VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech in INDUSTRIAL AUTOMATION ENGINEERING (MIA)
(Effective from the Academic year 2022-23)

Registrar,
Visvesvaraya Technological University
Jnana Sangam, Machhe, Belagavi-590018
e-Mail: registrar@vtu.ac.in
Contact: 0831-2498112

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech. in INDUSTRIAL AUTOMATION ENGINEERING(MIA)
Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical/Seminar	Tutorial / Skill Development activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	BSC	22MIA/MAR11	Applied Mathematics	03	--	--	03	50	50	100	3
2	IPCC	22MIA/MAR12	Computer Integrated Manufacturing	03	02	--	03	50	50	100	4
3	PCC	22MIA13	Artificial Intelligence and Expert System in Automation	03	--	02	03	50	50	100	4
4	PCC	22MIA14	Additive Manufacturing Technologies	02	--	02	03	50	50	100	3
5	PCC	22MIA/MAR15	Sensors Applications in Manufacturing	02	--	02	03	50	50	100	3
6	MCC	22RMI16	Research Methodology and IPR	03	--	--	03	50	50	100	3
7	PCCL	22MIAL17	PLC and Sensors Laboratory	01	02	00	03	50	50	100	2
8	AUD/AEC	22AUD18/ 22AEC18	BOS Recommended ONLINE Courses	Classes and evaluation procedures are as per the policy of the online course providers.							PP
			TOTAL	**17**	**04**	**06**	**21**	**350**	**350**	**700**	**22**

Note: BSC-Basic Science Courses, PCC: Professional core. IPCC-Integrated Professional Core Courses, MCC- Mandatory Credit Course,
AUD/AEC –Audit Course / Ability Enhancement Course(A pass in AUD/AEC is mandatory for the award of the degree)

Integrated Professional Core Course (IPCC): **Integrated Professional Core Course (IPCC)**: Refers to Professional Theory Core Course Integrated with practical of the same course. The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

Audit Courses /Ability Enhancement Courses Suggested by BOS (ONLINE courses): Audit Courses: .... These are prerequisite courses suggested by the concerned Board of Studies. Ability Enhancement Courses will be suggested by the BoS if prerequisite courses are not required for the programs. **Ability Enhancement Courses**:

- These courses are prescribed to help students to enhance their skills in fields connected to the field of specialisation as well allied fields that leads to employable skills. Involving in learning such courses are impetus to lifelong learning.
- The courses under this category are online courses published in advance and approved by the concerned Board of Studies.
- Registration to Audit /Ability Enhancement Course shall be done in consultation with the mentor and is compulsory during the concerned semester.
- In case a candidate fails to appear for the proctored examination or fails to pass the selected online course, he/she can register and appear for the same course if offered during the next session or register for a new course offered during that session, in consultation with the mentor.
- The Audit Ability Enhancement Course carries no credit and is not counted for vertical progression. However, a pass in such a course is mandatory for the award of the degree.

Skill Development Activities: Under Skill Development Activities in a concerning course, the students should

1. Interact with industry (small, medium, and large).
2. Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
3. Involve in case studies and field visits/ fieldwork.
4. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
5. Handle advanced instruments to enhance technical talent.
6. Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
7. Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc. Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities which will enhance their skill. The prepared report shall be evaluated for CIE marks.

Program Outcome of the Course

POs	Description
PO1:	Acquire, demonstrate, and apply basic knowledge in the field of Industrial Automation Engineering.
PO2:	Identify problems in the field of Industrial Automation Engineering, formulate them and solve by using advanced techniques.
PO3:	Independently carry out research/investigation and developmental work to solve practical problems in Industrial Automation Engineering.
PO4:	Write and present a substantial technical report/document.
PO5:	Demonstrate a degree of mastery over Industrial Automation Engineering.
PO6:	Employ Artificial Intelligence and robotics tool to cater into Industrial Automation needs in both discrete and process plants.
PO7:	Provide solutions to varied engineering problems through the interpretation of data using modern computational tools.

Semester- 01

Applied Mathematics Common to MIA/MAR			
Course Code	22MIA11	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

The goal of this course is to comprehend

- Solution of linear algebraic equations, basic concepts of vector space, linear transformation, Eigenvalues, Eigenvectors and construction of orthonormal basis.
- To extract maximum information about the population by examining the samples of the population.
- 3. Concepts of random variables, probability distributions, Markov chains and queuing systems.

Module-1	
Linear Algebra I : Solution of system of linear algebraic equations Triangularization method, Cholesky's method, Partition method, Gauss Seidel iterative method	
Teaching and Learning Process	Chalk and Talk and Power Point Presentation

Module-2	
Linear Algebra – 2: Vectors & vector spaces, Linear Transformations - Kernel, Range, Matrix of linear transformation, Inverse linear transformation, Inner product, Length / Norm. Orthogonality, orthogonal projections, Orthonormal bases. Gram-Schmidt process.	
Teaching and Learning Process	Chalk and Talk and Power Point Presentation
Module-3	
Linear Algebra – 3: Eigen values & Eigen vectors, Diagonalisation of a matrix, acobi's method for diagonalisation of symmetric matrices Power method, Inverse power method, Singular Value Decomposition.	
Teaching and Learning Process	Chalk and Talk and Power Point Presentation
Module-4	
Sampling Theory: Random sampling, Sampling distributions, Parameter estimation, Testing of hypothesis, Analysis of variance, Significance tests.	
Teaching and Learning Process	Chalk and Talk and Power Point Presentation
Module-5	
Probability: Joint probability distribution, Markov chains – probability vector, stochastic matrix, transition probability matrix, Concept of queuing – M/M/1 and M/G/1 queuing system	
Teaching and Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. Numerical methods for Scientific and engg computation, M K Jain, S.R.K Iyengar, R K. Jain, , New Age International, 2003.
2. Introductory Methods of Numerical Analysis S.S.Sastry, , PHI, 2005.
3. Linear Algebra – Larson & Falvo (Cengage learning)
4. Higher Engineering Mathematics – Dr. B.V. Ramana, 5 th edition, Tata McGraw – Hill publications.
5. Higher Engineering Mathematics – Dr. B.S. Grewal, 42nd edition, Khanna publication. Probability and Statistics – Schaum Series (All lates teditions)

Web links and Video Lectures (e-Resources):

- https://youtu.be/pOtnzAXlXvI?list=PL3pGy4HtqwD0CWdFuygdF-gk0ORk5EFZg
- https://youtu.be/zT83sJ5IrEE?list=PLyqSpQzTE6M-QT7PvEBHV0iNMvZk9mocO

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Apply matrix and iterative methods to solve a system of linear algebraic equations.	L3
CO2	Apply geometry of Linear transformations and construct orthonormal basis of an inner product space	L2
CO3	Diagonalising a matrix by finding the eigenvalues and the corresponding eigenvectors, compute the smallest and the largest eigenvalues and also singular values.	L3
CO4	Use statistical tools to draw inferences for the given data	L2

Mapping of COs and POs

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

1:Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": no correlation

Semester - 01

Computer Integrated Manufacturing			
Course Code	22MIA12	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 + 12Hours	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

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

MODULE-1

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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

MODULE-2

CNC Hardware fundamentals: Structure of CNC machine tools, Spindle design, Drives, actuation systems, feedback devices: optical rotary encoder, linear scale, axes standards.

CNC tooling: cutting tool materials, turning tool geometry, milling tool systems, tool presetting**,** and Automatic tool changers. Work holding, cutting process parameter selection.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

MODULE-3

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,

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

MODULE-4

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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

MODULE -5	
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	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	CNC turning, CNC milling programming using simulation software.
2	Simulation inspection planning for automated inspection for an automotive component
3	Simulation of Product layout using plant simulation software
4	Factory floor simulation using suitable simulation software
5	Machine vision based quality control
6	Remote Monitoring and Operation of a Computer Integrated Manufacturing System
7	Modeling, offline programming and simulation of a 5-Axis Robot manipulator
8	Programming and operation of a 5-Axis Robot manipulator
9	Modeling and Simulation of Computer Integrated Manufacturing System
10	Each student will submit a research assignment in terms of a short report and a small presentation on topic related to either design/selection of criteria for critical CNC machine elements, CNC interpolation algorithms, need and design of special control features in CNC controller, or design of CNC tool path algorithms
11	Demo on CNC Machine using Program
12	Demo on Robot using Program

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 **20 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 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

1. 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.
2. 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.

3. The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

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

SEE for IPCC

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

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.

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

1. 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.
2. 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. 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.

Web links and Video Lectures (e-Resources):

- https://youtu.be/bXyxwcvM3_E
- https://youtu.be/49RET0N-ITY?list=PLFW6lRTa1g808_CfYhZKdv2eXplAQiAwS

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

Mapping of COS and POs

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

1:Slight (low) 2:Moderate (medium) 3: Substantial (High) "-": no correlation

Semester- 01

Artificial Intelligence in Automation			
Course Code	22MIA13	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:02	SEE Marks	50
Total Hours of Pedagogy	40Hrs+10-12Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will give an opportunity to gain expertise in topics related to human intelligence and its applications in industry, defence, healthcare, agriculture and many other areas. This course will give the students a rigorous, advanced and professional graduate-level foundation in Artificial Intelligence.

Module-1

Artificial INTELLIGENCE : Introduction to AI, Artificial Intelligence foundations, History of Artificial Intelligence, consequences and Advantages of AI, Sustainable AI.

Intelligent Agents: Understanding the AI Intelligent agents, Agents and environments, Rationality concept and Nature of its Environments, Structure of Agents.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

Problem Solving: Problem Solving Agents, Examples, Searching for solutions, Un-informed search, Strategies, BFS, Uniform-Cost search, DFS, Depth-limited search, Iterative deepening depth-first search, Bidirectional search, Heuristic search strategies, Greedy best first search, A*search, Heuristic functions, The effect of Heuristic accuracy on performance.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

Heuristic Search Techniques: Generate and Test, Hill-Climbing, Best-first search, Problem Reductions, Constraint Satisfaction, Means end analysis.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

Knowledge Representation Issues: Representation and Mappings, Approaches to knowledge representation, Issues in knowledge Representation, the frame problem.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

Expert Systems: Features of an expert System, expert system building, what good are expert systems? Organisation of expert system and its comparison with the Conventional programs. Basic activities of an Expert system. Types of problems expert system Solve, prospector – an expert system at work.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Nowig, PEARSON 3rd Edition.
2. Artificial Intelligence : Eliane Rich, Kelvin Knight, Shivashakar B. Nair, 3rd edition.
3. A Guide to Expert Systems: DONALD A WATERMAN Pearson.

Web links and Video Lectures (e-Resources):

- https://youtu.be/fV2k2ivttL0?list=PLCD819D1E1C4F91C3
- https://youtu.be/XCPZBD9lbVo?list=PLbMVogVj5nJQu5qwm-HmJgjmeGhsErvXD

Skill Development Activities Suggested

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

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand problem solving methods, state space problems and search methods.	L1
CO2	Understand knowledge acquisition and representation methods.	L2
CO3	Apply knowledge on decision making.	L3
CO4	Assess critically the techniques presented and apply them to real world problems.	L3
CO5	Develop knowledge of decision making and learning methods.	L4

Mapping of COS and POs

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

1:Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": no correlation

Semester- 01

Additive Manufacturing Technologies			
Course Code	22MIA14	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning Objectives:
Develop a comprehensive understanding of fundamental additive manufacturing – alternatively, "three-dimensional (3D) printing" – approaches, including extrusion-based deposition, stereo lithography, powder bed-based melting, and inkjet-based deposition. Cultivate a "design-for-additive manufacturing" skillset for combining computer-aided design (CAD) and computer-aided manufacturing (CAM) methodologies to produce successful 3D prints. Fabricate 3D mechanical objects using a variety of 3D printing technologies on campus. Execute a design project that demonstrates how additive manufacturing technologies can overcome critical limitations of traditional manufacturing processes.

Module-1

Introduction and Basic Principles: The Generic AM Process and its Benefits. Distinction between AM and CNC Machining. Example of AM Parts and other Related Technologies.

Development of Additive Manufacturing Technology: Computer-Aided Design Technology and Other Associated Technologies. The Use of Layers. Metal Systems and Hybrid Systems

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

Generalized Additive Manufacturing Process Chain: Introduction. Steps in Additive Manufacture, Variations from One AM Machine to Another. Maintenance of Equipment and Materials Handling Issues.

Vat Photo polymerization Processes: Introduction, Reaction Rates, Laser Scan Vat Photo polymerization, Photo polymerization Process Modelling, Vector Scan VP Machines, Scan Patterns. Vector Scan Micro-Vat Photo polymerization. Process Benefits and Drawbacks

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

Extrusion-Based Systems: Introduction, Basic Principles, Material Loading Liquefaction, Extrusion, Solidification, Positional Control, Bonding, Support Generation Plotting and Path Control. FDM Machine. Types, Materials, Limitations of FDM. Bio-Extrusion and Other Systems
Material Jetting: Materials for Material Jetting, Materials for Material Jetting, MJ Process Modelling, Material Jetting Machines, Process Benefits and Drawbacks

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

Design for Additive Manufacturing: Motivation, Design for Manufacturing and Assembly, AM Unique Capabilities. Shape Complexity. Hierarchical Complexity. Functional Complexity Material Complexity Core DFAM Concepts and Objectives Complex Geometry Integrated Assemblies Customized Geometry Multifunctional Designs Elimination of Conventional DFM Constraints Contents Exploring Design Freedoms Part Consolidation and Redesign Hierarchical Structures Industrial Design Applications.

Rapid Tooling: Introduction Direct AM Production of Injection Moulding Inserts EDM Electrodes Investment Casting Other Systems Vacuum Forming Tools Paper Pulp Moulding Tools Formwork for Composite Manufacture Assembly Tools

and Metrology Registration Rigs	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

Applications for Additive: Manufacture Introduction Historical Developments Value of Physical Models Functional Testing Rapid Tooling The Use of AM to Support Medical Applications Surgical and Diagnostic Aids Prosthetics Development Manufacturing Tissue Engineering and Organ Printing Software Support for Medical Applications

Limitations of AM: Limitations of AM for Medical Applications Speed Accuracy Materials Ease of Use Further Development of Medical AM Applications Approvals Insurance Engineering Training Location of the Technology Service Bureaus Aerospace Applications Characteristics Favouring AM Production Manufacture Automotive Applications

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three 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. Pham D.T. & Dimov S.S "Rapid Manufacturing" Springer London 2011. 2.
2. C.P. Paul & A.N. Jinoop, "Additive Manufacturing: Principles, Technologies and Applications", McGraw Hill 2021.
3. TerryWohlers "Wohler's Report 2000" Wohler's Association2000
4. Paul F.Jacobs: "Stereo lithography and other RP & M Technologies", SME, NY1996,Springer

Web links and Video Lectures (e-Resources):

- https://youtu.be/t7yv4gSnNkE?list=PLwdnzlV3ogoWI8QEu4hsT-n_r8UbWbquy
- **https://youtu.be/Bwog2XYCmN8**

Skill Development Activities Suggested

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

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Explain the importance and growth of Rapid Prototyping Techniques.	L1

CO2	Differentiate and describe the operation, applications and advantages of Stereo lithography, selective Laser sintering and fused deposition modelling.	L2
CO3	Analyze solid ground curing and laminated object manufacturing processes and their working.	L3
CO4	Evaluate different Concept Modeless and recommend different tooling requirements for Rapid Proto type	L3

Mapping of COS and POs

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

1:Slight (low) 2:Moderate (medium) 3: Substantial (High) "-": no correlation

Semester- 01

Sensors Applications in Manufacturing			
Course Code	22MIA15	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. Discussion on various signal conditioning devices, sensors and RFID.
2. Discussion on various identification systems.
3. Applications in industrial sectors

Module-1

Fundamentals of Sensors and Transducers: Performance terminology, static and dynamic characteristics of transducers, classification of sensors and transducers, signal processing and signal conditioning. Operational amplifiers, filters, protection devices, analog to digital converter, digital to analog converter. Sensors and their applications: Inductive, capacitive, and magnetic. Various types of photo sensors, detection methods, through beam detection, reflex detection & proximity detection, ultrasonic and microwave sensors. Applications and understanding of the above sensors, limit switches.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

Advanced Sensor Technologies: Laser production, characteristics of lasers, and types of laser sensors, bar code sensors, and benefits of bar coding, transponder, RFID (Radio Frequency Identification). Electro- magnetic identifier, optical encoders, colour sensors, sensing principles. Colour theory, unit colour measurement, colour comparator, colour sensing algorithm, fuzzy logic colour sensor. Fuzzy logic for opt- electronic colour sensor in manufacturing.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

Flexible Manufacturing Systems: Introduction of FMS, types. Sensors used in FMS, integration sensors. Vision sensors (image capturing, image transformations and analysis), detecting partially visible objects, overlap and defects using vision sensors.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

Sensors for Special Applications: Cryogenic manufacturing applications, semiconductor absorption sensors, semiconductor temperature detector using photoluminescence temperature detectors using point contact, Sensors in process manufacturing plants, measurement of high temperature, robot control through sensors, other sensors (predictive monitoring serving the CIM strategy. Optical sensor quantifying acidity of solution, reflective strip imaging camera sensor, ultrasonic stress sensor for measuring dynamic changes in materials. Acoustic optical synthetic aperture radar, sensors for vibration measurement of structures), collection and generation of process signals in decentralized manufacturing system.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

Networking: Networking of sensors, control of manufacturing process tracking- the mean time between operations interventions. Tracking the yield, mean process time, detection of machining faults. Diagnostic systems, resonance vibration analyzer, Sensing motor current for signature analysis, temperature sensing (RTD, thermocouple).

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**
   to attain the COs and POs

The sum of three 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. Sabnesoloman, sensors & control systems in manufacturing. Mc-Graw Hill book Company Network, 1994.
2. Mechatronics by W.Bolton,
3. Sensor Technology Handbook by Jon S.Wilson
4. N.L.Buck & T.G. Buckwith, Mechanical measurement.
5. Sensors and Transducers by Ian Sinclair

Web links and Video Lectures (e-Resources):

- https://youtu.be/sCTgZv33tuA
- https://youtu.be/hv-aBonZMRQ

Skill Development Activities Suggested

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

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Explain various signal condition devices used in electronic devises and use of appropriate method in signal conditions in various applications.	L1
CO2	Describe impact of an RFID system on manufacturing, defence, distribution, retail and health sectors & abstract ("filter") information in RFID	L1
CO3	Summaries the future advances to the quality and integrity of manufacturing and related sectors resulting from the use of RFID and other sensor	L2

	technologies	
CO4	Analyze and choose appropriate sensors in different industrial applications.	L2

Mapping of COS and POs

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

1:Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": no correlation

Semester- 01

Research Methodology and IPR			
Course Code	22RMI16	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. Students should understand a general definition of research design.
2. Students should know why educational research is undertaken, and the audiences that profit from research studies.
3. Students should be able to identify the overall process of designing a research study from its inception to its report.
4. Students should be familiar with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research.

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Techniques, Multidimensional Scaling, Deciding the Scale. Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention onBiological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition

Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. C.R. Kothari, Gaurav Garg, Research Methodology: Methods and Techniques, New Age International, 4th Edition, 2018
2. Ranjit Kumar, Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), SAGE Publications, 3 rd Edition, 2011

Web links and Video Lectures (e-Resources):

- https://youtu.be/E2gGF1rburw
- https://youtu.be/rz30rRfManE?list=PLdj5pVg1kHiOypKNUmO0NKOfvoIThAv4N

Skill Development Activities Suggested

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Discuss research methodology and the technique of defining a research problem	L1
CO2	Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review	L1
CO3	Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.	L2
CO4	Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports	L1
CO5	Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR.	L3

Mapping of COS and POs

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

1:Slight (low) 2:Moderate (medium) 3: Substantial (High) "-": no correlation

Semester-01

PLC and Sensors Laboratory			
Course Code	22MIAL17	CIE Marks	50
Teaching Hours/Week (L:P: S)	1:2:0	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
	Part A
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
9	Substation Automation with SCADA
	Part B
10	Demonstration of various sensors suitable for industrial automation application (Capacitive sensor, Inductive sensor, magnetic, photo electric sensor, ultrasonic sensor)

Course outcomes (Course Skill Set):

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

1. the students will be able to write and execute PLC ladder logic for different practical problems of automation
2. 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**.

1. Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
2. Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
3. Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
4. Weightage to be given for neatness and submission of record/write-up on time.
5. Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
6. In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
7. The suitable rubrics can be designed to evaluate each student's performance and learning ability.
8. The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

1. SEE marks for the practical course is 50 Marks.
2. SEE shall be conducted jointly by the two examiners of the same institute; examiners are appointed by the University.
3. All laboratory experiments are to be included for practical examination.
4. (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.
5. Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
6. Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
7. 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)
8. Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.
9. The duration of SEE is 03 hours

Suggested Learning Resources:

- Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005
- MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran & GK Vijaya Raghavan/WILEY India Edition/2008

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech in INDUSTRIAL AUTOMATION ENGINEERING (MIA)
(Effective from the Academic year 2022-23)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech. in INDUSTRIAL AUTOMATION ENGINEERING(MIA)
Choice Based Credit System (CBCS) and Outcome-Based Education(OBE)

II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Seminar	Tutorial / Skill Development activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	PCC	22MIA21	Robotics for Industrial Automation	02	--	02	03	50	50	100	3
2	IPCC	22MIA/MAR22	Hydraulics and Pneumatics Control System	03	02	--	03	50	50	100	4
3	PCC	22MIA23X	Professional Elective 1	02	---	02	03	50	50	100	3
4	PEC	22MIA24X	Professional Elective 2	02	--	02	03	50	50	100	3
5	MPS	22MIA25	Mini Project with Seminar	--	04	02	--	100	--	100	3
6	PCCL	22MIAL26	Automation and Robotics Laboratory	01	02	00	03	50	50	100	02
7	AUD/AEC	22AUD27	Suggested ONLINE courses	Classes and Evaluation Procedures are as per the Policy of the Online Course Providers.							PP
TOTAL				**10**	**08**	**08**	**15**	**350**	**250**	**600**	**18**

Note: PCC: Professional Core Courses, PEC: Professional Elective Courses, IPCC-Integrated Professional Core Courses.
MPS-Mini Project With Seminar; AUD/AEC; Audit Courses / Ability Enhancement Courses (Mandatory)

Professional Elective 1		**Professional Elective 2**	
Course Code under 22MIA23X	**Course title**	**Course Code under 22MIA24X**	**Course title**
22MIA/MAR231	Big Data Analytics for Automation	22MIA/MPY/MPT/MTE/MSE/MEM/MPM241	Agile Manufacturing
22MIA/MAR232	Modelling, Simulation and Analysis of Manufacturing Systems	22MIA242	Drives and Control System in Automation
22MIA/MAR233	IoT in Manufacturing	22MIA/MAR243	Microprocessor & Microcontroller
22MIA/MAR234	Advanced Control Engineering	22MIA/MAR244	Digital Manufacturing
22MIA/MAR235	Automation and Manufacturing Systems	22MPD/MAU/MDE/MEA/MMD/MTP/MPY/MIA/MAR/CAE/MPE/MPM/MCM245	Industry 4.0

Note:

1 Mini Project with Seminar: This may be hands-on practice**,** survey report, data collection and analysis, coding, mobile app development, field visit and report preparation, modelling of system, simulation, analysing and authenticating, case studies, etc.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Students can present the seminar based on the completed mini-project. Participation in the seminar by all postgraduate students of the program shall be mandatory.

The CIE marks awarded for Mini-Project work and Seminar shall be based on the evaluation of Mini Project work and Report, Presentation skill and performance in Question and Answer session in the ratio 50:25:25. Mini-Project with Seminar shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the Mini Project and Seminar shall be declared as fail in that course and have to complete the same during the subsequent semester. There is no SEE for this course.

2. Internship: All the students shall have to undergo a mandatory internship of **06 weeks** during the vacation of II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted in the same semester. The internship shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in the internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Program Outcome of the Course

POs	Description
PO1:	Acquire, demonstrate, and apply basic knowledge in the field of Industrial Automation Engineering.
PO2:	Identify problems in the field of Industrial Automation Engineering, formulate them and solve by using advanced techniques.
PO3:	Independently carry out research/investigation and developmental work to solve practical problems in Industrial Automation Engineering.
PO4:	Write and present a substantial technical report/document.
PO5:	Demonstrate a degree of mastery over Industrial Automation Engineering.
PO6:	Employ Artificial Intelligence and robotics tool to cater into Industrial Automation needs in both discrete and process plants.
PO7:	Provide solutions to varied engineering problems through the interpretation of data using modern computational tools.

Semester-02

Semester- 02

Robotics for Industrial Automation			
Course Code	22MIA21	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Elaborate discussion on various robot configurations and its applications.
- Kinematic and dynamic analysis for various robot configurations.
- Understanding and implementation of D-H conventions.
- Mathematical formulations for trajectory planning and robot control systems.

Module-1

Introduction: Automation and Robotics, Historical Development, Definitions, Basic Structure of Robots, Robot Anatomy, Complete Classification of Robots, Fundamentals about Robot Technology, Factors related to use Robot Performance, Basic Robot Configurations, Types of Drive Systems, Wrist & Gripper Subassemblies, Robot Controls

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

Robot Sensing & Vision: Introduction to Various Sensors and their Classification, Use of Sensors and Sensor Based System in Robotics, Machine Vision System: Sensing, Digitizing, Image Processing and Analysis and Application of Machine Vision System, Robotic Assembly Sensors and Intelligent Sensors.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

Kinematics of Robot Manipulator: Introduction, General Description of Robot Manipulator, Mathematical Preliminaries on Vectors & Matrices, Homogenous Representation of Objects, Robotic Manipulator Joint Co-Ordinate System, Euler Angle Roll-Pitch-Yaw(RPY) Transformation, Direct & Inverse Kinematics Solution, D-H Representation & Displacement Matrices for Standard Configurations.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

Robot Arm Dynamics: Introduction, Lagrange – Euler Formulations, Joint Velocities of a robot manipulator, Kinetic energy of a robot manipulator, Potential energy of a robot manipulator.

Time and Motion: Trajectories, Smooth One-Dimensional Trajectories, Multi-Dimensional Case, Multi-Segment Trajectories, Interpolation of Orientation in 3D, Cartesian Motion.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

Robot teaching & industrial Applications: Various Teaching Methods, A Robot Program as a Path in Space, Motion Interpolation, WAIT, SIGNAL & DELAY Commands, Branching, Robot Language Structure, various Textual Robot Languages Such as VAL II, RAIL, AML and their Features. Typical Programming Examples such as Palletizing, Loading a Machine, Robot Applications in Manufacturing.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. "A Robot Engineering Textbook "– Mohsen Shahinpoor – Harper & Row publishers, New York,. ISBN-13: 978-0060459314
2. "Robotics, control vision and intelligence," Fu, Lee and Gonzalez. McGraw Hill, International, ISBN – 8131518124
3. "Robotics for Engineers", YoramKoren, McGraw Hill International, ISBN-10: 0070353999
4. "Industrial Robotics", Groover, Weiss, Nagel, McGraw Hill International, ISBN 10: 1259006212
5. "Fundamentals of Robotics Analysis and Control" -Schilling, PHI, ISBN: 9789332555235
6. "Robot Vision and Sensor Controls", Rooks B, Vol-3 North Holland,ISBN 978-3- 319-54413-7
7. "Robotics Technology and Flexible Automation", Second Edition, S R Deb, Sankha Deb, Tata McGraw-Hill Education, ISBN-(13):978-0-07-007791-1.

Web links and Video Lectures (e-Resources):

- https://youtu.be/a6_fgnuuYfE?list=PLyqSpQzTE6M_XM9cvjLLO_Azt1FkgPhpH
- https://youtu.be/rYWJdZ5qg6M?list=PLbRMhDVUMngcdUbBySzyzcPiFTYWr4rV_

Skill Development Activities Suggested :

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

  Assignments, Quiz and Industrial Visit on relevant topic of the course.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Explain basic components, drive systems, control systems and configurations of industrial Robots.	L1
CO2	Explain various sensing, vision and teaching techniques of robotics systems.	L1
CO3	Apply different robot teaching methods and programming techniques for various industrial applications.	L3
CO4	Apply analytical techniques and basic principles of robotic design for solving the kinematics of a robot manipulator.	L3
CO5	Analyse the dynamic behaviour of the Robotic joints.	L4

Mapping of COS and POs

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

1:Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": no correlation

emester - 02

Hydraulics and Pneumatics Control System			
Course Code	22MIA/MAR22	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:02:00	SEE Marks	50
Total Hours of Pedagogy	40Hrs+10-12Activities	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

This course provides a comprehensive introduction to fluid power, including both oil hydraulics and pneumatics, by focusing on the following learning objectives. Upon completion of a course, the student will

- 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

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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 rod less cylinder, control of a rod less 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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

MODULE 5
Design of pneumatic and hydraulic circuits andarrangement 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, fault diagnosis 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 forfault finding.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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 **20 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 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

1. 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.
2. 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.
3. The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

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

SEE for IPCC

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

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.

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

5. 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.
6. 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.
8. Allen C. Morse. Electro-hydraulic Servo-mechanisms. McGraw-Hill, 1963.
9. John Watton. Fluid Power Systems. Prentice-Hall International (UK) Ltd., 1989.

Web links and Video Lectures (e-Resources):

- https://youtu.be/dxAsr14DW6Y?list=PLbMVogVj5nJTKwm1WjlutrAEZrLE995Ja
- https://youtu.be/akZjDHD6JC4

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

Mapping of COS and POs

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

1:Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": no correlation

Semester-02

Professional Elective-1

Semester- 02

Big Data Analytics for Automation			
Course Code	22MIA/MAR231	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

To impart knowledge on overview of big data and study history, evolution and uses of big data, Introducing Technologies for Handling Big Data and Hadoop Ecosystem Distributed and Parallel Computing for Big Data, Understanding Map Reduce Fundamentals and H Base The Map Reduce Framework, Understanding Hadoop YARN Architecture and Mahout Background of YARN

Module-1	
Getting an Overview of Big Data What is Big Data? , History of Data Management – Evolution of Big Data, Structuring Big Data, Types of Data, Elements of Big Data, Volume, Velocity, Variety ,Veracity ,Big Data Analytics ,Advantages of Big Data Analytics, Use of Big Data in Social Networking, Use of Big Data in Preventing Fraudulent Activities, Use of Big Data in Retail Industry.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2	
Introducing Technologies for Handling Big Data and Hadoop Ecosystem Distributed and Parallel Computing for Big Data, Introducing Hadoop, How does Hadoop Function?, Cloud Computing and Big Data, Features of Cloud Computing, Cloud Deployment Models, Cloud Delivery Models, Cloud Services for Big Data, Cloud Providers in Big Data Market, In-Memory Computing Technology for Big Data.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3	
Understanding MapReduce Fundamentals and H Base The MapReduce Framework, Exploring the Features of MapReduce, Working of MapReduce, Exploring Map and Reduce Functions, Techniques to Optimize MapReduce Jobs, Hardware/Network Topology, Synchronization, File System, Uses of Map Reduce, Role of HBase in Big Data Processing, Characteristics of H Base.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4	
Understanding Big Data Technology Foundations and Processing your Data with MapReduce Exploring the Big Data Stack,Virtualization and Big Data, Virtualization Approaches,Developing a Simple MapReduce Application, Points to Consider while designing MapReduce.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5	
Understanding Hadoop YARN Architecture and Mahout Background of YARN, YARN Architecture, Working of YARN, YARN Schedulers, Backward Compatibility with YARN, YARN Configurations, YARN Commands, What is Mahout?, Machine Learning, Collaborative Filtering, Clustering, Classification, Mahout Algorithms, Environment for Mahout.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. 1.Big Data: Black Book, DT Editorial Services, Wiley India Pvt Ltd, 2015 Edition (Chapters 1,2,3,4,5,6,8,11,12,17)
2. ArvindSathi, "Big Data Analytics: Disruptive Technologies for Changing the Game", 1st Edition, IBM Corporation, 2012
3. Big Data Analytics with R and Hadoop, VigneshPrajapati, -Packt Publishing 2013
4. MichaelMinelli, Michehe Chambers, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business", 1st Edition, AmbigaDhiraj, Wiely CIO Series, 2013.
5. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", 1st Edition, Wiley and SAS Business Series, 2012.
6. Tom White, "Hadoop: The Definitive Guide", 3rd Edition, O'reilly, 2012.
7. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data EMC Education Services, Wiley India Pvt Ltd.

Web links and Video Lectures (e-Resources):

- https://youtu.be/r5k-_RLIpuA?list=PLFW6lRTa1g813IyYHLRP_bWJEKQDeEcSP
- https://youtu.be/4SJ7bEILPJk?list=PLLy_2iUCG87CNafffzNZPVa9rW-QmOmEv

Skill Development Activities Suggested

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

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe Overview of Big Data and Related Technologies	L1
CO2	Analyze Technologies for Handling Big Data and Hadoop Ecosystem	L3
CO3	Acquire clear understanding of MapReduce Fundamentals and HBase	L1
CO4	Acquire clear understanding of Virtualizing and Processing Data using MapReduce	L1
CO5	Acquire a clear understanding of YARN and Mahout	L2

Mapping of COS and POs

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

1:Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": no correlation

Semester- 02

Modelling, Simulation and Analysis of Manufacturing Systems			
Course Code	22MIA/MAR232	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12Activities	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	
Principles of Modelling and 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	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2	
Modeling Approaches: List processing in simulation, Simple simulation language, Single server queuing systems, Time shared computer model, Multiteller banking with jockeying, Job shop model.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation
Module-3	
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.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation
Module-4	
Random Variate Generation: Introduction, different techniques to generate random variate: Inverse transforms technique,-exponential, Normal, uniform, and 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	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

Statistical Techniques: Comparison of two system designs, Comparison of several system designs – 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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. Simulation, Modeling 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):

- https://youtu.be/AKhN-dBoBjM?list=PLHGmNPVOI3GElgoeCoescO3LRfErfmW0i
- https://youtu.be/zmbS_TmNDP4?list=PLSGws_74K01-4rcWuB5BEATHSsOrBd1ye

Skill Development Activities Suggested

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

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	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.	L3

Mapping of COS and POs

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

1:Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": no correlation

Semester- 02

IoT in Manufacturing			
Course Code	22MIA/MAR233	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12Activities	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	
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.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation
Module-2	
Understanding the Industrial process and devices: Industrial process, automation in the industrial process, control and measurement systems, types of industrial process, The CIM pyramid, CIM pyramid architecture – devices and networks, CIM network, The I-IoT data flow, The Industrial IoT data flow in a factory, The edge device, The Industrial IoT data flow in the cloud. Industrial data flow and devices, The I-IoT data flow in the factory, Measurement and the actuator chain.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3	
Understanding of Node MCU: Open Source Microcontroller Platform, Node GPIO Pins, and Basics of Electronics. Introduction toEsp8266, Wifi Network, Web serve. Cloud Servers. IoT Sensors- Temperature, Humidity Sensor, Light, Gyro, Inclination, Magneto, Pressure, Flow, Aqua, Position, vibration and acoustic sensors. Protocol -MQTT Protocol, HTTP vs MQTT, Creating Adafruit account, Using Adafruit to read sensors value and send data to Node MCU	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation
Module-4	
Implementing the I-IoT data flow: Discovering OPC, OPC classic, The data model and retrieving, data in OPC classic, OPC UA, The OPC UA information model, OPC UA sessions, OPC UA security model, The OPC UA data exchange, OPC UA notifications, Understanding the I-IoT edge, Features of the edge – edge gateway, edge tools, edge computing, The I-IoT edge architecture, Edge implementations – Azure IoT edge, Green grass, Android IoT, Node red, Docker edge, Intel IoT gateway, Edge Internet protocols.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation
Module-5	
Understanding of I-IoT data loggers: Internal architecture of I-IoT data logger, communication protocols, I/O modules (Digital and Analog).Configuring I-IoT data logger through a web based application, Establishing communication between PLC and I-IoT data logger. Interfacing of industrial sensor with I-IoT data logger. Development of cloud based applications for the Mechatronics systems using the I-IoT data logger thorough web portal.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. Oliver Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key, Applications and Protocols", Wiley Publications, 2011. ISBN: 1119966701.
2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", A press, 1st Edition, 2017. ISBN: 1484220463.
3. RMD Sundaram Shriram K Vasudevan, Abhishek S Nagarajan, "Internet of Things", Wiley Publications, 2019. ISBN: 8126578378.

Web links and Video Lectures (e-Resources):

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

Skill Development Activities Suggested

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

Course outcome (Course Skill Set)

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

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

Mapping of COS and POs

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

1:Slight (low) 2:Moderate (medium) 3: Substantial (High) "-": no correlation

Semester- 02

Advanced Control Engineering			
Course Code	22MIA/MAR234	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12Activities	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	
Motivation for control. Review of differential equations, impulse response and Laplace transformations, Introduction to state equations and transfer functions.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation
Module-2	
Interpretation of poles and zeros of transfer functions. Time domain response of second order system. Command tracking and system type. Rough/Hurwitz test	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation
Module-3	
Frequency response and frequency domain methods. Nyquist stability test. Bode plots. Phase and gain margins. Bode phase formula	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation
Module-4	
Robustness. Uncertainty and performance weights. Robust stability test. Robust performance test. Loop shaping necessary and sufficient conditions. Bode integral formula.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation
Module-5	
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.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. 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):

- https://youtu.be/bbm79-UcNN0?list=PLbMVogVj5nJTNkhtkCEKQHhPOr2bpS3za
- https://youtu.be/8OVD2BHA5Hg?list=PLLy_2iUCG87CVglDEadTd_PRjA-g1KqVo

Skill Development Activities Suggested

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

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	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

Mapping of COS and POs

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

1:Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": no correlation

Semester- 02

Automation and Manufacturing Systems			
Course Code	22MIA/MAR235	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To provide a substantial information on automation and control systems.
2. Exposure towards various manufacturing systems.
3. Implementation of group technology and cellular manufacturing technology for various industry requirements.
4. Importance of FMS

Module-1

Production systems: facilities, manufacturing support systems. Automation in production systems: automated manufacturing systems, computerized manufacturing support systems, reasons for automating, Automation principles and strategies: The USA principle, Ten strategies for automation and process improvement, automation migration strategy. Production facilities. Basic elements of automated systems: power to accomplish the automated process, program of instructions, control system. Advanced automation functions: safety monitoring, maintenance and repair diagnostics, error detection and recovery, error recovery. Levels of automation.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

Industrial control systems-Process industries versus discrete manufacturing industries, levels of automation in the two industries, variables and parameters in the two industries. Continuous versus discrete control: continuous control systems, regulatory control, feed forward control, steady state optimization, adaptive control, online search strategies. Discrete control system. Computer process control, control requirements, capabilities of computer control, polling, interlocks, interrupt system, exception handling. Forms of computer process control.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

Overview of manufacturing systems- Components of a manufacturing system, production machines, material handling systems, and computer control system, human resources. Types of manufacturing systems, types of operations, number of workstation and system layout, level of automation, system flexibility. Classification of manufacturing systems, single station cell, multi-station systems with fixed and variable routing.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

Group technology and cellular manufacturing - Part families and machine groups, intuitive grouping, parts classification and coding, production flow analysis, Cellular manufacturing, composite part concept, machine cell design, applications of group technology, Analysis of cellular manufacturing, rank order clustering, arranging machines in a GT cell, performance metrics in cell operations. Numerical on rank order clustering and performance metrics in cell operations.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

Flexible manufacturing cells and systems: Flexible manufacturing system, types of FMS, FMC/FMS components, workstations, material handling and storage system, computer control system, FMS applications, FMS planning and implementation issues, FMS benefits, Analysis of FMS, bottleneck model, terminology and symbols, FMS operation

parameters, System performance metrics, extended bottleneck model, sizing the FMS.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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

Semester End Examination:

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

Suggested Learning Resources:

Books

1. Automation, Production Systems and Computer Integrated Manufacturing- M. P. Groover, Pearson Education. Fourth edition, 2016.
2. Fluid Power with Applications-Anthony Esposito, Peason, Sixth Addition.
3. Pneumatic Systems, Principles and Maintenance- SR Majumdar, 2011Edition.
4. Industrial Robotics, Technology, Programming, and applications-MikellP.Groover.
5. Computer Based Industrial Control- Krishna Kant, EEE-PHI,2nd edition,2010
6. An Introduction to Automated Process Planning Systems- Tiess Chiu Chang &Richard A. Wysk

Web links and Video Lectures (e-Resources):

- https://youtu.be/v-3TmN4HhLc?list=PLwdnzlV3ogoW31clPN6Dn6c8Ia-n36vXk
- https://youtu.be/-NINgz6KQTA?list=PLOSWwFV98rfLAVnU2DJq8xO1LuFw6SXEa

Skill Development Activities Suggested

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

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the importance of Automation in Manufacturing and modelling.	L1
CO2	Students will gain the knowledge of Industrial control systems and overview of manufacturing system	L2
CO3	demonstrate appropriate features Group Technology and Flexible Manufacturing system	L2

Mapping of COS and POs

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

1:Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": no correlation

Professional Elective-2

Semester- 02

Agile Manufacturing			
Course Code	22MIA/MPY/MPT/MTE/MSE/MEM/ MPM241	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	40Hrs+10-12 Activities	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

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

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

Developing Agile Manufacturing: Enterprise design, System concepts as the basic manufacturing theory-joint technical and Organizational design and a model for the design of agile manufacturing enterprise. Enterprise design process insights into design processes, what are interdisciplinary design, main issues, and 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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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

Semester End Examination:

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

Suggested Learning Resources:

Books

1. **Agile Manufacturing**- Forging New Frontiers',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):

- https://youtu.be/_n28vUPJzxM
- https://youtu.be/HQEkn-mJnas

Skill Development Activities Suggested

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

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	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

Mapping of COS and Pos

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

1: Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": no correlation

Semester- 02

Drives and Control System in Automation			
Course Code	22MIA242	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

To make students apply the concepts of Industrials Drives, Programmable Logic Controllers and Supervisory control & data Acquisitions in automation application

Module-1

Introduction: Working principle of synchronous, Asynchronous & stepper motors, Difference between Induction and servo motors, Torque v/s speed characteristics, Power v/s. Speed characteristics, Vector duty induction motors, Concepts of linear and frameless motors, Selection of feedback system, Duty cycle, , V/F control, Flux Vector control.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

Industrials Drives: DC and AC motors operation and selection, method of control and application of brushless DC motor, PMSM, stepper motor, A.C servomotor, selection criteria for servo motor and servo amplifier, universal motor, electric drive, types of industrial drives, the characteristics of drive, advantages of drives over other prime movers, motor rating, heating effects, electric braking.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

Introduction to Programmable Logic Controllers: Definitions of PLC, basic structure of PLC, working principles, data storage methods, inputs / outputs flag processing's, types of variables, definition of firmware, software, programming software tool and interfacing with PC (RS232 & TCP-IP), methods of PLC programming (LD, ST, FBD & SFC), What is logic, Conventional Ladder v/s PLC ladder, series and parallel function of OR, AND, NOT logic function.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

Application of PLC using Timers and Counters Timer and Counter Instructions: On delay and Off delay and retentive timer instructions, retentive timers,, Programming examples, Counter- counter up and down instructions, combining counters and timers, Comparison and data handling instructions, Arithmetic functions, Sequencer instruction, PLC Safety, Commissioning, Testing.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

Supervisory control & data Acquisitions: Introduction to Supervisory control & data Acquisitions, distributed Control System (DCS): computer networks and communication in DCS. different BUS configurations used for industrial automation – GPIB, HART and OLE protocol, Industrial field bus – FIP (Factory Instrumentation Protocol),

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. Process Control Instrumentation Technology, Johnson Curties, Prentice hall of India, 8th edition
2. Andrew Parr, Industrial drives, Butterworth –Heineamann G.K.Dubey. Fundamentals of electrical drives
3. Programmable Logic Controllers by W.Bolton
4. Introduction to Programmable Logic Controllers by Garry Dunning, 2ndedition, Thomson,ISBN:981-240-625-5
5. Instrumentation Engineers Hand Book - Process Control, Bela G Liptak, Chilton book company, Pennsylvania
6. A.E. Fitzerald ,C.Kingsley and S.D Umans, Electric Machinery - McGraw Hill Int. StudentEdition
7. S.K.Pillai. A First course on electric drives –Wiley Eastern1990
8. Programmable Logic Controllers by HughJack.

Web links and Video Lectures (e-Resources):

- https://youtu.be/oxMdDsud5vg?list=PLE8F9BF5CB1201D23
- https://youtu.be/1AT1yuQ9awM?list=PLFW6lRTa1g83sIfVY1p1xGqPGYUmXyahx

Skill Development Activities Suggested

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

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe and analyze working principles of various types of motors, differences, characteristics and selection criteria, control methods, SCADA	L1
CO2	Applytheknowledgeinselectionofmotors,heatingeffectsandbrakingconceptsinvarious industrial applications	L3
CO3	Construct a program using PLC to problems pertaining to automation industries	L2
CO4	To understand visualization systems and its integrations	L3

Mapping of COS and POs

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

1:Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": no correlation

Semester- 02

Microprocessor and Microcontroller			
Course Code	22MIA/MAR243	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12Activities	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

- To illustrate the architecture of 8085 and 8086 microprocessors.
- To introduce the programming and interfacing techniques of 8086 microprocessor.
- To analyse the basic concepts and programming of 8051 microcontroller
- To understand the interfacing circuits for various applications of 8051 microcontroller.
- To introduce the architecture of advanced microprocessors and microcontrollers.

Module-1	
Introduction to Microprocessors: Introduction to Microprocessors, RISC and ARM design Philosophy, ARM Processor Fundamentals, registers, Current Program Status Register, Pipeline, Interrupts and Vector Table, Architecture Revisions, ARM Processor Families.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation
Module-2	
ARM Instruction Set: Data processing instruction, branch instructions, load store instructions, software interrupt instructions, program status register instructions, loading constants, conditional executions, efficient C programming for ARM processor.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation
Module-3	
IoT Definitions: IoT Frameworks, Internet of things application examples, Identification of IoT Objects and Services, Structural Aspects of the IoT Key, IoT Technologies. IoT Protocols: Application protocols- MQTT, LORA, CoAP, Infrastructure Protocols- WiFi, Bluetooth, Zigbee, RFIP, Wireless sensor networks	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation
Module-4	
AVR Microcontroller: Overview of AVR family, AVR Microcontroller architecture, Register, AVR status register, ROM space and other hardware modules. ATmega8 pin configuration and pin functions. **AVR Assembly Language Programming:** Addressing modes of AVR, Data transfer Arithmetic, Logic and Compare, Rotate and Shift, Branch and Call instructions. AVR data types and assembler directives, AVR assembly language programs and I/O port programming	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation
Module-5	
Peripheral Interfacing: LED and Keyboard Interfacing, ADC, DAC and IR sensor interfacing, Stepper Motor Interfacing, DC motor control	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. Microprocessors and Interfacing- A. P Godse, D.A. Godse. Technical Publications 2013.
2. The 8086 Programming and Interfacing- Kenneth J Ayala, Cengage Learning 2010.
3. Microprocessor and Interfacing- Douglas V Hall, McGraw Hill Publications 2013.
4. Microprocessor and Microcontroller-Uday Kumar, Pearson Education 2012.

Web links and Video Lectures (e-Resources):

- https://youtu.be/o6W0opScrKY?list=PLuv3GM6-gsE01L9yDO0e5UhQapkCPGnY3
- https://youtu.be/liRPtvj7bFU?list=PL0E131A78ABFBFDD0

Skill Development Activities Suggested

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

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	In-depth understanding of the operation of microprocessors and microcontrollers, machine language programming & interfacing techniques	L1
CO2	Strong understanding of main components and working principles of the Intel 8086 microprocessor and Intel 8051microcontroller	L2
CO3	Memory organization and memory interfacing with 8086 and 8051 systems	L2
CO4	Interfacing microprocessor and microcontroller with real life systems	L3
CO5	Interrupt vectors, interrupt process, and interrupt priorities, external and advanced interrupts, timers and delays.	L3

Mapping of COS and POs

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

1:Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": no correlation

Semester- 02

Digital Manufacturing			
Course Code	22MIA/MAR244	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12Activities	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

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

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

Automated Material Handling and Identification Technology: Overview of Material Handling, Material Transport Equipment, Analysis of Material Transport Systems, Storage Systems. Introduction to Storage Systems, Conventional Storage Methods and Equipment, Automated Storage Systems, Automatic Identification and Data Capture.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

Analysis of Automated flow lines: Analysis of transfer lines without storage, with storage buffer, single stage, double stage, multistage with problems. Automated assembly systems, design for automated assembly, parts feeding devices, analysis of multi station assembly machine, and analysis of single stage assembly machine.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

Electro-Pneumatics: Introduction, Pressurized Air: Production & Distribution, Pneumatic Devices, Single &Double Acting Cylinders, Calculations, Length of Piston Stroke, Speed of Piston's Translation, Pressurized Air Flow Control Valves, Directional Valves, Valves Actuation. Manual, Mechanical, Electrical, Pneumatic.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

PLCs: Introduction, Modular Construction of a PLC, PLC I/O Components, Digital Input Modules, Digital Output Modules, Communication Modules, Central Processing Unit. PLC Programming: Introduction to Programming of PLCs, The IEC 61131 Standard, Structural Programming, Basic Programming Instructions. The Result of an Instruction Execution, Boolean Logic Instructions, Activation Instructions, Complementary Instructions.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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

Semester End Examination:

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

Suggested Learning Resources:

Books

1. Automation Production Systems and CIM – Mikell P Groover, 4th Edition, Pearson, 2016. ISBN: 978-93-325-7249-2
2. Introduction to Industrial Automation, StamatiosManesis&George Nikolakopoulos, CRC Press, 2018, ISBN: 978-1-4987-0540-0
3. Principles of Computer Integrated Manufacturing – S.Kant Vajpayee, PHI, ISBN 13: 978-81203-1476-4
4. Mechatronics – William Bolton, Sixth Edition, Pearson , ISBN-9788131732533

Web links and Video Lectures (e-Resources):

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

Skill Development Activities Suggested

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

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Apply automated material handling and identification technologies to upgrade material handling system in industries	L2
CO2	Analyse the automated flow lines and assembly systems	L3
CO3	Design and analyse pneumatic circuits for various applications.	L2
CO4	Apply the concepts of PLC for industrial applications	L2

Mapping of COS and POs

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

1:Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": no correlation

Semester- 02

Industry 4.0			
Course Code	22MPD/MAU/MDE/MEA/MMD/MTP/MPY/MIA/MAR/CAE/MPE/MPM/MCM245	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

The course is designed to offer fundamentals of Industry 4.0, IoT 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

Industry 4.0: Introduction, Various Industrial Revolutions, Fourth Revolution, Drivers, Enablers and Challenges for Industry 4.0. Lean Production System, Smart Factories, Smart and Connected Business Perspectives, Collaboration Platform and Product Life-Cycle Management.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

Cyber-Physical Systems (CPS) and Next Generation Sensors, Industrial Sensing and Actuation, Smart Manufacturing, Smart Devices and Products, Smart Logistics. Automation and Robotics in Industry, Artificial Intelligence, Support system for Industry 4.0, Opportunities in future and strategies for competing in Industry 4.0 era

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

Industrial IoT: Introduction, Internet of Things (IoT), Industrial IoT, Industrial Processes, Advanced technologies: Software Defined Networking and Security in IIoT.

Key Enablers of IIoT: Sensing, Connectivity, Processing & Process control, IIoT Analytics and Data Management: Machine Learning and Cloud computing (Brief description only)

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

Applications of IIoT: Inventory Management & Quality Control, Plant Security and Safety, Facility Management, Oil-Chemical & Pharmaceutical Industry, UAVs in Industries, Factories and Assembly Line, Food Industry,

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

Case Studies for Industry 4.0 and IIoT: Milk Processing & Packaging Industries, Manufacturing Industries, Virtual Reality Lab, Steel Technology Lab

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. Oliver Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key Applications and Protocols", Wiley Publications, 2011. ISBN: 1119966701.
2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", A press, 1st Edition, 2017. ISBN: 1484220463.
3. RMD Sundaram Shriram K Vasudevan, Abhishek S Nagarajan, "Internet of Things", Wiley Publications, 2019. ISBN: 8126578378.

Web links and Video Lectures (e-Resources):

- https://youtu.be/p7kYStiASLo?list=PLbRMhDVUMngdcLdH4-YF1uJI4IuhcDZPR
- https://youtu.be/hv-aBonZMRQ?list=PLWbMIWDTOauBvP0ZxvoIshg55WPMF37UI

Skill Development Activities Suggested

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

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe the fundamentals of Industry 4.0, Industrial revolution and challenges being faced.	L1
CO2	Summarize and classify various sensors and actuators used in Industry 4.0, Smart Manufacturing and other cyber-physical related attributes.	L2
CO3	Demonstrate various aspects of IoT, IIoT, current technologies that are driving industries in manufacturing and management.	L3
CO4	Correlate various applications and case studies of IoT and IIoT in various streams	L3

Mapping of COS and POs

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

1:Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": no correlation

MINI PROJECT WITH SEMINAR			
Course Code	**22MTE25**	CIE Marks	100
Number of contact Hours/Week	**0-4-2**	SEE Marks	--
Credits	**03**	Exam Hours/Batch	--

Course objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Mini-Project with seminar: This may be hands-on practice**,** survey report, data collection and analysis, coding, mobile app development, field visit and report preparation, modelling of system, simulation, analysing and authenticating, case studies, etc.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Students can present the seminar based on the completed mini-project. Participation in the seminar by all postgraduate students of the program shall be mandatory.

The CIE marks awarded for Mini-Project work and Seminar, shall be based on the evaluation of Mini Project work and Report, Presentation skill and performance in Question-and-Answer session in the ratio 50:25:25. Mini-Project with Seminar shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the Mini Project and Seminar shall be declared as fail in that course and have to complete the same during the subsequent semester.

There is **no SEE** for this course.

Course outcomes:

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

- Present the mini-project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills.
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

Automation and Robotics Laboratory			
Course Code	22MIAL26	CIE Marks	50
Teaching Hours/Week (L:P: S)	01:02:00	SEE Marks	50
Credits	02	Exam Hours	03

Course objectives:

1. Impart the knowledge of CNC programming
2. Impart the knowledge of robot programming

Sl.NO	Experiments
	PART-A
1	Generation of CNC program by optimizing tool path movement using CAM software for lathe
2	Generation of CNC program by optimizing tool path movement using CAM software for milling
	PART-B
3	**Robotics lab:** Movement program with "MOVE" and Output Set/Reset
4	Movement program with abortion of movement
5	Movement program with Rounding of the 90° Turns
6	Program to demonstrate Wait for an input before movement is continued
7	Movements with fixed values and Axis-Values from Teach Point
8	Demonstration of FMS

Course outcomes (Course Skill Set):

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

1. Simulate manufacturing processes before being put to actual machining
2. Apply/develop solutions or to do research in the areas of Design and simulation in Mechanical Engineering.
3. Program and control robot path for industrial applications.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation (CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course 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:

- CAD/CAM/CIM – P. Radhakrishna, New Age International.
- M. P. Grover, Automation, Production Systems & Computer Aided manufacturing, Prentice Hall.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech in INDUSTRIAL AUTOMATION ENGINEERING (MIA)
(Effective from the Academic year 2022-23)

Registrar,
Visvesvaraya Technological University
Jnana Sangam, Machhe, Belagavi-590018
e-Mail: registrar@vtu.ac.in
Contact: 0831-2498112

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech. in INDUSTRIAL AUTOMATION ENGINEERING(MIA)
Choice Based Credit System (CBCS) and Outcome-Based Education(OBE)

III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical / Mini–Project/ Internship	Tutorial / Skill Development activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	PCC	22MIA31	Programmable Logic Control	03	--	02	03	50	50	100	4
2	PEC	22MIA32X	Professional Elective Courses-3	03	--	--	03	50	50	100	3
3	OEC	22MIA33X	**Professional Elective 4**	03	00	00	03	50	50	100	3
4	PROJ	22MIA34	Project Work Phase – 1	00	06	00	--	100	--	100	3
5	SP	22MIA35	Societal Project	00	06	00	-	100	-	100	3
6	INT	22MIAI36	Internship	(06 weeks Internship Completed during the intervening vacation of II and III semesters.)			03	50	50	100	6
TOTAL				**09**	**12**	**02**	**12**	**400**	**200**	**600**	**22**

Note: PCC: Professional core Courses, PEC: Professional Elective Courses. PROJ-Project Work, INT-Internship, OEC Open Elective Courses, SP- Societal Project

Professional Elective 3		**Professional Elective 4**	
Course Code under 22MIA32X	**Course Title**	**Course Code under 22MIA33X**	**Course Title**
22MIA/MAR321	Intelligent Manufacturing System	22MIA/MAR331	Industrial Safety
22MIA/MAR322	Micro-Machining Process	22MIA/MAR332	Non Traditional Machining
22MIA/MAR323	Tooling for Manufacturing in Automation	22MIA/MAR333	Flexible Manufacturing System
22MIA/MAR324	Micro Electromechanical System	22MIA/MPM/MST/MPT/MAR334	Total Quality Management
22MIA/MAR325	Electric Vehicles	22MIA/MAR335	Advanced Materials and Processing

Note:

1. Project Work Phase-1: The project work shall be carried out individually. However, in case a disciplinary or interdisciplinary project requires more participants, then a group consisting of not more than three shall be permitted.

Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall pursue a literature survey and complete the preliminary requirements of the selected Project work. Each student shall prepare a relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

2. Societal Project: Students in consultation with the internal guide as well as with external guide (much preferable) shall involve in applying technology to work out/proposing viable solutions for societal problems.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

Those, who have not pursued /completed the Societal Project, shall be declared as fail in the course and have to complete the same during subsequent semester/s after satisfying the Societal Project requirements. There is no SEE (University examination) for this course.

3. Internship: Those, who have not pursued /completed the internship, shall be declared as fail in the internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech. in INDUSTRIAL AUTOMATION ENGINEERING(MIA)
Choice Based Credit System (CBCS) and Outcome-Based Education(OBE)

IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
				L	P					
1	Project	22MIA41	Project Work Phase -2	--	08	03	100	100	200	18
TOTAL				--	**08**	**03**	**100**	**100**	**200**	**18**

Note:

1. Project Work Phase-2:

Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall continue to work of Project Work phase -1 to complete the Project work. Each student / batch of students shall prepare project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -1 shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

Total Credits 22+18+22+18 =**80**

Program Outcome of the Course

POs	Description
PO1:	Acquire, demonstrate, and apply basic knowledge in the field of Industrial Automation Engineering.
PO2:	Identify problems in the field of Industrial Automation Engineering, formulate them and solve by using advanced techniques.
PO3:	Independently carry out research/investigation and developmental work to solve practical problems in Industrial Automation Engineering.
PO4:	Write and present a substantial technical report/document.
PO5:	Demonstrate a degree of mastery over Industrial Automation Engineering.
PO6:	Employ Artificial Intelligence and robotics tool to cater into Industrial Automation needs in both discrete and process plants.
PO7:	Provide solutions to varied engineering problems through the interpretation of data using modern computational tools.

Semester- III

Semester- 03

Programmable Logic Control			
Course Code	22MIA31	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

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

Module-1

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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

Introduction To Logic: Equivalent ladder neither 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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

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 I/O modules.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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) „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):

- https://youtu.be/MS3qJq2jvu0
- https://youtu.be/MS3qJq2jvu0

Skill Development Activities Suggested

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

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	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

Mapping of COS and POs

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

1:Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": no correlation

Professional Elective-3

Semester- 03

Intelligent Manufacturing System			
Course Code	22MIA/MAR321	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

To provide students with the concepts of

- Planning manufacturing systems
- Computer integrated manufacturing and enterprise integration
- Group Technology
- Knowledge based systems

Module-1

Computer Integrated Manufacturing Systems Structure and functional areas of CIM system – CAD, CAPP, CAM, CAQC, ASRS. Advantages of CIM. Manufacturing Communication Systems – MAP/TOP, OSI Model, Data Redundancy, Top-down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing System Components, System Architecture and Data Flow, System Operation.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

Components of Knowledge Based Systems – Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

Machine Learning: Concept, Artificial Neural Networks, Biological and Artificial Neuron, Types of Neural Networks, Applications in manufacturing. Use of probability and fuzzy logic for machine thinking.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

Knowledge Based Group Technology: Group Technology: Models and Algorithms Visual Method, Coding Method, Cluster Analysis Method. Knowledge Based Group Technology – Group Technology in Automated Manufacturing System. Structure of Knowledge based system for group technology (KBST) — Data Base, Knowledge Base, Clustering Algorithm.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

Industrial applications of AI: Intelligent system for design, equipment selection, scheduling, material selection, maintenance, facility planning and process control.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", 8th edition, PHI, 2008.
2. Yagna Narayana, "Artificial Neural Networks", PHI, 2009.
3. Andre Kusaic, " Intelligent Manufacturing Systems", PHI,1989
4. Hamid R. Parsaei and Mohammad Jamshidi, "Design and Implementation of Intelligent Manufacturing Systems", PHI, 2009

Web links and Video Lectures (e-Resources):

- https://youtu.be/De8MQWbhu3k
- https://youtu.be/-2Cd38P6YO0

Skill Development Activities Suggested

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	assess the performance of manufacturing systems	L1
CO2	develop a systematic approach for design and implementation of manufacturing systems	L2
CO3	suggest new procedures to improve the productivity of existing manufacturing systems	L2
CO4	utilise online collaboration tools to work in complex teams	L4

Mapping of COS and POs

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

1:Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": no correlation

Semester- 03

Micro – Machining Process			
Course Code	22MIA/MAR322	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
Students are offered with the opportunity of Identify the traditional and micro machining processes, Describe advanced micromachining and Nano-finishing processes and Explain thermoelectric advanced micromachining processes.

Module-1

Micromachining: Definition, historical background, Need and applications of micromachining in engineering industries. Principle of mechanical micromachining - Classification of micromachining and nano finishing processes. Size comparisons in micro manufacturing and micro products. Problems in micro machining.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

Mechanical Advanced Micromachining and Nano-finishing Processes: Abrasive Jet Micromachining (AJMM), Ultrasonic Micromachining (USMM), Abrasive Water Jet Micro Machining (AWJMM), Abrasive Flow nano finishing (AFNF). Principle of working and applications.

Teaching-Learning Process	**Understanding**

Module-3

Thermoelectric Advanced Micromachining Processes: Electric Discharge Micromachining (EDMM), Wire Electric Discharge Micromachining (WEDMM), Laser Beam Micromachining (LBMM), Electron Beam Micromachining (EBMM). Principle of thermal advanced micromachining processes and applications.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

Electrochemical and Chemical Micromachining Processes: Electrochemical Micromachining (ECMM), Electrochemical Micro Grinding (ECMG), Electro stream Micro drilling (ESMD), Electrochemical Micro deburring (ECMDe), Chemical Micromachining (ChMM). Principle of thermal advanced micromachining processes and applications.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

Advanced nano finishing processes: Elastic Emission Machining (EEM) and Ion Beam Machining (IBM). Integrated-circuits based micro fabrication technology: Surface micromachining and Bulk micromachining. Principle of thermal advanced micromachining processes and applications.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. Jain V. K., Introduction to Micromachining, 2nd edition, Narosa Publishers, New Delhi (2014)
2. Jackson M. J., Micro and Nanomanufacturing, CRC Press, Taylor and Francis (2006). 54
3. Ghosh, A. and Mullick, S., Manufacturing Science, New Age International (2001).
4. Pandey, P.C. and Shan H.S., Modern Machining Processes, McGraw Hill (2004).
5. Micromachining of Engineering Materials J.A. McGeough. CRC Press
6. Hofy, H.E., Advanced Manufacturing Process, B and H Publication (1998)
7. Mishra, P.K., Non Conventional Machining, Narosa (2006).

Web links and Video Lectures (e-Resources):

- https://youtu.be/9V_y41MF-co?list=PLSGws_74K018uDGyEGytB6-q31SpmAKug
- https://youtu.be/2YTyyFzJvEw?list=PLsROtkZ0LLB-SeADjhsjYb8wSklNKNQmD

Skill Development Activities Suggested

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	To analyze and determine material fabrication processes	L2
CO2	Study of various micro machining processes	L1
CO3	Application of these machining methods in various fields	L3
CO4	Enhance his knowledge in semiconductor manufacturing processes.	L1

Mapping of COS and POs

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

1:Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": no correlation

Semester- 03

Tooling for Manufacturing in Automation			
Course Code	22MIA/MAR323	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

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

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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

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, Vice fixtures, Milling fixtures.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

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

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. **Tool Design-**Cyrol Donaldson, Tata McGraw Hill, India.ISBN 10: 0070153922
2. **Fundamentals of Tool Design** - Edward G Hoffman, SME, USA. ISBN-10: 0872631346
3. **Jigs & Fixtures-** Joshi, **P.H.,** , Second Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi 2004. ISBN 10: 0070680736
4. **Jigs and Fixture-**Hiram E Grant, Tata McGraw-Hill, New Delhi, 2003
5. **Tool Engineering & Design-**G.Nagpal, Khanna publications, ISBN-13: 978-8174092038
6. **Metal cutting and tool design-**Dr. B.J. Ranganath, Vikas publishing house, ISBN,0706970888

Web links and Video Lectures (e-Resources):

- https://youtu.be/v-3TmN4HhLc?list=PLwdnzlV3ogoW31clPN6Dn6c8Ia-n36vXk
- https://youtu.be/-NINgz6KQTA?list=PLOSWwFV98rfLAVnU2DJq8xO1LuFw6SXEa

Skill Development Activities Suggested

-

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

Mapping of COS and POs

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

1:Slight (low) 2:Moderate (medium) 3: Substantial (High) "-": no correlation

Semester- 03

Micro Electro-Mechanical System			
Course Code	22MIA/MAR324	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course the student will develop and/or refine the following areas of knowledge:

- Know what types of MEMS devices there are and when it makes sense to fabricate one
- Understand the basic concepts of semiconductor device physics
- Understand the micromachining techniques, including what they are, when to use them, and what needs to be considered when using them
- Demonstrate proficiency in designing process sequences

Module-1

Introduction: Micro Electro-Mechanical Systems, Ultra Precision Engineering, Micro sensors, Micro-actuators, Microelectronics Fabrication, Micromachining, Mechanical MEMS, Thermal MEMS, MOEMS, Magnetic MEMS, RF MEMS, Micro-fluidic Systems, Bio and Chemo – Devices, MEMS Packages and Design Considerations, Micro-Instrumentation.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

Micro fabrication and Micromachining: Integrated Circuit Processes, Bulk micromachining: Isotropic Etching and Anisotropic Etching, Wafer Bonding, High Aspect-Ratio Processes (LIGA)

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

Mechanical Sensors and Actuators: Principles of Sensing and Actuation; Beam and Cantilever; Micro plates; Capacitive Effects; Piezoelectric material as Sensing and Actuating Elements; Strain Measurement; Pressure measurement; Flow Measurement using Integrated Paddle – Cantilever Structure; Pressure Measurement by Microphone; Shear mode Piezo actuator; Gripping Piezo actuator; Inchworm Technology.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

Thermal and Fluidic Micro Sensors and Actuators :Thermal sensors, Electrical Sensors, Chemical and Biosensors Electromagnetic and Thermal micro actuation, Mechanical design of micro actuators, Micro actuator examples, Micro Fluidic systems, Fluid actuation methods, micro valves, micro pumps, micro motors-Micro actuator systems : Ink-Jet printer heads, Micro mirror TV Projector.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

MEMS: Characterization: Technologies for MEMS characterization, Scanning Probe. Microscopy (SPM): Atomic Force Microscopy (AFM), Scanning tunnelling microscopy (STM), Magnetic Force Microscopy, Scanning Electron Microscope, Laser Doppler vibrometer, Electronic Speckle Interference Pattern technology (ESPI).

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. Chang Liu, Foundations of MEMS, Pearson Education Inc., 2012.
2. Stephen D Senturia, Microsystem Design, Springer Publication, 2000.
3. Tai Ran Hsu, MEMS & Micro systems Design and Manufacture, TMH, New Delhi, 2002.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/108106165
- https://www.me.iitb.ac.in/~gandhi/me645/05L1_coursecontents_mtvn.pdf
- https://youtu.be/j9y0gfN9WMg?list=PL5873EDBDFB69BAD8

Skill Development Activities Suggested :

-

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 operation of micro devices, micro systems and their applications (L2)	L1
CO2	Apply scaling laws that are used extensively in the conceptual design of micro devices and systems (L3)	L2
CO3	Choose a micromachining technique, such as bulk micromachining and surface micromachining for a specific MEMS fabrication process (L3)	L3
CO4	Simplify the design of micro devices, micro systems using the MEMS fabrication process (L4)	L2

Mapping of COS and POs

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

1:Slight (low) 2:Moderate (medium) 3: Substantial (High) "-": no correlation

Semester- 03

Electric Vehicles			
Course Code	22MIA/MAR325	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Explain the need past, present and future of EV's
- Describe basic terms of EV parameters
- Explain major components of EV
- Describe energy storage technology and fuel cell

Module-1

Introduction: Need of electric drive, past present and future of EV's, Historical development of EV, current issues with EV, engineering philosophy of EV, concepts of EV, key EV technologies.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

Basics terms of Electrical end EV parameters: electrical terms, current, AC, DV voltage, power, conductors, insulators, resisters, relays, capacitors, solenoids, AC, DC motors and generators. EV parameters: weight and size parameters, force parameters, energy parameters and performance parameters

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

Introduction to Battery Operated Electric Vehicles(BOEV): Advantages, disadvantages, major components of BOEV, comparison with IC engine vehicles, flywheel energy storage, controller/inverter, regenerative braking, starting, driving and braking an EV, basic diagnostics and precautions, self diagnostics

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

Energy storage technology: Battery basics, different types of batteries (lithium-acid battery, lithium/alkaline, lithium ion, nickel metal hybrid) high discharge capacitors, battery rating, battery parameters, battery discharging and charging characteristics, battery chargers, battery indicating methods and devices.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

Fuel cells: Characteristics of fuel cells, fuel cell types- alkaline fuel cell, proton exchange membrane, direct methanol fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, hydrogen storage systems, reformers, fuel cell EV.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. Modern Electric Vehicle Technology, C C Chan& KT Chau, Oxfor University press 2001
2. Hybrid Electric and fuel cell vehicles, Jack Erjavec, Delmar, Cengage Learning, 2013
3. Electric and Hybrid Vehicles Design and Fundamentals, Iqbal Husain, CRC Press 2005
4. The Electric car, Michael H. Westbrook British library Cataloguing in Publication IET Power and energy series 38
5. Electric and Hybrid Vehicles, Tom Denton Rouledge 2016

Web links and Video Lectures (e-Resources):

- https://youtu.be/UgtjRob5qMg?list=PLyqSpQzTE6M9spod-UH7Q69wQ3uRm5thr
- https://youtu.be/V004WUdpHeA?list=PLlYm0-AHZdZRLYSylFinxkspWmcgNvbtl
- https://youtu.be/omauHunp3EM?list=PLxApjaSnQGi5EN-fTsIxTKaXLQaVPKdor

Skill Development Activities Suggested

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Discuss the historical developments and basic terminologies of EV	L1
CO2	Describe the working of eclectic drives and compare with IC engine vehicles	L2
CO3	Demonstrate the energy storage techniques and Fuel cells	L3

Mapping of COS and POs

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

1:Slight (low) 2:Moderate (medium) 3: Substantial (High) "-": no correlation

Professional Elective 4

Semester- 03

Industrial Safety			
Course Code	22MIA/MAR331	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

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

Module-1	
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 colour codes. Fire prevention and fire fighting, equipment and methods	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2	
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	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3	
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.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4	
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.	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5	
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	
Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. 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.
4. Winterkorn, Hans, Foundation Engineering Handbook, Chapman & Hall London, 1975

Web links and Video Lectures (e-Resources):

- https://youtu.be/jFDWlKayrTc?list=PLbRMhDVUMngdXebaRB59KdKwstzuAovua
- https://youtu.be/v-eltsixu4I?list=PLRa9Tg6V1LmeFDszsCBdtCVOfge7dmnRK

Skill Development Activities Suggested

-

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

Mapping of COS and POs

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

1:Slight (low) 2:Moderate (medium) 3: Substantial (High) "-": no correlation

Non-Traditional Machining			
Course Code	22MIA/MAR332	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40	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

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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

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.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

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

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. 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.
8. Modern Manufacturing Methods - Adithan

Web links and Video Lectures (e-Resources):

- https://youtu.be/06QxjEAMrKc?list=PLwFw6Nkm8oWqFJUxiUuu5c0uHK076lz2K
- https://youtu.be/Sfj8_9oRCNk

Skill Development Activities Suggested

-

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

Mapping of COS and POs

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

1:Slight (low) 2:Moderate (medium) 3: Substantial (High) "-": no correlation

Flexible Manufacturing System			
Course Code	22MIA/MAR333	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

To make student understand

- The need for flexibility in manufacturing industries
- To learn the development and implementation of an FMS
- To learn the different types of automated material handling systems its design and calculations for different applications of both AS/RS

Module-1

FMS Introduction and Description: Definition of FMS, Types of flexibility, Types of FMS, Levels of Flexibility, FMS Components, FMS Layout Configurations, FMS Applications and Benefits, Objectives and Aims of an FMS, FMS Planning and Implementation issues, Advantages and Disadvantages of FMS Implementation, Quantitative Analysis of Flexible Manufacturing Systems.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

Automated Material Movement and Storage System. Introduction, Types of AGVs, ASRS systems available, Analysis of AGV systems, ASRS, , Advance ASRS, Analysis of ASRS, Quantitative Analysis, Storage system performance, Carousel storage system, WIP storage system, Interfacing handling storage with manufacturing.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

FMS System Hardware and Software Structure: System Hardware and General Functionality, Cell controllers, Communication Networks, FMS Software Structure, Activities and Functions of FMS Software, Types of FMS Software Modules, Computer Simulation, functions of an FMS host computer

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

Scheduling & Loading of FMS:Introduction, Scheduling of operations on a single machine, 2 machine flow shop scheduling, 2 machine job shop scheduling, 3 machine flow shop scheduling, scheduling 'n' operations on 'n' machines, Scheduling rules, loading problems , material Handling system schedule. Problems.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

Cutting tool and Tool Management: Introduction, tool management, Tool Strategies, tool preset, Identification and Data Transfer, Tool Monitoring and fault detection, Experimental setup and Data collection.

Group Technology and Cellular Manufacturing: Introduction, Part families, parts classification and coding, production flow analysis, Machine cell design, Benefits of Group Technology.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. Groover, Mikell P. (2002), 2/e, " Automation, Production Systems & Computer Integrated Manufacturing", Pearson Education or PHI

2. Viswanadhan, N. & Narahari, Y. (1998), "Performance Modelling of Automated Manufacturing Systems", PHI

3. Pinedo, Michael & Chao, Xiuly (1999), "Operations Scheduling with Applications in Manufacturing & Services", McGraw Hill International Editions (with 2 Floppy Disks of LEKIN Scheduling Software)

4. Kelton, Sadowsky & Sadowsky, "Simulation with ARENA",2/e, McGraw Hill International Editions (with CD of ARENA Simulation Software)

5. Radhakrishnan, Subramanyan, "CAD / CAM / CIM", John Wiley

6. Rao, PN, Tewari NK, Kundra TK, "Computer Aided Manufacturing", TMH

7. Rong, Yeming; "Computer Aided Fixture Design", Marcel Dekker, ISBN 0-8247-9961-5

8. Hobbs, "Lean Manufacturing Implementation", J. Ross Publishing, ISBN 1-932150-14-2 6. Chowdiah, Gargesa & Kumar, "Agile Manufacturing", TMH

Web links and Video Lectures (e-Resources):

- https://youtu.be/tiarT1YS-lM
- https://youtu.be/YoslM2Sxihs

Skill Development Activities Suggested

-

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	The students will get a clear idea of importance of an FMS system in present manufacturing world	L1
CO2	The student will learn the different types of FMS layouts , material handling and retrieval systems	L2
CO3	They will be able to solve the sequencing problems for different cases and tool management.	L2

Mapping of COS and POs

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

1:Slight (low) 2:Moderate (medium) 3: Substantial (High) "-": no correlation

Total Quality Management			
Course Code	22MIA/MPM/MST/MPT/MAR334	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To give an overview of quality and TQM and explaining the salient contributions of Quality Gurus like Deming, Juran and Crosby. General barriers in implementing TQM.
- To study the TQM concepts like customer Focus, Employee Focus and their involvement, continuous process improvement and Supplier Management.
- To learn the basic and new seven management tools, Quality concepts like Six sigma, Failure mode effect analysis
- To explore industrial applications of Quality function deployment, Taguchi quality concepts and TPM.
- Detailed exposure to students on various quality systems like ISO and its standards.

Module-1

Introduction: Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements – Customer focus - Customer orientation, Customer satisfaction, Customer complaints, and Customer retention - Cost of Quality

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

TQM Principles: Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

TQM Tools & Techniques – I: The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Benchmarking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

TQM Tools & Techniques – II: Control Charts - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

QUALITY SYSTEMS Need for ISO 9000 - ISO 9001-2008: Quality System - Elements, Documentation, Quality Auditing - QS 9000 - ISO 14000 - Concepts, Requirements and Benefits - TQM Implementation in manufacturing and service sectors.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. Dale H. Besterfiled, et at., "Total quality Management", Third Edition, Pearson Education Asia, Indian Reprint, 2006.
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012. www.padeepz.net www.padeepz.net
3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
4. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006

Web links and Video Lectures (e-Resources):

- https://youtu.be/5pMWmU_8lfI?list=PLPjSqITyvDeUUUwunyiwq41yJZofQEzMI
- https://youtu.be/VxNIYCMr1Nc?list=PLueDbnzoKDZ-ZIJigjav-j8ZWz5CEoz-0

Skill Development Activities Suggested

-

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	To realize the importance of significance of quality	L1
CO2	Manage quality improvement teams	L2
CO3	Identify requirements of quality improvement programs	L2

Mapping of COs and POs

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

1:Slight (Low) 2:Moderate (Medium) 3: Substantial (High) "-": No correlation

Advanced Materials and Process			
Course Code	22MIA/MAR335	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
This course provides a comprehensive knowledge of production, structure, property, function relation and application of a number of advanced materials used in industrial applications

Module-1

Classification and Characteristics: Metals, Non ferrous Metals and Ferrous Metals, classification of Ferrous Metals and Non Ferrous Metals, Types of Ceramics, Polymers and composites and classification of composites. General Properties and Structure: Atoms, molecules bonds in solids, Crystalline - Defects in Metallic structure, Dislocations and plastic deformation - Strengthening mechanism - grain size, dislocation - Cold work, precipitation hardening, dispersion hardening - phase reactions, fatigue and Creep behaviour

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-2

Ferrous Alloys: iron carbon equilibrium diagrams - Steels and cast irons - properties, structure, composition and applications transformation hardening in steels - TIT diagrams - Heat treatment processes - Effect of alloying elements - High alloy steels, Stainless steel types, tool Steels, Manganese steels, heat resistant steels, HSLA, Managing steels. Non Ferrous Alloys: Alloys of copper, Aluminium, nickel, magnesium, titanium, lead, tin, Zinc - composition, heat treatment, structure, properties and application.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-3

Polymers and Polymerizations: Structure and properties of thermoplastics and thermo sets – Engineering Applications - property modifications - Mechanical and thermal behaviour – processing methods Ceramics : Nature and structure of Ceramics - Refractory Abrasives glasses - glass ceramics - Advanced ceramics processing methods.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-4

Composites: Definition - classification and characteristics of composite materials - Volume fraction - laminated composites particulate composites, fibrous composites - Types of reinforcements, their shape and size - production and properties of fiber reinforced plastics, Metal Matrix composites and ceramic matrix composites - Applications.

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

Module-5

Processing of Polymers: composites, ceramics - thermal spraying - Ion beam machining diamond coating techniques-tribological applications

Teaching-Learning Process	Chalk and Talk and Power Point Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three 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. Engineering Metallurgy - Raymond and Higgens - ELBS/EA
2. Introduction to Material Science and Engineering James.F.Shackleford - Mc Millan, NY - 7th edition.
3. Powder Metallurgy-Metals Hand Book -ASM, USA - Vol.7, 1974.
4. Composite Materials - Science and Engineering - Chawla K.K. , - Springer - Verlag, Newyork - 2nd edition, 1998.
5. Cast Metal Matrix Composites ASM Metals Hand Book - P.K. Rohagti - VI5.
6. Elements of Material Science and Engineering - Van Vlack L.H. - Addison Wesley, NY - 1989.
7. Material science and metallurgy - by Calliester, John Willey & Sons.

Web links and Video Lectures (e-Resources):

- https://youtu.be/MtqugJcsHZs?list=PLbRMhDVUMngdzwQyMgoUgdaGBqi_p4nVM
- https://youtu.be/KMcsjCXfLQw?list=PLyAZSyX8Qy5Am_2StOOQ5vCUE3VIcAenE

Skill Development Activities Suggested

-

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand and apply the various processing and manufacturing techniques	L1
CO2	Understand and apply the techniques and their characteristics/limitations of synthesis of polymers	L1
CO3	Understand the structure-processing-property relationship of metals and polymers.	L2
CO4	Understand the basic issues involved in polymer blends, metal matrix composites and ceramic matrix composites	L3
CO5	Understand the significance of alloying element and phase diagrams.	L2

Mapping of COS and POs

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

1:Slight (low) 2:Moderate (medium) 3: Substantial (High) "-": no correlation

PROJECT WORK PHASE – 1			
Course Code	**22MIA34**	CIE Marks	100
Number of contact Hours/Week	**0-6-0**	SEE Marks	**--**
Credits	**03**	Exam Hours	**--**

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Phase-1: The project work shall be carried out individually. However, in case a disciplinary or interdisciplinary project requires more participants, then a group consisting of not more than three shall be permitted.
Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall pursue a literature survey and complete the preliminary requirements of the selected Project work. Each student shall prepare a relevant introductory project document, and present a seminar.

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

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation, and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.
- Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

- CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question-and-Answer session in the ratio of **50:25:25**.
- There will be **no SEE**.

INTERNSHIP			
Course Code	**22MIAI36**	CIE Marks	50
Number of contact Hours/Week	**6 Weeks**	SEE Marks	50
Credits	**06**	Exam Hours	03

Course Objectives:

Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc.

The objectives are further,

- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
- To identify personal strengths and weaknesses.
- To develop the initiative and motivation to be a self-starter and work independently.

Internship: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

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

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.
- Acquire the knowledge of administration, marketing, finance and economics.

Continuous Internal Evaluation

CIE marks for the Internship report, presentation and question and answer session shall be awarded in the ratio of 50:25:25 for the **total CIE of 50 marks** by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments.

Semester End Examination

SEE marks for the internship report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded in the ratio of 50:25:25 for the **total SEE of 50 marks** (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University.

IV SEMESTER

PROJECT WORK PHASE -2

Course Code	**22MIA41**	CIE Marks	100
Number of contact Hours/Week	**8 Hours/Week**	SEE Marks	100
Credits	**18**	Exam Hours	03

Course Objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instill responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase - II: Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall continue to work of Project Work phase -1to complete the Project work. Each student / batch of students shall prepare project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question-and-Answer session in the ratio of 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

Course Outcomes:

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

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.