KUMARAGURU COLLEGE OF TECHNOLOGY,

An autonomous Institution affiliated to Anna University, Chennai

COIMBATORE – 641 049.

Curriculum and Syllabus for

M. E. INDUSTRIAL AUTOMATION & ROBOTICS

REGULATION 2024 A

I to IV SEMESTERS

Department of Mechanical Engineering

VISION

To achieve global recognition for the programs of the department by promoting innovation, sustainability, and leadership, contributing to the society

MISSION

1. To promote innovation in Mechanical Engineering through curriculum, focusing on sustainability and ethical practices.
2. To create an active learning ecosystem for acquiring knowledge and skills in Mechanical Engineering.
3. To facilitate research in mechanical systems and sustainable technologies that have an impact on industry and society.

PROGRAM EDUCATIONAL OBJECTIVES(PEOs):

PEO1: Graduates will be on roles in implementing cutting edge automation technologies by integrating intelligent system and driving advancements in industrial processes.

PEO2: Graduates will excel as professionals by applying concepts of industrial robotics and advanced engineering principles to develop innovative and sustainable solutions.

PEO3: Graduates will engage in lifelong learning as educators and researchers in the field of industrial automation.

PROGRAM OUTCOMES (POs)

PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: Apply advanced engineering techniques, modern automation tools, and emerging technologies to solve complex industrial problems efficiently.

PO5: To collaborate effectively in interdisciplinary teams, demonstrating leadership and ethical responsibility in automation and robotics projects.

PO6: An ability to continuously engage in lifelong learning and professional development to adapt to technological advancements in industrial automation and robotics.

KUMARAGURU COLLEGE OF TECHNOLOGY

MECHANICAL ENGINEERING

M.E. Industrial Automation & Robotics - Programme - Curriculum

Semester I

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24IRT501	Artificial Intelligence in Automation	Theory	PC	3	0	0	0	3
2	24IRI502	Computer Integrated Manufacturing	Embedded Theory and Practical	PC	3	0	2	0	4
3	24IRT03	Robotics for Industrial Automation	Theory	PC	3	0	0	0	3
4	24IRI504	Product Design and Development	Theory+ Lab+ Project	PC	3	0	2	2	5
5	24IRT505	Industrial Internet of Things	Theory	PC	3	0	0	0	3
6	24IRT502	Research Methodology and Statistics	Theory	BS	3	0	0	0	3
7	24IRE0_ _	Professional Elective - 1	Theory	PE	3	0	0	0	3
								Total Credits	24
								Total Contact Hours/week	27

Semester II

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24IRI506	Product Life Cycle Management	Embedded Theory and Practical	PC	3	0	2	0	4
2	24IRT507	Robotic Operating Systems & Robot Simulation	Theory	PC	3	0	0	0	3
3	24IRT508	Modern material handling systems	Theory	PC	3	0	0	0	3
4	24IRI509	Fluid Power Automation	Theory+ Lab+ Practical	PC	3	0	2	2	5
5	24IRE0_ _	Professional Elective - II	Theory	PE	3	0	0	0	3
6	24IRE0_ _	Professional Elective - III	Theory	PE	3	0	0	0	3
7	24IRE0_ _	Professional Elective - IV	Theory	PE	3	0	0	0	3
								Total Credits	24

								Total Contact Hours/week	27
Semester III									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24IRJ601	Project – I / Industrial Internship	Project	J	0	0	0	20	10
2	24IRJ602	Industrial Training	Project	J	0	0	0	4	2
								Total Credits	12
								Total Contact Hours/week	24
Semester IV									
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**
1	24ILJ603	Project – II/ Industrial Internship	Project	J	0	0	0	40	20
								Total Credits	20
								Total Contact Hours/week	40
PROFESSIONAL ELECTIVES									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24IRE001	CNC Machines	Theory	PE	3	0	0	0	3
2	24IRE002	Automated Manufacturing Systems	Theory	PE	3	0	0	0	3
3	24IRE003	Inventory and Materials Management	Theory	PE	3	0	0	0	3
4	24IRE004	Maintenance and Reliability Engineering	Theory	PE	3	0	0	0	3
5	24IRE005	Optimization Techniques	Theory	PE	3	0	0	0	3
6	24IRE006	Flexible Manufacturing System	Theory	PE	3	0	0	0	3
7	24IRE007	Additive Manufacturing	Theory	PE	3	0	0	0	3
8	24IRE008	Assembly Automation	Theory	PE	3	0	0	0	3
9	24IRE009	Industrial Safety and Hygiene	Theory	PE	3	0	0	0	3

10	24IRE010	Design of fluid power systems	Theory	PE	3	0	0	0	3
11	24IRE011	Autonomous Wheeled Robots	Theory	PE	3	0	0	0	3
12	24IRE012	Machine Learning for Robotics	Theory	PE	3	0	0	0	3
13	24IRE013	Underwater Robotics	Theory	PE	3	0	0	0	3
14	24IRE014	PLC and SCADA	Theory	PE	3	0	0	0	3
15	24IRE015	Sensors and Vision Systems	Theory	PE	3	0	0	0	3
16	24IRE016	Virtual and Augmented Reality in manufacturing	Theory	PE	3	0	0	0	3
17	24IRE017	Autonomous Navigation and Path Planning	Theory	PE	3	0	0	0	3
18	24IRE018	Business Process Automation	Theory	PE	3	0	0	0	3
19	24IRE019	Cyber Physical Systems	Theory	PE	3	0	0	0	3
20	24IRE020	Data analytics for decision making	Theory	PE	1	0	4	0	3
21	24IRE021	Industrial drives and control	Theory	PE	3	0	0	0	3
22	24IRE022	Machine Vision & Image Processing	Theory	PE	3	0	0	0	3
23	24IRE023	Virtual Instrumentation	Theory	PE	3	0	0	0	3
24	24IRE024	Dynamics and Control of Manipulators	Theory	PE	3	0	0	0	3
25	24IRE025	Electric Vehicle Technology	Theory	PE	3	0	0	0	3

SEMESTER WISE CREDITS	
Semester I	24
Semester II	24
Semester III	12
Semester IV	20
TOTAL CREDITS	**80**

COURSE TYPE	CREDITS
Basic Science	03
Professional Core	33
Professional Electives	12
TOTAL CREDITS	**80**

SEMESTER I

24IRT501	ARTIFICIAL INTELLIGENCE IN AUTOMATION	L	T	P	J	C
		3	0	0	0	3
ES		SDG	4,8,9,11,12,13			

Pre-requisite courses	Nil	Data Book / Codes / Standards (If any)	Nil

Course Objectives:	
The purpose of taking this course is to:	
1	To impart fundamental knowledge of Artificial Intelligence (AI) and intelligent agents, enabling students to understand AI-driven decision-making in industrial automation.
2	To equip students with practical knowledge of machine learning and neural networks, allowing them to analyze and optimize automation processes.
3	To develop AI-based solutions using deep learning and reinforcement learning techniques, fostering innovation in predictive maintenance, health monitoring, and smart manufacturing.

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Apply the concepts of intelligent agents to analyze different agent architectures and their applications in automation.	Ap
CO 2	Analyze various machine learning techniques to categorize and optimize automation processes.	An
CO 3	Evaluate neural network architectures to assess their suitability for automation tasks.	E
CO 4	Develop AI-based solutions by integrating reinforcement learning and deep learning techniques for industrial automation.	C
CO 5	Design AI-driven predictive maintenance systems for enhanced efficiency in manufacturing and health monitoring.	C

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced Industrial Problem Solving	Professional and Ethical Responsibility	Continuous Professional Development
1.		2		2		2
2.	3		2	2		
3.		3		3	3	
4.		2	3	2		3

5.	3		3			2
6.						

Course Content	
INTRODUCTION TO ARTIFICIAL INTELLIGENCE Introduction - Foundations of AI- History of AI Intelligent agents: Agents and Environment- Reactive agent- deliberative- goal-driven, utility driven, and learning agents.	**9 Hours**
MACHINE LEARNING Supervised learning– Classification methods-Nearest neighbor- Decision trees- Linear discriminant Analysis - Logistic regression- Support Vector Machines Unsupervised learning: Clustering- Clustering Methods-Partitioned based Clustering - K-means- K-medoids; Hierarchical Clustering - Agglomerative- Divisive- Distance measures.	**9 Hours**
NEURAL NETWORKS AND LEARNING ALGORITHMS Structure and function of a single neuron; Artificial Neural Networks (ANN); Single-layer networks; Perceptron-Linear separability, Training algorithm, Limitations; Multi-layer networks-Architecture, Back Propagation Algorithm (BTA) training algorithms; Recurrent Networks; Feed-forward networks; Radial-Basis-Function (RBF) networks.	**9 Hours**
TYPICAL APPLICATIONS OF ANNs Classification, Function Approximation, Forecasting, Control, Optimization.-Reinforcement learning, Basics of Deep Learning-CNN-LSTM.	**9 Hours**
APPLICATIONS OF ARTIFICIAL INTELLIGENCE ML and DL models in Manufacturing-Health Monitoring-Predictive Maintenance.	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**0**	**Project Hours:**	**0**	**Total Hours:**	**45**

Learning Resources*
Textbooks
1. Rich and Knight, “Artificial Intelligence”, 3rd Edition, Tata McGraw Hill, 2014. 2. Ethem Alpaydin, “Machine Learning the New AI”, MIT press, 2016. 3. Ian Good Fellow, Yoshua Bengio, Aaron Courville, DEEP LEARNING - The MIT Press (18 November 2016).
References:
1. Stuart Russell and Peter Norvig, “Artificial Intelligence - A Modern Approach”, 4th Edition, Pearson, 2020. 2. Richard E. Neapolitan, and Xia Jiang, “Artificial Intelligence -With an Introduction to Machine Learning”, 2nd Edition, CRC press, 2018. 3. Anuradha Srinivasaraghavan, Vincy Joseph “Machine Learning”, Wiley, 2019 4. Wolfgang Ertel,” Introduction to Artificial Intelligence”, Second Edition, Springer, 2017. 5. Rajiv Chopra, “Deep Learning”, 1st edition, Khanna Publishing House, 2018. 6. Deepak Khemani, “A First Course in Artificial Intelligence”, McGraw Hill Education, 2013.
Online Educational Resources

Assessment (Theory course)
CAT, Activity and Learning Task(s)*, Mini project, End Semester Examination (ESE)

24IRT502	Computer Integrated Manufacturing	L	T	P	J	C
		3	0	2	0	4
PC		SDG	4,8,9,12			

Pre-requisite courses	Fundamental knowledge of Manufacturing Processes Basics of CAD/CAM Introduction to Automation and Control Systems	Data Book / Codes / Standards (If any)	Nil

Course Objectives:	
The purpose of taking this course is to:	
1	Understand the fundamentals, structure, and applications of CIM systems.
2	Apply computer-based tools in design, manufacturing, and production planning.
3	Integrate various manufacturing activities using computer networks and control systems.
4	Explore the role of Flexible Manufacturing Systems (FMS), Robotics, and Automation in modern industries.
5	Analyze contemporary trends such as Industry 4.0, IoT, and Digital Manufacturing.

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	Explain the components, structure, and functionalities of Computer Integrated Manufacturing systems.	Ap
CO2	Apply CAD/CAM tools and techniques for design and manufacturing integration.	Ap
CO3	Design Group Technology layouts and implement CAPP systems for optimized process planning.	E
CO4	Analyze and configure Flexible Manufacturing Systems and Robotic systems for industrial applications.	An
CO5	Integrate production control, data communication, and emerging technologies for smart manufacturing environments.	Ap
C06	Demonstrate various CIM software and hardware tools to develop and simulate end-to-end automated manufacturing scenarios.	An

	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
Course Outcomes (CO)	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced Industrial Problem Solving	Professional and Ethical Responsibility	Continuous Professional Development
1.		2	3			
2.		2		2		3

3.	3		2	3	2	
4.			2			3
5.	2			3	2	
6.		2		2		

Course Content	
Introduction to CIM Evolution, concept, and scope of CIM, Components and structure of CIM. Benefits and barriers to CIM implementation, CIM wheel, CIMOSA model, and Open System Architecture, Overview of hardware and software in CIM	**9 Hours**
Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) Role of CAD in CIM. Geometric modeling techniques: Wireframe, Surface, and Solid modeling. Data exchange standards (IGES, STEP). CNC machine control systems: NC, CNC, DNC concepts. Part programming: Manual and Computer-Aided (APT, G & M Codes) Tool path generation and post-processing.	**9 Hours**
Group Technology (GT) and Process Planning Concept and advantages of GT. Part classification and coding systems (Opitz, MICLASS) Production flow analysis and machine cell design. Computer-Aided Process Planning (CAPP): Retrieval and Generative systems. Integration of CAPP with CAD/CAM and MRP	**9 Hours**
Flexible Manufacturing Systems (FMS) and Robotics Components, configuration, and layout of FMS. Material handling and storage systems. FMS control strategies and scheduling. Industrial robots: Types, configurations, and applications. Robot programming, sensors, and vision systems.	**9 Hours**
CIM Networking, Production Control, and Emerging Trends Computer networking in CIM environments. Data communication protocols and standards (MAP/TOP). Production Planning and Control (MRP, MRP II, ERP). Shop floor control and inventory management. Emerging concepts: Industry 4.0, IoT, Additive Manufacturing, Digital Twin, Smart Factories. Case studies of CIM applications.	**9 Hours**
Practical components 1. 3D Modeling Techniques using CAD Tools 2. CNC Programming and Simulation 3. CAM Tool Path Generation and Post-Processing 4. Group Technology and Cell Layout Design 5. Process Planning using CAPP Systems 6. Flexible Manufacturing System (FMS) Simulation 7. Robot Programming and Sensor Interfacing **8.** Smart Manufacturing with IoT and ERP Integration	**15 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**15**	**Project Hours:**	**0**	**Total Hours:**	**60**

Learning Resources*

Textbooks

1. **Mikell P. Groover**, *Automation, Production Systems, and Computer-Integrated Manufacturing*, 4th Edition, Pearson Education, 2015.
2. **Radhakrishnan, P., Subramanyan, S., & Raju, V.**, *CAD/CAM/CIM*, 3rd Edition, New Age International Publishers, 2008.
3. **Yusuf Altintas**, *Manufacturing Automation: Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design*, Cambridge University Press, 2012.
4. **Kundra, T.K., Rao, P.N., & Tewari, N.K.**, *Numerical Control and Computer Aided Manufacturing*, Tata McGraw Hill, 1991.

5. **David D. Bedworth, Mark R. Henderson, & Philip M. Wolfe**, *Computer-Integrated Design and Manufacturing*, McGraw Hill, 1991.
6. **Tony W. Ranky**, *Computer Integrated Manufacturing*, Prentice Hall, 1986.

References:

1. **James A. Rehg & Henry W. Kraebber**, *Computer-Integrated Manufacturing*, 2nd Edition, Pearson Education, 2004.

Online Educational Resources

NPTEL Courses:
1. *Computer Integrated Manufacturing Systems* by IIT Kanpur
2. *Flexible Manufacturing Systems* by IIT Delhi

Assessment (Embedded course)

CAT, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)
Lab Workbook, Experimental Cycle tests, viva-voce, etc…

24IRT503	Robotics for Industrial Automation	L	T	P	J	C
		3	0	0	0	3
PC		SDG	4,8,12,13			

Pre-requisite courses	Nil	Data Book / Codes / Standards (If any)	

Course Objectives:	
The purpose of taking this course is to:	
1	Introduce fundamental concepts of robotics in industrial automation
2	Provide knowledge about robotic configurations, kinematics, and control.
3	Explore robotic applications in manufacturing, assembly, material handling, and inspection
4	Familiarize students with robot programming, vision systems, and safety
5	Analyse trends in smart automation and Industry 4.0 applications.

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Apply the principles of automation to analyze various automation strategies and hardware components used in manufacturing.	AP
CO 2	Analyze automated flow lines and part transfer mechanisms to assess their efficiency and effectiveness.	AN
CO 3	Evaluate assembly line balancing methods to recommend optimal techniques for improving line efficiency.	E
CO 4	Create kinematic models of robotic manipulators using D-H notation to perform forward and inverse kinematics analysis.	C
CO 5	Design robot programs for industrial applications by integrating appropriate actuators, sensors, and programming techniques.	C

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced Industrial Problem Solving	Professional and Ethical Responsibility	Continuous Professional Development
1.		3	2	3	3	2
2.	2	3		3	2	3
3.		2	3	2	3	
4.	2	3		3	3	3
5.	2		2	3	2	
6.		3		3		

Course Content	
INTRODUCTION TO AUTOMATION: Need, Types, Basic elements of an automated system, Manufacturing Industries, Types of production, Functions in manufacturing, Organization and information processing in manufacturing, Automation strategies and levels of automation. Hardware components for automation and process control, mechanical feeders, hoppers, orienters, high speed automatic insertion devices.	**9 Hours**
AUTOMATED FLOW LINES: Part transfer methods and mechanisms, types of Flow lines, flow line with/without buffer storage, Quantitative analysis of flow lines. ASSEMBLY LINE BALANCING: Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.	**9 Hours**
INTRODUCTION TO INDUSTRIAL ROBOTICS: Classification of Robot Configurations, ROBOTICS: functional line diagram, degrees of freedom. Components common types of arms, joints grippers, factors to be considered in the design of grippers. ROBOT ACTUATORS AND FEEDBACK COMPONENTS: Actuators, Pneumatic, Hydraulic actuators, Electric & Stepper motors, comparison. Position sensors potentiometers, resolvers, encoders - velocity sensors, Tactile sensors, Proximity sensors..	**9 Hours**
KINEMATICS: Homogenous transformation MANIPULATOR KINEMATICS: Homogenous transformations as applicable to rotation and transition - D-H notation, Forward inverse kinematics. MANIPULATOR DYNAMICS: Differential transformations, Jacobians, Lagrange Euler and Newton - Euler formations. Trajectory Planning: Trajectory Planning and avoidance of obstacles path planning, skew motion, joint integrated motion - straight line motion.	**9 Hours**
ROBOT PROGRAMMING: Methods of programming requirements and features of programming languages, software packages. Problems with programming languages. ROBOT APPLICATION IN MANUFACTURING: Material Transfer Material handling, loading and unloading Process spot and continuous arc welding & spray painting - Assembly and Inspection.	**9 Hours**

Theory Hours: 45	**Tutorial Hours:** 0	**Practical Hours:** 0	**Project Hours:** 0	**Total Hours:** 45

Learning Resources*

Textbooks

3. Automation, Production systems and CIM, M.P. Groover/Pearson Edu.
4. Industrial Robotics - Mikell P. Groover and Mitchell Weiss, Roger N. Nagel, Nicholas, G.Odrey - McGraw Hill, 1986

References:

1.Robotics and control - RK Mittal and I J nagrath, Tata McGraw Hill 2004.
2.An Introduction to Robot Technology, P. Coiffet and M. Chaironze, Kogam Page Ltd. 1983 London.
3. Robotic Engineering integrated approach by Richard d Klafter-London: Prentice-Hall-1989.
4. Robotics, Fundamental Concepts and analysis-Ashitave Ghosal, Oxford Press
5. Introduction to Robotics - John J. Craig, Pearson Edu.

Online Educational Resources

1..http://nptel.iitm.ac.in/video.php?courseId=1052
2..http://www.nptel.iitm.ac.in/and iitb.ac.in,

Assessment (Theory course)

CAT, Activity and Learning Task(s)*, Mini project, End Semester Examination (ESE)

24IRI504	PRODUCT DESIGN AND DEVELOPMENT	L	T	P	J	C
		3	0	2	0	5
PC		SDG	4,8,9,12,17			

Pre-requisite courses	Nil	Data Book / Codes / Standards (If any)	Nil

Course Objectives:	
The purpose of taking this course is to:	
1	To impart knowledge on the fundamentals of product development, including its significance, challenges, and organizational processes.
2	To enable students to analyze customer needs, generate design concepts, and evaluate product specifications for effective development..
3	To equip learners with skills to apply various design models, system-level planning, and embodiment design techniques for product architecture.
4	To develop competencies in manufacturing planning, design management, and quality assurance to ensure robust and cost-effective production.
5	To foster creativity in integrating intellectual property protection and economic strategies for successful project execution in industrial applications.

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	Apply the principles of product development to identify opportunities and plan pre-project activities.	Ap
CO2	Analyze customer needs and evaluate concept development methods for effective product design.	An
CO3	Evaluate different design models and system-level design issues to optimize product architecture and embodiment design.	E
CO4	Create a manufacturing and design management plan to ensure robust and quality-driven product development.	C
CO5	Develop strategies for intellectual property protection and economic assessment to support project execution.	C
CO6	Design and analyze 3D models and assemblies by selecting appropriate materials, optimizing shapes, and simulating motion to develop efficient and manufacturable products. (LABORATORY)	C
CO7	Develop an innovative product by integrating design principles, material selection, and manufacturing considerations to address real-world industrial challenges (PROJECT)	C

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced Industrial Problem Solving	Professional and Ethical Responsibility	Continuous Professional Development

1.	2	3			3	2
2.			2	3	2	
3.	2	3		2		2
4.			3		3	
5.	2			2	2	2
6.		2	3	2		3

Course Content	
INTRODUCTION Product Development: Characteristics, Importance, Societies, Customers, Business, Challenges, Organizations - Development Process: Processes, Process Flow - Product Planning: Identifying Opportunities, Prioritization, Resource Allocation and Pre-Project Planning	**9 Hours**
CONCEPT DEVELOPMENT Customer Needs – Data Gathering - Organizing Needs - Product and Target Specification - Concept Generation Process - Concept Selection Process - Screening – Scoring - Concept Testing: Purpose and Process, Survey, Response and Interpretation	**9 Hours**
DESIGN PROCESS: Product Architecture – Modular- Integrated Design Models: Shighley, Paul and Beitz, Ohsuga and Earle Models - Platform Planning - System Level Design Issues - Embodiment Design: Size and Strength, Scheme Drawing - Form Design - Provisional Material and Process Determination - Design or Assembly and Manufacture - Industrial Design Process	**9 Hours**
PLANNING FOR MANUFACTURE AND MANAGEMENT Detail Design: Factor of Safety, Selection Procedure for Bought out Components, Material Selection - Robust Design, Experimental Plan, Design Management: Management of Design for Quality, Project Planning and Control, Production Design Specification (PDS) - Quality Function Deployment (QFD) - Design Review, Value Analysis - Prototype: Uses and Types, Testing and Refinement - Production Ramp-up	**9 Hours**
INTELLECTUAL PROPERTY RIGHTS AND PROJECT ECONOMICS Intellectual Property Rights: Introduction, Types, Write the Description of the Invention, Refine Claims, Pursue Application - Economics and Management – Financial Model, Project Trade – Off, Accelerating Projects - Project Execution	**9 Hours**
PRATICAL LABORATORY COMPONENT: 1. Basic 3D Modeling & Assembly 2. Material Selection & Strength Analysis 3. Product Design for 3D Printing 4. Shape Optimization 5. Design & Motion Simulation	**15 Hours**
PROJECT COMPONENT: Innovative Product Design and Development for Industrial Applications	**15 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**15**	**Project Hours:**	**15**	**Total Hours:**	**75**

Learning Resources*
Textbooks
1. T Karl, Ulrich and D Steven, Eppinger, "Product Design and Development", McGraw Hill, 2012. 2. Dieter G E, "Engineering Design", McGraw – Hill, 2009.
References:
1. Ken Hurst, "Engineering Design Principles", Elsevier Science and Technology Books, 2006. 2. E Deborah, Bouchoux, "Intellectual Property Rights", Cengage Learning, 2008.

3. Kevin Otto, Kristin Wood, "Product Design: Techniques in Reverse Engineering and New Product Development", Pearson Education Limited, 2017 4. Peter Scalon, "Process Planning, Design / Manufacture Interface", Elsevier Science Technology Books, 2002
Online Educational Resources
5. https://nptel.ac.in/courses/112107217 6. https://www.coursera.org/learn/engineering-and-product-design-processes

Assessment (Embedded course)
CAT, Activity and Learning Task(s), project, MCQ, End Semester Examination (ESE) Lab Workbook, Experimental Cycle tests, viva-voce, etc…

24IRI505	INDUSTRIAL INTERNET OF THINGS	L	T	P	J	C
		3	0	0	0	3
PC		SDG				

Pre-requisite courses	Nil	Data Book / Codes / Standards (If any)	

Course Objectives:	
The purpose of taking this course is to:	
1	To understand the fundamentals of Internet of Things
2	To learn about the basics of IOT protocols
3	To build a small low cost embedded system using IoT
4	To apply the concept of I0T in the real world scenario

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Apply the fundamental concepts and architecture of IoT to design basic industrial IoT solutions.	Ap
CO 2	Understand various IoT Layers and their relative importance.	U
CO 3	Realize the importance of Data Analytics in IoT.	Ap
CO 4	Study various IoT platforms and Security	Ap
CO 5	Design innovative industrial IoT applications by integrating various techniques for real-world case studies.	C

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced Industrial Problem Solving	Professional and Ethical Responsibility	Continuous Professional Development
1.			2			3
2.	2		2	3	2	
3.		2				
4.			3	2	3	2
5.		2				
6.	1		3	2		

Course Content	
INTRODUCTION AND ARCHITECTURE OF IoT Introduction – Definition and characteristics of IoT – Physical and Logical Design of IoT - Communication models and APIs – Challenges in IoT - Evolution of IoT- Components of IoT - A Simplified IoT Architecture – Core IoT Functional Stack	**9 Hours**
INDUSTRIAL IoT IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking.	**9 Hours**
IIOT ANALYTICS Big Data Analytics and Software Defined Networks, Machine Learning and Data Science, Julia Programming, Data Management with Hadoop	**9 Hours**
IOT SECURITY Industrial IoT: Security and Fog Computing - Cloud Computing in IIoT, Fog Computing in IIoT, Security in IIoT	**9 Hours**
CASE STUDY Industrial IOT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies: Milk Processing and Packaging Industries, Manufacturing Industries	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**0**	**Project Hours:**	**0**	**Total Hours:**	**45**

Learning Resources*
Textbooks
References:
1. Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress), 2017 2. Industrial Internet of Things: Cybermanufacturing Systems"by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), 2017 3. Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018.
Online Educational Resources
1. https://onlinecourses.nptel.ac.in/noc20_cs69/preview

Assessment (Theory course)
CAT, Activity and Learning Task(s)*, Mini project, End Semester Examination (ESE)

24INT501	Research Methodology & IPR (Common to CN, EN, MB, ST)	L	T	P	J	C
		3	0	0	0	3
ES		SDG	9,12,13			

Pre-requisite courses	Nil	Data Book / Codes / Standards (If any)	Nil

Course Objectives:	
The purpose of taking this course is to:	
1	equip students with the knowledge and skills necessary to design, conduct and critically evaluate research
2	draft research reports and present effective research findings
3	foster an understanding of intellectual property rights and ethical considerations essential for successful research and innovation

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	apply the scientific method and research planning steps to formulate research problems and objectives	Ap
CO2	analyze different research designs and ethical considerations to classify research types and ensure ethical integrity	An
CO3	evaluate the structure and components of research reports to organize and present research findings effectively	E
CO4	interpret data collection tools and statistical methods to visualize and analyze biological research data	An
CO5	create a research proposal incorporating IPR principles to develop innovative and ethically sound research plans	C

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1.	3	3		3	3	
2.	3	3		3		
3.	3			3		3
4.	3	3		3		3
5.	3	3		3		
6.	2	2		3	3	

Course Content	
INTRODUCTION TO RESEARCH METHODS Definition and Objectives of Research, Scientific Method, Various Steps in Scientific Research, Research Planning, Selection of a Problem for Research, Formulation of Selected Problems, Purpose of the Research, Formulation of Research Objectives, Formulation of Research Questions, Hypotheses Generation and Evaluation, Literature Search and Review Process	**9 Hours**
RESEARCH DESIGN AND ETHICS Types and Methods of Research, Classification of Research, Research Ethics: Informed Consent, Confidentiality, Data Protection, Sampling Techniques, Methods of Collecting Primary Data, Use of Secondary Data, Experimentation, Design of Experiments, Survey Research, Construction of Questionnaires, Pilot Studies, and Pre-tests, Data Collection Methods, Processing, Editing, Classification, and Coding Validity, Reliability, Ethical Dilemmas and Solutions	**9 Hours**
RESEARCH REPORTS Components of Research Articles, Manuscripts, Thesis, and Review Papers, Preparation of Thesis Documents: Referencing, In-text Citations, Tools like Endnote, Mendeley, Writing Techniques: CARS Model, Organizing Literature Review, Materials, and Methods Critical Thinking for Writing the Discussion Section. Case Study: Comparison of Research Articles with and without Referencing Tools	**12 Hours**
DATA COLLECTION AND ANALYSIS FOR RESEARCH Tools for Data Collection: Clinical Trials, Surveys, Questionnaires, Observational Methods, Data Management and Preparation, Overview of Statistical Concepts, Descriptive Statistics: Mean, Median, Mode, Variance, Standard Deviation, Data Visualization Techniques Case Study: Journal Club on Research Papers Published in Tier 1 Journals	**6 Hours**
INTELLECTUAL PROPERTY RIGHTS (IPR) AND RESEARCH GRANTS Introduction to Intellectual Property Rights: Patents, Trademarks, Copyrights, Trade Secrets, Importance of IPR in Research and Innovation, developing a Research Proposal: Components, Do's and Don'ts, Writing Winning Research Proposals, Peer Review, and Feedback, Finalizing Research Plans. Case Study: Evaluating Successful Research Proposals and Understanding the Role of IPR	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**0**	**Project Hours:**	**0**	**Total Hours:**	**60**

Learning Resources*

Textbooks

1. Cooper, D. R., Schindler, P. S., & Sharma, J. K. (2012). Business research methods (11th ed.). Tata McGraw Hill Education.

2. Hazari, A. (2023). Research Methodology for Allied Health Professionals. Springer Nature Singapore.

3. Goh, K. M. (2023). Research Methodology in Bioscience and Biotechnology. Springer.

4. Ganguli, P. (2017). Intellectual property rights: Unleashing the knowledge economy. McGraw Hill Education

References:

1. AJIET. (n.d.). Lecture Notes on Research Methodology & Intellectual Property Rights.
2. Retrieved from https://www.ajiet.edu.in/img/basic-science/21RMI56%20notes.pdf
3. 2. Oxford University Press. (n.d.). Handbook of Intellectual Property Research: Lenses, Methods,
4. and Perspectives. Retrieved from https://academic.oup.com/book/41122
5. 3. Goddard, W., & Melville, S. (2004). Research Methodology: An Introduction for Science &
6. Engineering Students. Juta and Company Ltd.
7. 4. Kumar, R. (2014). Res

Online Educational Resources

1. https://hrdc.ugc.ac.in/Web/Home/ViewCourseDetails/842/
2. https://onlinecourses.swayam2.ac.in/ntr24_ed08/preview

Assessment

SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)