feature tolerance, Geometrical tolerance, Surface finish, Review of relationship between attainable Tolerance grades, and different machining processes, Economics of process selection, Principles of Design for Manufacture, Quality Manufacturability, Introduction to Tolerance Charting Technique.	
Teaching-Learning Process	Chalk and Talk / White board, Power Point Presentation, Video Demonstration or Simulation.

Module-2	
DESIGN OF CASTINGS: Redesign of castings based on parting line considerations, Minimising core requirements, other design consideration, economic production quantities**.** **DESIGN OF WELDMENTS:** Advantages of weldments, Design for economical and efficient welding, Redesigning cast members using weldments, use of welding symbols, Economic production quantities,	
Teaching-Learning Process	Chalk and Talk / White board, Power Point Presentation, Video Demonstration or Simulation.

Module-3	
DESIGN FOR ASSEMBLY: Applications of selective assembly, Design recommendations for different fastening arrangements, Automatic assembly, control of axial play in assemblies, Design for easy assembly, Design for easy disassembly. **TRUE POSITION THEORY AND DATUM SYSTEMS:** Theoretically exact dimension, virtual size concept, assembly considerations as applied to True Position Tolerancing, examples, Grouped datum systems, different types examples.	
Teaching-Learning Process	Chalk and Talk / White board, Power Point Presentation, Video Demonstration or Simulation.

Module-4	
DESIGN FOR MACHINING: Parts cut to length, screw machined products, Machined round holes, Moulded parts, Parts produced buy planning. shaping& slotting, Broached parts, Ground parts, roller burnished parts, Gears, Economical deburring, re dimensioning of parts based on manufacturing datum. **DESIGN FOR FORGING:** Introduction, open die forging. Closed die forging.	
Teaching-Learning Process	Chalk and Talk / White board, Power Point Presentation, Video Demonstration or Simulation.

Module-5	
DESIGN FOR POWDER METALLURGY: Introduction, Design guidelines, Background, Design for Powder Metallurgy parts. **A review of design** considerations in formed metal components, non metallic parts, Designing for heat	

treatment, Design for quality and mass production.

Teaching-Learning Process	Chalk and Talk / White board, Power Point Presentation, Video Demonstration or Simulation.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks**or**oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. "Product Design for Manufacture and Assembly" Geoffrey Boothroyd, Peter Dewhurst and Winston A. Knight, Standardsmedia. ISBN-13: 978-1420089271,
2. "Product Design and Development".Karl T. Ulrich and Steven D. EppingerMcGraw-Hill EducationISBN-13: 978-0073404776
3. "Product Design and Manufacturing", Chitale A. K and Gupta R. C, Prentice Hall India Learning Private Limited,ISBN-13: 978- 8120342828, 5th Edition. 2011

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=igWfQpxI100
- https://www.youtube.com/watch?v=6BTofPdLbNo
- https://www.youtube.com/watch?v=SXPsS2vjoRI
- https://dfmpro.com/manufacturing-processes/dfmpro-for-machining/
- https://www.youtube.com/watch?v=n-2oOq3Ao9U

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Explain the principles of manufacturability and design for manufacture	L1, L2, L3, L4
CO2	Design casting and weldment for economic production quantity.	L1, L2, L3, L4,L5
CO3	Understand the concept of assembly, its design and true position of datum system.	L1, L2, L3, L4,L5
CO4	Design parts cut to length and screw machine parts of various processes, open and closed die forging.	L1, L2, L3, L4,L5
CO5	Design guidelines and background for powder metallurgy part and	L1, L2, L3,

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research/investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	To be able to demonstrate a degree of mastery over the area as per the specialization of the program.	PO3
4	Understand contemporary issues in manufacturing engineering and develop relationship between product design and manufacturability to create safe, reliable, and cost-effective products.	PO4
5	Understand the process of converting customer needs into engineering specifications to create product designs that are sensitive to user needs and robust against unanticipated use and misuse	PO5
6	Employ advanced prototyping methods to shorten design cycles and narrow alternatives without restricting innovation.	PO6
7	Understand and debate the roles and responsibilities of a product	PO7

Mapping of COS and POs (Note : High - 3, Medium – 2, and Low – 1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**1**	**1**	**2**	**2**	**3**	**3**	**2**
CO2	**1**	**2**	**2**	**2**	**3**	**3**	**2**
CO3	**1**	**2**	**2**	**2**	**3**	**3**	**2**
CO4	**1**	**2**	**2**	**2**	**3**	**3**	**2**
CO5	**1**	**2**	**2**	**2**	**3**	**3**	**2**

Semester-II

MANUFACTURING LABORATORY			
Course Code	**MSEL207**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	0:0:2	SEE Marks	50
Credits	02	Exam Hours	03

Courseobjectives:

- Understand the basic components of pick and place Robot.
- Awareness on assembly activities and programming
- Study the Palletizing operations, assembly,and inspection operation etc.
- Understand on revolute-type 6DOF robot.

Sl.NO	Experiments
1	Study of pick and place Robot-basic components, configuration, work volume.
2	Experiments with Robot. Kit for minimum four assembly activities and programming.
3	Programming of robots by manual, lead through and offline methods.
4	Programming languages for stacking of objects in increasing or decreasing size. Palletizing operations, assembly, and inspection operation etc.
5	Demonstration of robot with 2DOF,3DOF,4DOF
6	To become acquainted with the operation of a revolute type 6DOF robot. To program a robotic system using at each independent and a high-level programming language. Emphasis is made on the constraints associated when positioning and orienting an object within a 3-DspaceThe Practical includes point-to-point tasks and continuous robot motion.
	Demonstration Experiments (For CIE) if any
7	Two programming exercises for robots
8	Two case studies of applications in industry
9	Exercise on robotic simulation software
10	Two assignments on programming the robot for applications

Course out comes(Course Skill Set):

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

- Explain the basic components of pick and place Robot.
- Demonstrate the awareness on assembly activities and programming
- Analyze the Palletizing operations, assembly, and inspection operation.
- Design and demonstrate the operation of a revolute-type 6 DOF robot.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40%of maximum marks in the semester-end examination (SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.

- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation(SEE):

SEE marks for the practical course is50Marks.

- SEE shall be conducted jointly by the two examiners of the same institute; examiners are appointed by the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Break up of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal/external examiners jointly.
- Evaluation of test write-up/conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, write up-20%, Conduction procedure and result in-60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero. The duration of SEE is 03 hours

Suggested Learning Resources:

- K.S.Fu,R.C.Gonzalez and C.S.G.Lee, "Robotics Control, Sensing, Vision and Intelligence", Mc Graw Hill, 1987.
- Yoram Koren," Robotics for Engineers'", Mc Graw-Hill, 1987.
- Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey," Industrial Robotics Technology, Programming and Applications", McGraw-Hill, Int. 1986.

Web References

http://www.ifr.org/gallery/type.htm

Ability Enhancement Course

IOT IN MANUFACTURING			
Course Code	MMSE258A	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	00:02/01:00	SEE Marks	50
Total Hours of Pedagogy	30/15	Total Marks	100
Credits	01	Exam Hours	03

Course Learning objectives:
The course is designed to offer fundamentals of IoT in manufacturing and their applications in the business world. Learners will gain deep insights into how smartness is being harnessed and what needs to be done to overcome some of the challenges in the field of Mechanical Engineering

Module-1

Introduction to Industrial IoT: IoT background, History and definition, IoT enabling factors, IoT use cases, IoT key technologies, I-IoT – Fourth industrial revolution, use cases of the I-IoT, Similarities and differences of IoT and I-IoT, IoTanalytics and AI, Industry environment scenarios covered by I-IoT.

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Module-2

Understanding the Industrial process and devices: Industrial process, automation in the industrial process, control and measurement systems, types of industrial process, The CIM pyramid, CIM pyramid architecture – devices and networks, CIM network, The I-IoT data flow, The Industrial IoT data flow in a factory, The edge device, The Industrial IoT data flow in the cloud. Industrial data flow and devices, The I-IoT data flow in the factory, Measurement and the actuator chain.

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Module-3

Understanding of Node MCU: Open Source Microcontroller Platform, Node GPIO Pins, and Basics of Electronics. Introduction toEsp8266, Wifi Network, Web serve. Cloud Servers. IoT Sensors- Temperature, Humidity Sensor, Light, Gyro, Inclination, Magneto, Pressure, Flow, Aqua, Position, vibration and acoustic sensors. Protocol -MQTT Protocol, HTTP vs MQTT, Creating Adafruit account, Using Adafruit to read sensors value and send data to Node MCU

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Module-4

Implementing the I-IoT data flow: Discovering OPC, OPC classic, The data model and retrieving, data in OPC classic, OPC UA, The OPC UA information model, OPC UA sessions, OPC UA security model, The OPC UA data exchange, OPC UA notifications, Understanding the I-IoT edge, Features of the edge – edge gateway, edge tools, edge computing, The I-IoT edge architecture, Edge implementations – Azure IoT edge, Green grass, Android IoT, Node red, Docker edge, Intel IoT gateway, Edge Internet protocols.

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Module-5

Understanding of I-IoT data loggers: Internal architecture of I-IoT data logger, communication protocols, I/O modules (Digital and Analog).Configuring I-IoT data logger through a web based application, Establishing communication between PLC and I-IoT data logger. Interfacing of industrial sensor with I-IoT data logger. Development of cloud based applications for the Mechatronics systems using the I-IoT data logger thorough web portal.

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Textbooks

1. Oliver Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key, Applications and Protocols", Wiley Publications, 2011. ISBN: 1119966701.
2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", A press, 1st Edition, 2017. ISBN: 1484220463.
3. RMD SundaramShriram K Vasudevan, Abhishek S Nagarajan, "Internet of Things", Wiley Publications, 2019. ISBN: 8126578378.

Web links and Video Lectures (e-Resources):

- https://youtu.be/hv-aBonZMRQ?list=PLWbMIWDTOauBvP0ZxvoIshg55WPMF37UI
- https://youtu.be/De8MQWbhu3k

Skill Development Activities Suggested

- Individual projects on topics covered in class. Students will choose a real life problems related to the discussedtopics and implement the solution by using techniques and strategies discussed in the class. For each project,students have to submit a report and present a seminar.
- Assignments, Quiz and Industrial Visit on relevant topic of the course.

Program Outcome of this course

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

Sl. No.	Description Blooms Level	Blooms Level
CO1	Use IoT Sensors for data logging and communicate the data to cloud	L1
CO2	Use IoT Sensors data in AI & ML	**L1**
CO3	Automate different process using sensors and control components	**L2**
CO4	Understand IOT alliances/hardware and standards	**L1**

Mapping of COS and Pos (Note : High – 3, Medium – 2, and Low – 1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	2	2	2
CO2	3	2	2	2	1	1	2
CO3	3	2	1	2	2	1	2
CO4	3	2	1	2	1	2	1
CO5	3	2	1	3	1	2	1

MICRO MACHINING PROCESSES			
Course Code	MMSE258B	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	00:02/01:00	SEE Marks	50
Total Hours of Pedagogy	30/15	Total Marks	100
Credits	01	Exam Hours	03

Course Learning objectives:

- Understand the Micro System design, Material properties, micro fabrication technologies etc.
- Study the Microstructure of materials, phase transformations in crystalline solids and smart materials.
- Learn about the various processes and special machining's.
- Understand the micro-and ultra precision machining.
- Awareness on semiconductors manufacturing using micro fabrication technologies.

Module-1

INTRODUCTION: Introduction to Micro System design, Material properties, micro fabrication technologies. Structural behavior, sensing methods, micro scale transport – feedback systems.

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Module-2

MICROMECHANICS: Microstructure of materials, its connection to molecular structure and its consequences on macroscopic properties – Phase transformations in crystalline solids including martensite, ferroelectric, and diffusional phase transformations, twinning and domain patterns, smart materials.

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Module-3

BASIC MICRO – FABRICATION: Bulk Processes – Surface Processes – Sacrificial Processes and Bonding Processes– Special machining: Laser beam micro machining – Electrical Discharge Machining – Ultrasonic Machining – Electro chemical Machining, Electron beam machining.

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Module-4

MECHANICAL MICROMACHINING: Theory of micromachining – Chip formation – Size effect in micromachining – micro turning, micro milling, micro drilling – Micromachining tool design – Precision Grinding – Partial ductile mode grinding – Ultra precision grinding – Binder less wheel – Free form optics.

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Module-5

SEMICONDUCTORSMANUFACTURING: Basic requirements–clean room–yield model–Wafer IC manufacturing–feature micro fabrication technologies–PSM–IC industry–New Materials–Bonding and layer transfer–devices–micro fabrication industries.

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**

to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Textbooks

1 SamiFranssila,"IntroductiontoMicroFabrication",JohnWileyandsonsLtd.,UK,2004,ISBN:978-0-470- 85106-7.
2 MadoreJ,"FundamentalofMicroFabrication",CRCPress,2002
3 MarkJ.Jackson,"MicrofabricationandNanomanufacturing",CRCPress,2006.
4 PeterVanZant,"Microchipfabrication",McGrawHill,2004.

Program Outcome of this course

Sl. No.	Description	Pos
1	An ability to independently carry out research/investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	To be able to demonstrate a degree of mastery over the area as per the specialization of the program.	PO3
4	Understand contemporary issues in manufacturing engineering and develop relationship between product design and manufacturability to create safe, reliable, and cost-effective products.	PO4
5	Understand the process of converting customer needs into engineering specifications to create product designs that are sensitive to user needs and robust against unanticipated use and misuse	PO5
6	Employ advanced prototyping methods to shorten design cycles and narrow alternatives without restricting innovation.	PO6
7	Understand and debate the roles and responsibilities of a product designer/manufacturer on society.	

Mapping of COS and Pos (Note : High – 3, Medium – 2, and Low – 1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	2	3	3	3	2
CO2	1	1	2	2	3	-	2
CO3	2	2	2	3	3	-	2

ARTIFICIAL INTELLIGENCE IN MANUFACTURING			
Course Code	MMSE258C	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	00:02/01:00	SEE Marks	50
Total Hours of Pedagogy	30/15	Total Marks	100
Credits	01	Exam Hours	03

Course Learning objectives:

- To understand the modern manufacturing concepts.
- To learn the concept of AI based methods for process controls.
- To analyse the automated material handling systems.

Module-1

Introduction to Modern Manufacturing and AI Based Applications: Introduction to Modern Manufacturing Process, Industry 4.0, Introduction to AI and its applications in manufacturing, Design in Manufacturing and AI Requirements.

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Module-2

AI based Methods for Process Control & Monitoring: Machine Learning methods, AI based Monitoring and control of discrete manufacturing process, Online process monitoring in additive manufacturing, Industrial Machine Vision, Development of Digital Twins.

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Module-3

AI based Design Space Exploration: Multi objective heuristic search for DSE, Algorithms for Customizable Manufacturing, Allocation and Layout, Scheduling for flexible manufacturing systems**.**

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Module-4

AI & Robotics: AI based Robot Architecture & Applications in Automated Manufacturing, Robot Vision & Motion, Multi agent and swarm robotics, Robot to Robot and Robot to human coordination (Cobots - collaborative robotics) Reliable & Trusted AI in Robotics.

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Module-5

Automated material Handling Storage: Material functions, types of material handling equipment, analysis of material handling systems, design of system, conveyor system, automated guided vehicle systems, automated storage/retrieval systems, caroused storage systems work in process storage, interfacing handling & storage with manufacturing.

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module The students will have to answer five full questions, selecting one full question from each module

Textbooks

1. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig, 3rd Edition, Prentice Hall, 2009.
2. Deep Learning - Ian Goodfellow, YoshuaBengio, Aaron Courville, MIT Press, 2018
3. Additive manufacturing of Metals: The Technology, Materials , Design and Production; Ed. Li Yang, et al.; Springer International Publishing AG 2017
4. Laser Materials Processing, by W M Steen, J. Mazumder, 4th Ed. Springer
5. Handbook of Industrial Robotics by Shimon Y. Nof (Editor), ISBN 9788126540303.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=lTsvhSYstAE
- https://www.forbes.com/sites/bernardmarr/2018/09/02/what-is-industry-4-0-heres-a-super-easy-explanation-for-anyone/?sh=162dc3409788
- https://professional.mit.edu/news/articles/4-ways-ai-will-change-design-and-manufacturing
- https://theconversation.com/five-ways- -intelligence-can-help-space-exploration-153664
- https://www.systema.com/automated-material-handling-systems#:~:text=Automated%20material%20handling%20systems%20ensure,even%20in%20two%20separate%20buildings.

Course outcome

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

Sl. No.	Description	Blooms Level
CO1	Learn how AI methods can be used in a manufacturing workflow for process optimization and control	L1, L2, L3, L4
CO2	Discover AI/machine learning methods that enable design automation and customization	L1, L2, L3, L4,L5
CO3	Explore AI/machine learning methods for performance-driven design that automatically translate functional specifications of objects to manufacturable designs	L1, L2, L3, L4,L5
CO4	Learn AI based Robot Architecture & Applications in Automated Manufacturing, Robot Vision & Motion, Multi agent and swarm robotics.	L1, L2, L3, L4,L5
CO5	Explore Material functions, types of material handling equipment, analysis of material handling systems, design of system, conveyor system.	L1, L2, L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research/investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	To be able to demonstrate a degree of mastery over the area as per the specialization of the program.	PO3
4	Understand contemporary issues in manufacturing engineering and develop relationship between product design and manufacturability to create safe, reliable, and cost-effective products.	PO4
5	Understand the process of converting customer needs into engineering specifications to create product designs that are sensitive to user needs and robust against unanticipated use and misuse	PO5
6	Employ advanced prototyping methods to shorten design cycles and narrow alternatives without restricting innovation.	PO6
7	Understand and debate the roles and responsibilities of a product designer/manufacturer on society.	PO7

Mapping of COS and Pos (Note : High – 3, Medium – 2, and Low – 1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**1**	**1**	**2**	**2**	**3**	**3**	**2**
CO2	**1**	**2**	**2**	**2**	**3**	**3**	**2**
CO3	**1**	**2**	**2**	**2**	**3**	**3**	**2**
CO4	**1**	**2**	**2**	**2**	**3**	**3**	**2**
CO5	**1**	**2**	**2**	**2**	**3**	**3**	**2**

MACHINE LEARNING			
Course Code	MMSE258D	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	00:02/01:00	SEE Marks	50
Total Hours of Pedagogy	30/15	Total Marks	100
Credits	01	Exam Hours	03

Course Learning objectives:
To discover patterns in the user data and then make predictions based on these and intricate patterns for Answering business questions and solving business problems.

Module-1

Introduction, Concept Learning and Decision Trees Learning Problems – Designing Learning systems, Perspectives and Issues – Concept Learning – Version Spaces and Candidate Elimination Algorithm – Inductive bias – Decision Tree learning – Representation – Algorithm – Heuristic Space Search

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Module-2

Neural Networks and Genetic Algorithms: Neural Network Representation – Problems – Perceptron‟s – Multilayer Networks and Back Propagation Algorithms – Advanced Topics – Genetic Algorithms – Hypothesis Space Search – Genetic Programming – Models of Evolution and Learning.

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Module-3

Bayesian and Computational Learning Bayes Theorem – Concept Learning – Maximum Likelihood – Minimum Description Length Principle – Bayes Optimal Classifier – Gibbs Algorithm – Naïve Bayes Classifier– Bayesian Belief Network – EM Algorithm – Probably Learning – Sample Complexity for Finite and Infinite Hypothesis Spaces – Mistake Bound Model

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Module-4

Instant Based Learning and Learning Set of Rules: K- Nearest Neighbor Learning – Locally Weighted Regression – Radial Basis Functions – Case-Based Reasoning – Sequential Covering Algorithms – Learning Rule Sets – Learning First Order Rules – Learning Sets of First Order Rules – Induction.

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Module-5

Analytical Learning and Reinforced Learning: Perfect Domain Theories – Explanation Based Learning – Inductive Analytical Approaches - FOCL Algorithm – Reinforcement Learning – Task – Q-Learning – Temporal Difference Learning

Teaching-Learning Process	Chalk and talk method and Power Point presentation and YouTube videos, Animation videos, creating right time in classroom discussions. Giving activities &assignments.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**
    a. to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module The students will have to answer five full questions, selecting one full question from each module

Textbooks

(1) Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (INDIAN EDITION), 2013.
(2)EthemAlpaydin, "Introduction to Machine Learning", 2nd Ed., PHI Learning Pvt. Ltd., 2013.

Reference Books

(1) Stephen Marsland, Machine Learning: An Algorithmic Perspective
(2) T. Hastie, R. Tibshirani, J. H. Friedman, "The Elements of Statistical Learning", Springer; 1st Edition, 2001
(3) Tom Mitchell, Machine Learning,

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Course Outcomes

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

Sl. No.	Description Blooms Level	Blooms Level
CO1	Design the learning system for learning problem with this basic knowledge	**L2**
CO2	Apply effectively neural networks and genetic algorithms for appropriate applications.	**L3**
CO3	Apply bayesian techniques for classification problems	**L2**
CO4	Derive effectively learning rules for appropriate learning systems	**L2**
CO5	Choose and differentiate reinforcement and analytical learning techniques	**L3**

Program Outcome of this course

Sl. No.	Description POs	POs
1.	To prepare students to meet the industrial requirements at global level competitiveness.	**PO1**
2.	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	**PO2**
3.	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	**PO3**
4.	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	**PO4**
5.	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	**PO5**
6.	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	**PO6**
7.	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	**PO7**

Mapping of COS and Pos (Note : High – 3, Medium – 2, and Low – 1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**2**	**3**	**3**	**3**	**2**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**2**
CO3	**3**	**3**	**3**	**2**	**2**	**1**	**1**
CO4	**3**	**3**	**3**	**2**	**2**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**1**