VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

SEMESTER-I

Scheme of Teaching and Examinations and Syllabus

M.Tech in INDUSTRIAL AUTOMATION ENGINEERING (UIA)

(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(UIA)
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	22UIA/MAR11	Applied Mathematics	03	--	--	03	50	50	100	3
2	IPCC	22UIA/MAR/MIA 12	Computer Integrated Manufacturing	03	02	--	03	50	50	100	4
3	PCC	22UIA13	Artificial Intelligence and Expert System in Automation	03	--	02	03	50	50	100	4
4	PCC	22UIA14	Additive Manufacturing Technologies	02	--	02	03	50	50	100	3
5	PCC	22UIA/MAR/MIA 15	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	22UIAL17	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)

Semester- 01

Applied Mathematics			
Course Code	22UIA11/22MAR11/22MIA11	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	22UIA12/22MAR12/22MIA12	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 and Expert System in Automation			
Course Code	22UIA13	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	04	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	22UIA14	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	22UIA15/22MAR15/22MIA15	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)

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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	22UIAL17	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

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.