Semester- II

Automation and Manufacturing Systems			
Course Code	MMIA/MMAR201	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3-0-0	SEE Marks	50
Total Hours of Pedagogy	40 hrs	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To impart the knowledge of product cycle and its development.
- Understand the importance of prototypes, CAD/CAM & CIM.
- Students will get an exposure to fundamentals of networking
- Understand working of Material handling and storage systems.
- Exposure to Computer aided inspection methods

Module-1(8 Hours)

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.

Module-2(8 Hours)

Computer Integrated Manufacturing and Automation: Fundamentals of CAD/CAM, Computerized Manufacturing planning systems, shop floor control & automatic Identification techniques. Computer Network for manufacturing and the future automated factory **Detroit Type of Automation:** Flow lines, Different Transfer Mechanisms, work pattern Transfer, Different methods, Numerical.

Module-3(8 Hours)

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, Numerical.

Computer Process Monitoring: Process control methods, direct digital control, supervisory computer control, steady state optimal control, on line search strategies, adaptive control.

Module-4(8 Hours)

Fundamentals of Networking: Principles, techniques, networking methods, network standards, Ethernet, Internet, system security, remote systems, NFS, ATM, EWN, document and work flow management.

Automated Material Handling and 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.

Module-5 (8 Hours)

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 CAQC with CAD/CAM.

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, New Age International.
3. M. P. Grover, Automation, Production Systems & Computer Aided manufacturing, Prentice Hall.
4. CAD/CAM – Zeid, Mc-Graw Hill
5. CAD/Cam, P. N. Rao.

Web links and Video Lectures (e-Resources):

- VTUe- Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industrial Visit

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the importance of product development through CIM.Get knowledge of shop floor control , Computer Integrated Manufacturing and Automation.	L2
CO2	Adopt appropriate material handling and storage in an automated manufacturing environment	L2
CO3	Incorporate methods of utilization of appropriate features in CAD application enhancing productivity in design	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.	PO3

Mapping of COS and POs

	PO1	PO2	PO3
CO1	**1**	**2**	**3**
CO2	**1**	**2**	**2**
CO3	**1**	**2**	**2**

Semester - II

Hydraulics & Pneumatics Control System (IPCC)			
Course Code	MMIA/MMAR202	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:02:00	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

- Understand the underlying theoretical concepts
- Be familiar with the construction and function of the components
- Know how the components are selected and integrated into a system
- Understand the operation of basic circuits, and
- Know how to read basic circuits, troubleshoots and analyze

MODULE-1

Applications of pneumatics and hydraulics in industry: Industrial Applications. Combined technologies, Uses of fluid power systems, Hydraulic and pneumatic safety systems,

Basic principles of fluid power systems: Physical properties of air, the principle of hydraulic systems, the fluid power system, SI system of units, Newton's law, Boyle's law

MODULE-2

Features and Characteristics of Pneumatic and Hydraulic Systems: Air pressure relationship-atmospheric and gauge pressure, advantages and distinguishing characteristics of compressed air and hydraulic systems, disadvantages and limitations of pneumatic and hydraulic systems, basic requirements for mains air supplies.

Component, Equipment And Plant symbols: Identification of graphical symbols used in pneumatics and hydraulics, energy conversion symbols, examples of assemblies of equipment, examples of complete installations, component identification.

MODULE-3

Fluid power generation, supply and distribution: Air generation and distribution compressor types, positive displacement compressors, reciprocating compressors helical and spiral-lobe compressors (screw) sliding-vane compressors two impeller straight-lobe compressors and blowers dynamic compressors centrifugal compressors axial compressors coolers and dryers graphical symbols used in energy conversion and air preparation the hydraulic supply system hydraulic pumps accumulators.

Control valves I: Types and principles of operation. Types of valves, directional control valves – general the directional control valve as a signalling element the directional control valve as a processing element the directional control valve as a power element 5/2-way valve for cylinder control: double pilot valve methods of actuation – directional control valves the non-return valve the flow control valve.

MODULE-4

Control Valves II: Types and Principles of Operation. Pressure control valves, pressure regulating valve as used in pneumatic circuits, pressure control valves – symbols, combinational valves, time delay valve, time delay valve: normally closed, time delay valve: normally open, solenoid valves.

Actuators: Types of actuators, single-acting cylinder, direct control of a single-acting cylinder, indirect control of a single acting cylinder, double-acting cylinder cushioned double-acting cylinder, linear actuators – symbols, the rodless cylinder, control of a rodless cylinder, hydro-pneumatic systems, air motors – general, piston motors, sliding vane motors, pneumatic gear motors, turbines (flow motors), hydraulic motors, hydraulic gear motor, hydraulic high torque, low speed motor, rotary actuators, rotary motion actuators – symbols, methods of visual indication of actuation.

MODULE 5

Design of pneumatic and hydraulic circuits and arrangement of components: the logic or function, the fluid power logic 'or' circuit, the logic and function, the fluid power logic and circuit, the latched (memory) circuit, sequential circuits, cascading techniques. Electro-Pneumatics and electro-hydraulics, electro-pneumatics, electro-hydraulics.

Fluid Power Measurement Systems: the basic fluid power measuring system, pressure measurement, the bourdon tube pressure gauge, the strain gauge pressure measuring system, the piezoelectric pressure transducer, flow measurement, the turbine flowmeter, the industrial thermometer, the thermistor, the thermocouple common terms used in measuring systems.

Troubleshooting and Maintenance: Introduction, faultdiagnosis causes and effects of malfunctions fault finding on fluid power systems, malfunctions caused by undersized air supply in pneumatic systems, malfunctions caused by condensate

within pneumatic systems, problems in hydraulic systems, malfunctions caused by contamination, maintenance of pneumatic systems, maintenance of hydraulic systems, a guide to the use of functional charts for fault finding.

PRACTICAL COMPONENT OF IPCC*(May cover all / major modules)*

Sl.NO	Experiments
1	Fundamentals for Hydraulic and Pneumatic Systems: Physical properties , Mass, Weight, Volume, Density, Relative density or Specific gravity, Force, Work, Energy etc.
2	Operating of Hydraulic Single – Rod Cylinder /Pressure Intensification
3	Operating of Hydraulic Single – Rod Cylinder /Using 4/2 DCV (Meter –In and Meter-Out Circuits)
4	Applications of 4/3 directional Control Valve for Hydraulic Circuits
5	Study on Hydraulic Motor with 4/3 DCV for Hydraulic Circuits
6	Study on Hydraulic Accumulator
7	Operating of Pressure Switches for Pneumatic Circuit
8	Pressure-Dependent of 1 Double Acting Pneumatic Cylinder
9	Time-Dependent of 1 Double Acting Pneumatic Cylinder
10	Indirect Control of Pneumatic Single Cylinder
11	Demo experiments on Speed Control Single Acting Cylinder: Slow Speed Extension and Rapid Retraction
12	Demo experiments on Sequential of Two Double Acting Cylinders without Overlapping Signals

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**.

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SEE for IPCC

Theory SEE will be conducted by the 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. Engineering Applications of Pneumatics and Hydraulics. EUR ING Ian C. Turner 2nd Edition, BSc CEng CEnv HonFSOE HonFIPlantE FInstMC MICBSE MIET. Second edition published 2021 by Routledge, 2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN and by Routledge, 52 Vanderbilt Avenue, New York, NY 10017
2. Anthony Esposito. Fluid Power with Application, Pearson Education, inc, 2000.
3. John J Pippinger and Tyler Gregory Hicks. Industrial Hydraulics, McGraw-Hill, 1979.
4. Dudley A. Pease and John J. Pippenger. Basic Fluid Power. Prentice-Hall 1987.
5. John S. Cundiff. Fluid Power Circuits and Controls: Fundamentals and Applications, CRC Press, 2001.
6. Noah D. Manring and Roger C. Fales. Hydraulic
7. Herbert E. Merritt. Hydraulic Control Systems. John Wiley & Sons, Inc.USA, 1967.

Web links and Video Lectures (e-Resources):

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

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Study of working principle of various components used in hydraulic and pneumatic systems.	L1
CO2	Select different components used in hydraulic and pneumatic systems.	L2
CO3	Design of hydraulic and pneumatic circuits.	L3
CO4	Understand industrial applications of hydraulic and pneumatic circuits.	L1

Program Outcome of this course

Sl. No.	Description	POs
01	An ability to independently carry out research/investigation and development work to solve practical problems	PO1
02	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	PO2
03	Students should be able to design, synthesize and analyze a physical Engineering systems using modern tools and techniques.	PO3
04	Students should be able to conduct analytical and experimental investigations on Industrial and societal problems to provide sustainable solutions.	PO4

Mapping of COS and POs

	PO1	PO2	PO3	PO4
CO1	3	2	1	-
CO2	3	2	1	2
CO3	1	2	1	2
CO4	3	2	1	2

Semester- I

Computer Integrated Manufacturing			
Course Code	MMIA/MMAR203	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3-0-0	SEE Marks	50
Total Hours of Pedagogy	40 hrs	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

Understand the importance of product development through CIM. Get knowledge of shop floor control, Computer Integrated Manufacturing and Automation. Adopt appropriate automated manufacturing environment and Incorporate methods of utilization of appropriate features in CAD application enhancing productivity.

Module-1(8 Hours)

Introduction to Computer integrated Manufacturing Systems: Manufacturing Systems, Types of Manufacturing Systems, , Machine Tools and related equipment's, Material Handling Systems, Computer monitoring and control, Manufacturing support systems, Functions of computers in CIMS: CIMS Data Files, System Reports, Benefits of Computer integrated Manufacturing Systems.

Fundamentals of Numerical Control: Basic concepts of NC, Classification of NC- Point to Point and contouring, Incremental and absolute system, Open loop and closed loop system, Advantages of NC.

Module-2(8 Hours)

Features of NC Machine tools: Fundamentals of machining, design consideration of NC machine tools, methods of improving machining accuracy, increasing productivity with NC machines, machining centers, MCU Functions.

CIM System: Hierarchical computer control, DNC system, manufacturing cell, Flexible manufacturing system, CAD /CAM systems, computer machining systems, Factory of the future.

Module-3(8 Hours)

N.C part programming: Introduction, manual part programming, Practical Exercises on NC part programming, computer assisted part programming. NC part programming languages, the APT language, the macro statement in APT

Computer Controls in NC: CNC Technology: Functions of CNC Control in Machine Tools, Advantages of CNC, Direct Numerical Control(DNC Systems): Configuration of DNC system, Functions of DNC, Communication between DNC computer & MCU, Advantages of DNC,

Module-4(8 Hours)

Adaptive control: machining systems. Adaptive control optimization system, adaptive control constraint system, applications to machining processes, Benefits of Adaptive control Machining.

Industrial Robotics: Robotics technology: Types of Robots, Robot Technology Levels, Robot geometric configurations and Technical Features, basic robot motions, programs the robot, robot programming languages, end effectors, Work-cell control and Interlocks, robotic sensors. Robot applications: general considerations in robot applications, applications in Material transfer, machine loading, welding, spray coating, processing operation, assembly and inspection.

Module-5 (8 Hours)

Computer integrated production management systems: Traditional production planning and control, problems with traditional production planning and control, Computer integrated production management system, cost planning and control. Inventory management and MRP: Inventory management, Material requirement planning, basic MRP concepts, inputs to MRP, working of MRP, MRP output reports, benefits of MRP

Shop floor control and process monitoring: Functions of shop floor control, the shop floor control system operation scheduling, the factory data collection system, computer process monitoring

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:

3. Two Unit Tests each of **25 Marks**
4. 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:

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

Suggested Learning Resources:

Books

1. CAD /CAM by M Grover & Zimmers, PHI.
2. CAD/CAM principles and applications by PN Rao. McGraw Hill
3. Automation, Production Systems & Computer Aided manufacturing, M. P. Grover, Prentice Hall.
4. Computer control of manufacturing systems, Yoram Koren.

Web links and Video Lectures (e-Resources):

- VTUe- Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industrial Visit

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	To impart the basic concepts in manufacturing systems and fundamentals of NC & CNC system	L3
CO2	Knowledge enhancement in design consideration and increasing productivity with NC machine tools, machining centers and tooling for CNC machines	L1
CO3	To enhance students awareness in part programming and computer control in NC	L3
CO4	Knowledge enhancement in adaptive control and industrial robots in CIM environment	L2

CO5	To impart the basic concepts in Computerized Manufacturing Planning and Control Systems	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.	PO3

Mapping of COS and POs

	PO1	PO2	PO3
CO1	**1**	**2**	**3**
CO2	**1**	**2**	**2**
CO3	**1**	**2**	**2**
CO4	**1**	**2**	**3**
CO5	**1**	**2**	**2**

Professional Elective-I

Semester- II

Agile manufacturing			
Course Code	**MMIA214A**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	4-0-0	SEE Marks	50
Total Hours of Pedagogy	40 hrs	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
The objective of this course is to impart the concepts of enterprise level manufacturing strategy called agile manufacturing to enhance the competitiveness of the production firms in a global market.

Module-1(8 Hours)

Agile Manufacturing: Definition, business need, conceptual frame work, characteristics, generic features. Four Core concepts: Strategy driven approach-integrating organization, people technology, interdisciplinary design methodology.

Module-2(8 Hours)

Developing 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.

Integration of Product /Process Development: Principles, Robust design approach, Approaches to enhance ability in manufacturing, Role of QFD, Managing people in Agile organization, Approaches.

Module-3(8 Hours)

Application of IT/IS Concepts In Agile Manufacturing: Strategies, Management of complexities and information flow, approaches, applications of multimedia to improve agility in manufacturing, system concepts.

Module-4(8 Hours)

Agile Supply Chain Management: Principles, IT/IS concepts in supply chain management, enterprise integration and management in agile manufacturing, concepts, Agility, Adaptability and learners –Comparison of concepts.

Module-5 (8 Hours)

Design of Skill & Knowledge: Enhancing technology for Machine tool system, Resumption of design requirement geometry, definition, methods, decision support for selection of cutting parameters, design enhancements, parametric approach only.

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:

5. Two Unit Tests each of **25 Marks**
6. 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:

11. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
12. The question paper will have ten full questions carrying equal marks.
13. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
14. Each full question will have a sub-question covering all the topics under a module.
15. 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',Poul T Kidd, Amagow Co. UK, ISBN-0-201-63163-6, 1994
2. **Agile Manufacturing-** A Gunasekharan, the 21stCenturyCompetitive strategy, ISBN - 13 978-0-08-04 3567-1, Elsevier Press, India.
3. **O Levine Transitions to Agile Manufacturing,** Joseph C Moutigomery and Lawrence – Staying Flexible for competitive advantage, ASQC quality press, Milwaukee. Wisconsin, USA, 1996
4. **Agile Development for Mass Customization,** David M Anderson and B Joseph Pine, Irwin Professional Publishing, Chicago, USA, 1997.

Web links and Video Lectures (e-Resources):

- VTUe- Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industrial Visit

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 conceptual frame work of agile manufacturing environment	L1

CO2	Apply the concepts of enterprise design process to develop agile manufacturing	L2
CO3	Apply interdisciplinary design concepts to the production functions	L2
CO4	Apply the principles of agility for supply chain management	L2
CO5	Identify the benefits that can be derived by adopting newer manufacturing strategies of agile manufacturing	L1

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.	PO3

Mapping of COS and POs

	PO1	PO2	PO3
CO1	3	2	1
CO2	3	2	1
CO3	1	2	1
CO4	3	2	1
CO5	3	2	1

Semester- II

Advanced control engineering			
Course Code	MMIA/MMAR214B	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	4-0-0	SEE Marks	50
Total Hours of Pedagogy	40 hrs	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

The objective of this course is to impart the concepts of basics of control system, state space representation of control systems to use modern tools of stats Space models to analyse the performance of the control system.

Module-1(8 Hours)

Motivation for control. Review of differential equations, impulse response and Laplace transformations, Introduction to state equations and transfer functions.

Module-2(8 Hours)

Interpretation of poles and zeros of transfer functions. Time domain response of second order system. Command tracking and system type. Rough/Hurwitz test

Module-3(8 Hours)

Frequency response and frequency domain methods. Nyquist stability test. Bode plots. Phase and gain margins. Bode phase formula

Module-4(8 Hours)

Robustness. Uncertainty and performance weights. Robust stability test. Robust performance test. Loop shaping necessary and sufficient conditions. Bode integral formula.

Module-5 (8 Hours)

Applications of Root locus, Sensitivity of roots of characteristics equation, Tool for design and analysis of control systems, Case studies using mat lab on Bode, Nyquist and Root locus.

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:

7. Two Unit Tests each of **25 Marks**
8. 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:

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

Suggested Learning Resources:

Books

1. Feedback Control of Dynamical Systems, 5th Edition, Franklin, Powell, and Enami-Naeini, Addison-Wesley, 2006
2. Control Systems Engineering – I.J .Nagrath, M.Gopal, 5th Edition; New age International (P) Ltd, Publishers

Web links and Video Lectures (e-Resources):

- VTUe- Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industrial Visit

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe the concept of state variables and need of control system and applications of control charts	L1
CO2	Apply knowledge of mathematics, science and engineering to analysis and design classical linear control system	L2
CO3	Use modern computer tools such as MatLab tools to solve control problems.	L2
CO4	Analyze various control aspects for the automation application.	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.	PO3

Mapping of COS and POs

	PO1	PO2	PO3
CO1	3	2	1
CO2	3	2	1
CO3	1	2	1
CO4	3	2	1

Semester-I I

IOT in Manufacturing			
Course Code	MMIA/MMAR214C	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	4-0-0	SEE Marks	50
Total Hours of Pedagogy	40 hrs	Total Marks	100
Credits	03	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(8 Hours)

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, IoT analytics and AI, Industry environment scenarios covered by I-IoT.

Module-2(8 Hours)

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.

Module-3(8 Hours)

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

Module-4(8 Hours)

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, I-IoT data sources and data gathering, Edge deployment and data flow scenarios, Edge on field bus setup,Edge on OPC DCOM, Edge on OPC proxy, Edge on OPC UA, OPC UA on the controller.

Module-5 (8 Hours)

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.

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:

9. Two Unit Tests each of **25 Marks**
10. 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:

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

Suggested Learning Resources:

Books

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, 1 st Edition, 2017. ISBN: 1484220463.
3. RMD Sundaram Shriram K Vasudevan, Abhishek S Nagarajan, "Internet of Things", Wiley Publications, 2019. ISBN: 8126578378.

Web links and Video Lectures (e-Resources):

- VTUe- Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industrial Visit

Course outcome (Course Skill Set)

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

Sl. No.	Description	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

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.	PO3

Mapping of COS and POs

	PO1	PO2	PO3
CO1	3	2	1
CO2	3	2	1
CO3	1	2	1
CO4	3	2	1

Semester- II

Modelling, Simulation and Analysis of Manufacturing Systems			
Course Code	MMIA/MMAR214D	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	4-0-0	SEE Marks	50
Total Hours of Pedagogy	40 hrs	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Define the basics of simulation modelling and replicating the practical situations in organizations
- Develop simulation model using heuristic methods.
- Generate random numbers and random variates using different techniques.
- Analysis of Simulation models using input analyzer, and output analyzer
- Explain Verification and Validation of simulation model.

Module-1(8 Hours)

Principles of Modelling & Simulation: Basic Simulation Modeling, When simulation is appropriate, When simulation is not appropriate, Advantages and disadvantages and pit falls of Simulation, Monte - Carlo Simulation, Areas of Applications, Discrete and Continuous Systems, Modeling of a system, Types of Models, Discrete event simulation

Module-2(8 Hours)

Modelling Approaches: List processing in simulation, Simple simulation language, Single server queuing systems, Time shared computer model, Multiteller banking with jockeying, Job shop model.

Module-3(8 Hours)

Random Number Generation: Basic Probability and Statistics-Random variables and their properties, Properties of random numbers, generation of Pseudo random numbers, techniques for generating random numbers, Various tests for random numbers-frequency test, and test for Autocorrelation.

Module-4(8 Hours)

Random Variate Generation: Introduction, different techniques to generate random variate: Inverse transforms technique,- exponential, Normal, uniform, acceptance rejection techniques Poisson distribution. Output Data Analysis for a single system: Types of simulation with respect to output analysis, transient and steady state behaviour of a stochastic process. SLE: statistical analysis for terminating simulation

Module-5 (8 Hours)

Statistical Techniques: Comparison of two system designs, Comparison of several system design – Bonferroni approaches to multiple comparisons for selecting best fit, for screening, Variance reduction Techniques such as simple linear regression, multiple linear regression. Simulation Studies: Simulation of Inventory Problems, Discrete Event Simulation problems.

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:

11. Two Unit Tests each of **25 Marks**
12. 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:

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

Suggested Learning Resources:

Books

1. Simulation, Modelling and Analysis –Averill Law & David M.Kelton, TMH, 4th Edition, 2007.
2. Discrete event and Simulation Systems – Banks & Carson, Prentice Hall Inc, 4th edition, 2011
3. System Simulation- Gordon, PHI, 2nd edition, 2009
4. Probability and statistics for engineers – Richard A. Johnson, Prentice hall, 7th edition, 2006

Web links and Video Lectures (e-Resources):

- VTUe- Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industrial Visit

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe and explain model and analyze typical queuing scenarios	L1
CO2	Develop and apply appropriate random number, random variable generation techniques &appropriate simulation statistical output techniques	L3
CO3	Analyze appropriate input distributions and to explain simulation time advance mechanisms	L2

CO4	Use the Arena simulation language to model and analyze problems found in industrial engineering practice and to design and analyze a simulation experiment.	L2
CO5	Comparisons of systems and optimization techniques.	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.	PO3

Mapping of COS and POs

	PO1	PO2	PO3
CO1	3	2	1
CO2	3	2	1
CO3	1	2	1
CO4	3	2	1
CO5	3	2	1

Professional Elective-II

Semester- II

Tooling for Manufacturing in Automation			
Course Code	MMIA/MMAR215A	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	4-0-0	SEE Marks	50
Total Hours of Pedagogy	40 hrs	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

Students are introduced to metal cutting principles, cutting tool materials, types of cutting tools and its nomenclature.
Students get orientation into clamping methods and jigs used in automated environment.

Module-1(8 Hours)

Mechanics of Metal Cutting: Introduction, measurement of cutting forces and chip thickness, force components, chip formation and primary plastic deformation, shear plane and slip line theories for continuous chip formation.

Modern Cutting Tool Materials: Material properties, HSS related materials, sintered tungsten carbide, cermets, ceramics, polycrystalline tools, tool coatings.

Cutting tools: Basic types of cutting tools, turning tools, indexable inserts, groove geometry, edge preparation, wiper geometry, insert clamping methods, tool angles, threading tools, cutters.

Module-2(8 Hours)

Optimization: Machining cost and production rate verses cutting speed, role of computerized optimization system, economic considerations, optimization of machining system. Tooling Requirements for CNC Machines: Tool holding systems modular and quick change tool holding system, tool holder spindle connection, cutting tool clamping systems, milling cutter driver, side lock type chuck, collet chucks, hydraulic chucks, milling chucks. Tool magazines, Automatic tool changers.

Module-3(8 Hours)

Location and Clamping Methods: Basic principles of locating, locating methods &devices, Basic principles of clamping, clamping methods. Fixtures: Definitions, General considerations, Machine considerations, Process considerations, Product considerations, Types of fixtures, Vise fixtures, Milling fixtures.

Module-4(8 Hours)

Fixtures for Automation: Work holders for CNC, Fixturing in FMS: Part holding on Pallets, standard fixtures, pallet changers, pallet pool, flexible fixturing – principles and methodologies, modular fixturing system: T slot based, dowel pin based, fixturing components.

Module-5 (8 Hours)

Plastics for Tooling Materials: Introduction, Commonly used plastics for tooling, Epoxy plastics tools, Construction methods, Urethane dies, Force calculation for Urethane pressure pads.

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:

13. Two Unit Tests each of **25 Marks**
14. 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:

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

Suggested Learning Resources:

Books

Tool Design-Cyrol Donaldson, Tata McGraw Hill, India.ISBN 10: 0070153922
Fundamentals of Tool Design - Edward G Hoffman, SME, USA. ISBN-10: 0872631346
Jigs & Fixtures- Joshi, **P.H.,** , Second Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi 2004. ISBN 10: 0070680736
Jigs and Fixture-Hiram E Grant, Tata McGraw-Hill, New Delhi, 2003
Tool Engineering & Design-G.Nagpal, Khanna publications, ISBN-13: 978-8174092038
Metal cutting and tool design-Dr. B.J. Ranganath, Vikas publishing house, ISBN,0706970888

Web links and Video Lectures (e-Resources):

- VTUe- Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industrial Visit

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Select the cutting tool according to requirements and component design.	L1
CO2	Design the tooling requirement and customize the same for developing complex geometry components.	L3
CO3	Explain basic principles of locating & clamping. Discuss General considerations in design of drill jigs.	L1

CO4	Design flexible fixture for automation pre-processes.	L3
CO5	Demonstrate application of non-metal fixture	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.	PO3

Mapping of COS and POs

	PO1	PO2	PO3
CO1	3	2	1
CO2	3	2	1
CO3	1	2	1
CO4	3	2	1
CO5	3	2	1

Semester- II

Digital Manufacturing			
Course Code	MMIA/MMAR215B	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	4-0-0	SEE Marks	50
Total Hours of Pedagogy	40 hrs	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 analyse flow lines

Module-1(8 Hours)

Introduction to Automation: Production System Facilities, Automation in Production Systems: Types of Automation, Computerized Manufacturing Support Systems, Reasons for automating a production system, Automation Principles and Strategies, Levels of Automation. Basic Elements of an Automated System, Advanced Automation Functions.

Module-2(8 Hours)

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 Storage Methods and Equipment, Automated Storage Systems, Automatic Identification and Data Capture: Bar Code Technology, Radio Frequency Identification, Other AIDC Technologies.

Module-3(8 Hours)

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.

Module-4(8 Hours)

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. Circuits for Electro-Pneumatic Automation, Electro-Pneumatic Applications: An Arrangement for Separating Similar Balls, Object Stamping Machine, Automation of a Conveyor Arrangement for Objects Sorting, Problems.

Module-5 (8 Hours)

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.

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:

15. Two Unit Tests each of **25 Marks**
16. 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:

36. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
37. The question paper will have ten full questions carrying equal marks.
38. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
39. Each full question will have a sub-question covering all the topics under a module.
40. 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: 978-93-325-724
2. Introduction to Industrial Automation, StamatiosManesis&George Nikolakopoulos, CRC Press, 2018, ISBN: 978
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
5. Automation Production Systems and CIM – Mikell P Groover, 4th Edition, Pearson, 2016. ISBN: 978-93-325-724

Web links and Video Lectures (e-Resources):

- VTUe- Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industrial Visit

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	L3
CO3	Design and analyse pneumatic circuits for various applications.	L2

CO4	Apply the concepts of PLC for industrial applications	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.	PO3

Mapping of COS and POs

	PO1	PO2	PO3
CO1	3	2	1
CO2	3	2	1
CO3	1	2	1
CO4	3	2	1

Semester- II

Programmable logic Control			
Course Code	MMIA/MMAR215C	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	4-0-0	SEE Marks	50
Total Hours of Pedagogy	40 hrs	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course is intended for learning the principals of Programmable Logic Controls (PLC) including hardware, programming, and troubleshooting. and develop advanced working programs, and troubleshoot hardware and software communication problems.

Module-1(8 Hours)

Technical Definition: PLC, advantages, characteristic functions L1, of A PLC, chronological evolution of PLC, types of PLC, unitary PLC, modular small PLC, medium PLC, large PLC block diagram Of PLC : input / output (I/O) se processor section, power supply, memory. Central processing, processor soft executive software, multitasking, languages, ladder language. Input and output contact program symbols, numbering system of inputs and outputs, program form.

Module-2(8 Hours)

Introduction To Logic: Equivalent ladder diagram of AND gate, equivalent ladder diagram of OR gate, equivalent ladder diagram of NOT gate, equivalent ladder diagram of XOR gate, equivalent ladder diagram of NAND gate, equivalent ladder diagram of NOR gate, equivalent ladder diagram to demonstrate de-morgan theorem, ladder design. Timer and its classification: characteristics of PLC timer, functions in timer, resetting retentive and non-retentive, classification of PLC timer, or delay and off delay timers timer-on delay, timer off delay, retentive and non-retentive timers, format of a timer instruction.

Module-3(8 Hours)

PLC Counter: operation of PLC counter, counter parameters, Counter Instructions Overview Count up (CTU) Count Down (CTD).Introduction to comparison instructions, discussions on comparison instructions, “EQUAL." Or "EQU" instruction, "NOT EQUAL" or "NEQ" instruction, "LESS THAN" or "LES" instruction, "LESS THAN OR EQUAL" or "LEQ" Instruction, GREATER THAN" or "GRT" instruction, "GREATER THAN OR EQUAL TO" or "GRQ" Instruction, "MASKED COMPARISON FOREQUAL" or "MEQ" instruction, "LIMIT TEST" or "LIM" instruction.

Module-4(8 Hours)

Data Movement Instructions, logical instructions, mathematical instructions. Special mathematical instructions, data handling instructions, program flow control instructions, Proportional Integral Derivative (PID) Instruction. introduction to classification of I/O, I/O system overview, practical I/O system and its mapping addressing local and expansion I/O, input-output systems, direct I/O, Parallel I/O systems serial I/O systems. Sinking and sourcing, discrete input module, rectifier with filter, threshold detection, isolation, logic section specifications of discrete input module and output modules. Specifications of analog input module, types of analog input module special input modules, analog output module, I/O modules in hazardous locations power supply requirements, power supply configuration, filter.

Module-5 (8 Hours)

Industrial Communication and Networking : Evolution of industrial control process, types of communication interface types of networking channels, parallel communication interface, IEEE- 488 bus, devices useable with IEEE - 488, Handshaking process, interface management lines, serial communication interface. communication mode, synchronization and timing in communication, synchronous and asynchronous transmissions compared, different recommended standards compared software protocol, industrial network, network topology, media access methods, open system interconnection (OSI) network model, network components, advantage of standardized industrial network, industrial network, controller area network (CAN), AS-I Interface.

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:

17. Two Unit Tests each of **25 Marks**
18. 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:

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

Suggested Learning Resources:

Books

1) „PLC and Industrail Applications", Madhuchhandan Gupts and Samarjxit Sen Gupta, Pernram International Pub. (India) Pvt.Ltd., 2011

(2) Programmable Logic Controllers, 5th Edition W. Bolton John W. Webb PHI learning , New Delhi

(3) „Basic PLC Course (Programmable Logic Controller)" Mohd Shafiek Yaacob, Pearson, 2006.

(4) A practical Handbook to PLC Alireza H. Fassih New Generation publication

Web links and Video Lectures (e-Resources):

- VTUe- Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industrial Visit

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe and analyze working principles of various types of motors, differences, characteristics and selection criteria, control methods, SCADA.	L1
CO2	Apply the knowledge in selection of motors, heating effects and braking concepts in various industrial applications.	L2
CO3	Construct a program using PLC to problems pertaining to automation industries.	L2

CO4	Demonstrate self-learning capability	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.	PO3

Mapping of COS and POs

	PO1	PO2	PO3
CO1	3	2	1
CO2	3	2	1
CO3	1	2	1
CO4	3	2	1

Semester- II

Industrial Safety			
Course Code	MMIA/MMAR215D	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	4-0-0	SEE Marks	50
Total Hours of Pedagogy	40 hrs	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To impart knowledge on different facets and aspects of industrial systems safety
2. To familiarize the student with tools, techniques and methodologies needed for prevention of occurrences of unsafe operations and accidents under different industrial settings
3. To impart the knowledge of definition, function and types of maintenance activities
4. To familiarize the different wear and corrosion mechanisms and their prevention methods
5. To expose the students to different faults and their tracing mechanisms

To impart the art of planning periodic and preventive maintenance mechanisms

Module-1(8 Hours)

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

Module-2(8 Hours)

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

Module-3(8 Hours)

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Module-4(8 Hours)

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

Module-5 (8 Hours)

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

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:

19. Two Unit Tests each of **25 Marks**
20. 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:

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

Suggested Learning Resources:

Books

1. Lindley R. Higgins, Lester Coridon Morrow, Maintenance Engineering Handbook, Da Information Services, 1977.
2. H. P. Garg, Maintenance Engineering, S. Chand and Company, 1987.
3. Audels, Pump-hydraulic Compressors, Mc Graw Hill Publication, 1992.

Winterkorn, Hans, Foundation Engineering Handbook, Chapman & Hall London, 1975

Web links and Video Lectures (e-Resources):

- VTUe- Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industrial Visit

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	describe the different facets and aspects of industrial systems safety	L2
CO2	demonstrate the use of tools, techniques and methodologies needed for prevention of occurrences of unsafe operations and accidents under different industrial settings	L4
CO3	define the function and list the types of maintenance activities	L1

CO4	describe the concept of wear and corrosion mechanisms and their prevention methods	L2
CO5	enumerate the different faults and their tracing mechanisms	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.	PO3

Mapping of COS and POs

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

Semester- II

Non Traditional Machining			
Course Code	MMIA206	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3-0-0	SEE Marks	50
Total Hours of Pedagogy	40 hrs	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

Student will be in a position to appreciate the merits of non-traditional machining and its application in Industries
Justify and demonstrate the benefits of non-traditional machining processes over traditional machining processes
Students will be able to decide a process suitable for a particular material based on the availability of the sources

Module-1(8 Hours)

Introduction: Need for non-traditional machining processes, Process selection, classification, comparative study of different processes. Ultra Sonic Machining: Definition, Mechanism of metal removal, elements of the process, Tool feed mechanisms, Theories of mechanics, effect of parameters, Different types of concentrators, horn design, applications, Limitations . Abrasive Jet Machining: Principle, Process parameters, Influence of process parameters on MRR , applications, advantages and disadvantages.

Module-2(8 Hours)

Water Jet Machining: Principle, Equipment, Operation, Application, Advantages and limitations of water Jet machinery. Thermal Metal Removal Processes: Electric discharge machining, Principle of operation, mechanism of metal removal, basic EDM circuitry, spark erosion generators, Analysis of relaxation type of circuit, material, removal rate in relaxation circuits, critical resistance parameters in Ro Circuit, Die electric fluids, Electrodes for spark erosion- surface finish, applications.

Module-3(8 Hours)

Electro Chemical machining (ECM): Classification of ECM process, Principle of ECM, Chemistry of the ECM process, parameters of the process, Determination of the metal removal rate, dynamics of ECM process, Hydrodynamics of ECM process, polarization, Tool Design, advantages and disadvantages-applications. Electro Chemical grinding, Electro Chemical honing, Electrochemical deburring.

Module-4(8 Hours)

Chemical Machining: Introduction, fundamental principle types of chemical machining, Maskants, Etchants, Advantages and disadvantages, applications Plasma arc Machining: Introduction, Plasma, Generation of Plasma and equipment, Mechanism of metals removal, PAM parameters, process characteristics, types of torches, applications Electron beam machining (EBM): Introduction, Equipment for production of Electron beam, Theory of electron beam machining, Thermal & Non thermal type, Process characteristics, applications.

Module-5 (8 Hours)

Laser Beam Machining: Introduction, principles of generation of lasers, Equipment and Machining Procedure, Types of Lasers, Process characteristics, advantages and limitations, applications of laser beam machining. Ion Beam Machining: principle, equipment, working, sputtering rate, applications. High Velocity forming processes: Introduction, development of specific process, selection, comparison of conventional and high velocity forming methods. Types of high velocity forming methods: explosion forming process, electro-hydraulics forming, magnetic pulse forming. Applications, Advantages and limitations

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:

21. Two Unit Tests each of **25 Marks**
22. 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:

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

Suggested Learning Resources:

Books

1. Modern Machining Process - P.C Pandy& H.S Shan Tata McGraw Hill.
2. Modern Machining Processes - P.K Mishra
3. Thermal Metal Cutting Processes-Dr.B.J.Ranganath,I K International,New Delhi.
4. New technology - Bhattacharya, Institution of Engineers, India
5. Production technology - HMT Tata McGraw Hill.
6. Metals hand book - ASM Vol-3.
7. High velocity forming of metals - F.M Wilson ASTME PreticeHall.
   Modern Manufacturing Methods - Adithan

Web links and Video Lectures (e-Resources):

- VTUe- Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industrial Visit

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	To demonstrate the need for development of newer/ non-traditional machining processes	L1
CO2	able to identify different energy sources like fluid motion, electric current, high speed electrons, high energy radiation, etc	L2

CO3	To analyze the concept, mechanism, parameters associated with the processes.	L4
CO4	To demonstrate the operational principles, advantages applications, limitations of the various non-traditional machining processes.	L1

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.	PO3

Mapping of COS and POs

	PO1	PO2	PO3
CO1	**1**	**2**	**3**
CO2	**1**	**2**	**2**
CO3	**1**	**2**	**2**
CO4	**1**	**2**	**3**

PLC & Sensors Laboratory			
Course Code	MMIAL/MMARL207	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	01:00:02:00	SEE Marks	50
Credits	02	Exam Hours	03

Course objectives:

1. Impart the knowledge of PLC ladder logic programming for different applications.
2. Gain the knowledge of the working principle of different type of sensors used in automation applications

Sl.NO	Experiments
1	PLC programming on Automatic Bottle filling system
2	Application of PLC for Traffic Light Control
3	Develop the PLC Program to control level of water level controller
4	Develop the PLC Program to control batch process reactor
5	lift control system using PLC
6	Starting Three Phase induction Motors via Star-Delta Starter using PLC
7	Pressure Control Using PLC
8	Temperature Control Using PLC
	Demonstration Experiments (For CIE) if any
9	Demonstration of various sensors suitable for industrial automation application (Capacitive sensor, Inductive sensor, magnetic, photo electric sensor, ultrasonic sensor)
10	Substation Automation with SCADA

Course outcomes (Course Skill Set):

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

- the students will be able to write and execute PLC ladder logic for different practical problems of automation
- Students will be able to analyze the suitability of different sensors for different operational requirements in automation

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 an 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 down to 30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 01 tests for 100 marks, test shall be conducted after the 14th week of the semester.
- In 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 test marksis scaled down to 20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

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) Breakup 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, writeup-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 50 marks (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:

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MATLAB for Mechatronics		Semester	
Course Code	**MMIA/MMAR258A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	00:00:02:00	SEE Marks	50
Credits	01	Total SEE+CIE	100
Total hours of pedagogy	12 lab sessions	Exam Hours	2 Hours
Examination type (SEE)	**Practical**		

Course objectives:

- To obtain the Transfer Function and State Space Modeling and simulation of Physical systems
- To study the time response of first and second order system
- To study the error analysis of different control system
- To study the compensation techniques used to stabilize the system.

Sl.NO	Experiments
1	Mathematical (Transfer Function) modeling and simulation of any Mechanical System and any Electrical System using Matlab® (Simulink) / Scilab (xcos) or similar software.
2	Mathematical (State Space) modelling and simulation of any Mechanical System and any Electrical System using Matlab / Scilab or similar software.
3	Mathematical (Transfer Function) modelling of DC Motor using Matlab (Simulink) / Scilab or similar software.
4	D.C. Motor Parameter Identification.
5	Experiment on components of control system.
6	Transient response of 1st order & 2nd order system.
7	Frequency response of 1st order & 2nd order system.
8	Time and Frequency Response simulation in Matlab/Scilab.
	Demonstration Experiments (For CIE)
9	Steady state error analysis of different types of systems.
10	Stability analysis of a given Transfer Function based on Bode plot / Root locus / Nyquist plots using Matlab.
11	Design of Proportional Controller of Velocity for a DC Motor in Matlab/Scilab.
12	Frequency Response based Design of PD Position Control of a DC Motor in Matlab/Scilab.

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

- Model and simulate physical systems using software tools
- Perform Parameter Identification
- Define the open loop and closed loop system
- Simulate time and frequency response of first and second order systems.
- Simulate the control system for getting different responses.
- Design the controller for position/velocity control of DC Motor

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 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation (CIE):

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

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

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are 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 down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a 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 marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- **SEE shall be conducted by the two examiners. One from the same institute as an internal examiner and another from a different institute as an external examiner, appointed by the university.**
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup 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 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, writeup-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 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

- Vijay Madisetti, Arshdeep Bahga, Internet of Things. "A Hands on Approach", University Press
  Dr. SRN Reddy, Rachit Thukral and Manasi Mishra,
- "Introduction to Internet of Things: A practical Approach", ETI Labs
  Pethuru Raj and Anupama C Raman,
- "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
  Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi Adrian McEwen,
- "Designing the Internet of Things", Wiley Raj Kamal,
- "Internet of Things: Architecture and Design", McGraw Hill

Basics of Rapid Prototyping		Semester	02
Course Code	**MMIA/MMAR258B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	14	Total Marks	100
Credits	01	Exam Hours	1 Hour
Examination type (SEE)	**MCQ**		

Course objectives:
To provide knowledge on different types of Rapid Prototyping systems. and its applications in various fields.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.
Lecturer method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
- Encourage collaborative Learning (Group Learning) in the class.
- Ask HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking.
- Individual teachers can device innovative pedagogy to improve teaching-learning.

Module-1

Introduction:
Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems.

Module-2

Stereo Lithography Systems:
Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.

Module-3

Selective Laser Sintering:
Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications.

Module-4

Fusion Deposition Modelling:
Principle, Process parameter, Path generation, Applications.

Module-5

Solid Ground Curing: Principle of operation, Machine details, Applications.
Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:
1. Understand and use techniques for processing of CAD models for rapid prototyping.
2. Understand and apply fundamentals of rapid prototyping techniques.
3. Use appropriate tooling for rapid prototyping process.
4. Use rapid prototyping techniques for reverse engineering.

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 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Textbooks

1. Stereo lithography and other RP & M Technologies -Paul F. Jacobs - SME, NY1996.
2. Rapid Manufacturing - Flham D.T &Dinjoy S.S - Verlog London2001.128
3. Rapid automated - Lament wood - Indus press NewYork

Web links and Video Lectures (e-Resources):

- https://www.midaspattern.co.uk/news/the-history-of-rapidprototyping#:~:
- text=Who%20Invented%20Rapid%20Prototyping%3F,include%20various%20forms%20 of%20manufacture.
- https://www.youtube.com/watch?v=yW4EbCWaJHE
- https://www.youtube.com/watch?v=yiUUZxp7bLQ
- https://www.youtube.com/watch?v=7px1fl41cA4
- https://www.youtube.com/watch?v=ZZzDLQ-KoQ4
- https://www.youtube.com/watch?v=m0b3WIS2nqw

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

At the end of the lecture/presentation, numerical exercises are to be taken up to solve problems related to the topics covered. Additional problems are to be given for practice and also as assignments under each of the topics covered.

Environmental Studies and E-Waste Management		Semester	02
Course Code	**MMIA/MMAR258C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	14	Total Marks	100
Credits	01	Exam Hours	1 Hour
Examination type (SEE)	**MCQ**		

Course objectives:

- Identify the major challenges of environmental issues
- Develop skills, critical thinking and demonstrate socio-economic skills for Environmental protection
- Analyze the impact of issues w. r. t. waste management

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes Critical thinking.
5. Adopt Case study Based Learning (CBL), which fosters students' analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
6. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Ecosystem and Sustainability:

Ecosystem: Structure of Ecosystem, Types: Forest, Desert, Wetlands, Riverine, Oceanic ecosystems.

Sustainability: 17SDG targets and possible actions.

Self-Study Component (SSC): Components of the environment.

Textbook 1: CH- 3, e-resource: 1

Module-2

Natural resources and Energy:

Natural Resources: Water resources – Availability & Quality aspects, Water borne diseases & water induced diseases, Fluoride problem in drinking water.

Energy: Different types of energy, Conventional sources & Non -Conventional sources of Energy, Solar energy, Wind Energy, Hydrogen as an alternative energy

Self-Study Component (SSC): Alternative Energy sources

Module-3

Environmental Pollution:

Environmental Pollution: Water Pollution, Noise pollution, Air pollution (Sources, Impacts, Preventive measures and Public Health Aspects.

Self-Study Component (SSC): Case studies of air pollution episodes

Textbook 1: CH- 5

Module-4

Waste management:

Waste management: Solid Waste Management , types and sources, functional elements of SWM, Biomedical Waste Management - Sources, Characteristics

Environmental Legislation: Solid Waste Management Rules, 2016, Biomedical Waste Management Rules, 2016. Self-Study Component (SSC): Case studies on waste management options

Textbook 1: CH- 6, e-resource:2

Module-5

E - Waste Management

E- waste; composition and generation. Global context in e- waste; E-waste pollutants, E waste hazardous properties, Effects of pollutant (E- waste) on human health and surrounding environment, domestic e-waste

disposal, Basic principles of E waste management, Component of E waste management.
E-waste (Management and Handling) Rules, 2011; and E-Waste (Management) Rules, 2022 - Salient Features and its implications.
Self-Study Component (SSC): E-Waste (Management) Amendment Rules, 2023, 2024
Textbook 1: CH- 6, Textbook 2: CH-2, e-resource:3

Course outcome (Course Skill Set)

At the end of the course the student will be able to:
1. Comprehend the principles of ecology and environmental issues pertaining to air, land, and water on a global scale.
2. Acquire observation skills for solving problems related to the environment.
3. Conduct survey to describe the realities of waste management system.

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 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Textbooks

1. S M Prakash , "Environmental Studies" 3rd Edition, Elite Publishing House, Mangalore, 2018.
2. Hester R.E., and Harrison R.M, Electronic Waste Management. Science, 2009.

Reference Books:

1. Earch Barucha, "Environmental Studies for UG students", 2004.
2. Benny Joseph (2005), "Environmental Studies" , Tata McGraw – Hill Publishing Company Limited.
3. R. Rajagopalan, "Environmental Studies- From Crisis to Cure" , 2nd Edition, Oxford university press, New Delhi, 2013.
4. Johri R., E-waste: implications, regulations, and management in India and current global best practices, TERI Press, New Delhi.
5. Raman Sivakumar, "Principles of Environmental Science and Engineering", 2nd edition, Cengage learning Singapur, 2005.
6. G. Tyler Miller Jr., "Environmental Science – working with the Earth", Eleventh Edition, Thomson Brooks /Cole, 2006
7. Dr. Pratiba Singh, Dr.Anoop Singh and Dr. Piyush Malaviya, "Text Book of Environmental and Ecology", Acme Learning Pvt. Ltd. New Delhi.
8. P. Meenakshi, "Elements of Environmental Science and Engineering", Prentice Hall of India Private Limited, New Delhi, 2006

Web links and Video Lectures (e-Resources):
1. https://sdgs.un.org/goals 2. https://kspcb.karnataka.gov.in/waste-management/biomedical-waste 3. E Waste (Management) Rules, 2022: https://kspcb.karnataka.gov.in/sites/default/files/inlinefiles/E%20Waste%20%28Management%29%20Rules%2C%202022.pdf
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Analysis report of case study specified in the Textbooks and reference books (one per student). • Field Survey (In Team): The students' team of the size of 2 to 4 are expected to visit the organization or Industry understand the waste management, utilization of energy, pollution concerns, e-waste handling and other related suggested best practices specified in the syllabus and then submit a detailed visit report to the concerned staff.

FINITE ELEMENT MODELLING AND ANALYSIS		Semester	
Course Code	**MMIA/MMAR258D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	00:00:02:00	SEE Marks	50
Credits	01	Total SEE+CIE	100
	12 lab sessions	Exam Hours	2 Hours
Examination type (SEE)	**Practical**		

Course objectives:

CLO1. To acquire basic understanding of Modeling and Analysis software

CLO2. To understand the concepts of different kinds of loading on bars, trusses and beams, and analyze the results pertaining to various parameters like stresses and deformations.

CLO3. To lean to apply the basic principles to carry out dynamic analysis to know the natural frequencies of different kind of beams.

CLO4. To understand Piezoelectric analysis of cantilever beam.

Sl.NO	Experiments
1	Demonstrate FEA package and modeling the different structural elements.
2	Modeling and stress analysis of a rectangular plate with a circular hole
3	Modeling and stress analysis of "L" Bracket for pressure load.
4	Modeling and stress analysis of Bars of constant cross section area.
5	Modeling and stress analysis of Bars of tapered cross section area.
6	Modeling and stress analysis of stepped bar.
7	Stress analysis of Beams – Simply supported, cantilever, beams with point load.
8	Stress analysis Trusses.
	Demonstration Experiments (For CIE)
9	Dynamic Analysis to find natural frequency of beam with fixed – fixed end condition
10	Dynamic Analysis to find response of beam with fixed – fixed end conditions subjected to forcing function.
11	Demonstrate at least two different types of examples to model and analyze bars or plates made from composite material.
12	Piezoelectric analysis: cantilever beam.

Course outcomes (Course Skill Set):

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

CO1. Use the modern tools to formulate the problem, create geometry, descritize, apply boundary conditions to solve problems of bars, truss, beams, and plate to find stresses with different-loading conditions.

CO2. Demonstrate the ability to obtain deflection of beams subjected to point, uniformly distributed and varying loads and use the available results to draw shear force and bending moment diagrams.

CO3. Carry out dynamic analysis and finding natural frequencies of beams, for various boundary conditions and carry out dynamic analysis with forcing functions.

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 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation (CIE):

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

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

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are 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 down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a 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 marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- **SEE shall be conducted by the two examiners. One from the same institute as an internal examiner and another from a different institute as an external examiner, appointed by the university.**
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup 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 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, writeup-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 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

1. ANSYS Workbench Tutorial Release 14, Structural and Thermal Analysis Using Ansys Mechanical APDL Release 14 Environment, Kent Lawrence, Schroff Development Corporation, Website: www.SDCpublications.com

2. Practical Finite Element Analysis,Nitin S. Gokhale, Sanjay S. Despande, Dr. Anand N. Thite, Finite To Infinite, ISBN 978-81-906195-0-9, E-mail: finite@vsnl.com, Website: www.finitetoinfinite.com

3. FINITE ELEMENT ANALYSIS USING ANSYS®, SrinivasPaleti, Sambana, Krishna Chaitanya, Datti, Rajesh
   - Kumar, PHI Publication, ISBN: 978-81- 203-4108-1