Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore
Shri Vaishnav Institute of Technology and Science
Choice Based Credit System (CBCS) in the Light of NEP-2020
M.Tech. in Robotics and Automation w.e.f. 2024

COURSE CODE	CATE-GORY	COURSE NAME	TEACHING &EVALUATION SCHEME								
			THEORY			PRACTICAL					
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*	L	T	P	CREDITS
MTRA201		**Embedded System**	60	20	20	30	20	2	1	2	4

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit.
***Teacher Assessment** shall be based on the following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):

1. To provide a comprehensive understanding of microcontrollers and embedded systems.
2. To enable students to program, analyze and design embedded systems by exploring hardware, software, and interfacing concepts.
3. To expose students to advanced topics such as memory systems, power optimization, interrupts, timers, and communication protocols (UART, SPI, I2C).

Course Outcomes (COs):

After the successful completion of this course, the student will be able to:

1. Demonstrate understanding of microcontroller architecture, features, and development tools.
2. Apply fundamental programming concepts for embedded systems.
3. Utilize timers, interrupts, and watchdog systems for real-time embedded applications.
4. Implement analog peripherals and serial communication protocols (UART, SPI, I2C).

Syllabus

UNIT I **7 Hrs.**

Introduction to Microcontrollers & Embedded System

Microcontrollers: Definition, Classification, Features & Applications, General Architecture of Microcontrollers (Harvard vs. Von Neumann, RISC vs. CISC), Overview of ARM Cortex-M series and other common microcontrollers (8051, PIC, AVR; Arduino), Development Environments, Libraries, and Fundamental Programming Concepts,

Embedded Systems: Definition, Characteristics, Block Diagram, Design Process.

Case Study: Weather Monitoring System.

UNIT II **6 Hrs.**

MSP432 Operating Parameters and Interfacing

Operating Parameters of Microcontrollers (Voltage, Clock, Power, Memory), Input Devices and Output Devices, Interfacing to DC Devices, AC Devices, and High-Power Loads, Educational Kits and Development Boards (Arduino, STM32, ESP32, etc.).

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MTRA201		Embedded System	60	20	20	30	20	2	1	2	4

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit.
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UNIT III **7 Hrs.**

MSP432 Memory System and Power System

Memory System: Basic Concepts (RAM, ROM, Flash, EEPROM), Memory Operations in C Using Pointers, Memory Maps and Addressing, External Memory Interfaces (SD/MMC, External Flash, etc.).

Power Systems: Operating Modes and Speed of Operation, Power Supply and Control Modules, Low-Power Modes and Battery Operation.

UNIT IV **6 Hrs.**

Time-Related Systems, Resets and Interrupts

Time-Related Parameters: Frequency, Period, Duty Cycle, Clock Systems in Microcontrollers, Timers and Counters (Watchdog Timer, General-Purpose Timers, Real-Time Clock), Reset Mechanisms in Microcontrollers.

Interrupt Systems: Concept, Types, and Priority. Programming and Handling Interrupts in C

UNIT V **7 Hrs.**

Analog Peripherals & Communication Systems

ADC and DAC Systems in Microcontrollers, Voltage Reference and Comparators, Serial Communication Concepts, UART, SPI, and I²C Protocols, Introduction to CAN, USB, and Wireless Modules.

Note: MSP432 may be specifically studied as microcontroller.

Text Books:

1. Dung Dang, Daniel J. Pack, Steven F. Barrett, "Embedded Systems Design with the Texas Instruments MSP432 32-bit Processor" Morgan & Claypool Publisher, 2017.
2. Ying Bai, "Microcontroller Engineering with MSP432: Fundamentals and Applications" Taylor & Francis, CRC Press, 2017.

Reference Books:

1. Chris Nagy, "Embedded Systems Design with the TI MSP432 Series" Newnes, 2003.

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MTRA201		**Embedded System**	60	20	20	30	20	2	1	2	4

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit.
***Teacher Assessment** shall be based on the following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

2. John H. Davies, "MSP430 Microcontroller Basics" Newnes, 2008.
3. Manuel Jiménez, Rogelio Palomera, Isidoro Couvertier, "Introduction to Embedded Systems: Using Microcontrollers and the MSP430" Springer, 2014.
4. Raj Kamal, "Embedded Systems: Architecture, Programming and Design" TMH, 2008.

List of Experiments:

1. Introduction to MSP–EXP432P401R Launch Pad, Code Composer Studio and Energia.
2. Interfacing LED using MSP432.
3. Interfacing 7-segment display to MSP432.
4. Interfacing dot-matrix display to MSP432.
5. Setting up communication interface using IR sensors.
6. Interfacing MSP432 with various sensors
7. Driving stepper motor using MSP432.
8. Interfacing memory to MSP432
9. Setting up wireless communication Network.
10. Setting up IoT link for various sensors using MSP432.

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COURSE CODE	CATE-GORY	COURSE NAME	TEACHING &EVALUATION SCHEME								
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			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MTRA202		Advance Sensors	60	20	20	30	20	3	0	2	4

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit.
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):
During the course, the students will be able to:
1. Learn knowledge about the principles and analysis of sensors.
2. Understand the characteristics and response of microsensors.
3. Learn adequate knowledge of different transducers and Actuators.
4. Learn about the Microsensors and Micro actuators.
5. Develop understanding of sensor materials for fabrication for different applications

Course Outcomes (COs):
At the end of the course, the student will be able to:
1. Analyze the basics of sensors in terms of working principles and specifications.
2. Identify the materials and design of inductive and Capacitive Sensors.
3. Analyze basics of actuators in terms of working principles and specifications.
4. Design Micro sensors and Micro Actuators for various applications.
5. Implement fabrication processes and technologies and compare various Micromachining processes.

Syllabus:

UNIT I **8 Hrs.**
Introduction to Sensor-based Measurement Systems: Design of a general measuring system. Analysis of measurement systems- selection and characteristics, range, resolution, Sensitivity, error, repeatability, linearity and accuracy, Primary sensing elements.

UNIT II **7 Hrs.**
Micromachine Technologies: Thin Film and Thick Film Technologies, MEMS Technologies. Overview of silicon processes techniques, Photolithography, Ion Implantation, and Diffusion, Chemical Vapor Deposition, Physical vapor Deposition, Epitaxy, Etching, Bulk micromachining, Surface Micromachining.

UNIT III **6 Hrs.**
Sensors & Actuators: Definition, types, and selection of sensors, transducer, and actuators, Classification of sensors and actuators, Significance of Signal Conditioning circuits. Physical principles of sensors & actuators, basic parameters, and techniques of signal processing.

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			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MTRA202		**Advance Sensors**	60	20	20	30	20	3	0	2	4

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit.

***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

UNIT IV **8 Hrs.**

Sensor Classification to measure temperature, pressure, and force. Classification of temperature sensors, Definition, working principle, types- (RTD, thermocouple, thermistors).

Sensor Classification to measure pressure- Definition, working principle, types, materials-manometers.

Sensor Classification to measure force- Definition, working principle, types, Basic methods of force measurement- strain gauge.

UNIT V **6 Hrs.**

Advanced sensors: Working Principle, types, materials: Smart sensors, MEMS, Nano sensors IC sensors, optical fiber sensors. Applications in different domains, Intelligent sensors, sensor networks and systems.

Text Books:

1. Patranabis. D, *Sensors and Transducers*, Wheeler publisher, 1994.
2. Sabrie Soloman, Sensors *Handbook*, McGraw Hill Publication, First ed., 1998.
3. A. K. Sawhney, *Electrical & Electronic Instruments & Measurement*, Dhanpat Rai and Sons, Eleventh ed., 2000.
4. Jacob Fraden, *Hand Book of Modern Sensors: Physics, Designs and Application,* Fourth ed., Springer, 2010.
5. J. R. Westcott, A. K. Gupta, and S. K. Arora, *Industrial Automation and Robotics*, 2nd ed. Mercury Learning & Information, 2023.

Reference Books:

1. Robert H. Bishop, *The Mechatronics Hand Book*, CRC Press, 2002.
2. Thomas. G. Bekwith and Lewis Buck. N, *Mechanical Measurements*, Oxford and IBH publishing Co. Pvt. Ltd.,
3. K. Goyal and D. Bhandari, *Automation and Robotics*, New Delhi, India: Vayu Education of India, 2016.
4. R. S. Dahiya, O. Ozioko, and G. Cheng, Eds., *Sensory Systems for Robotic Applications*, London, U.K.: IET, 2022.

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MTRA202		**Advance Sensors**	60	20	20	30	20	3	0	2	4

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit.
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

List of Experiments:

1. Design tasks to test characteristics, performance, and limitations of multiple sensor types.
2. Implementation of Different Types of Actuators, interfacing and control of DC motors, stepper motors, servo motors, pneumatic and hydraulic actuators.
3. Design and Interfacing of a Temperature Sensor with a Controller Module.
4. Implement pressure measurement and signal conditioning for real-time monitoring by Interfacing a Pressure Sensor with a Controller Module.
5. Implement digital input for robotic control and decision-making by interfacing a Touch Sensor with a Controller Module.
6. Design and Interface a Light Dependent Resistor (LDR).
7. Implement speed control using PWM and motor driver circuits by interfacing with a DC motor.
8. Interfacing the color sensor with a controller module.
9. Implement distance measurement and obstacle detection for mobile robot navigation using Ultrasonic sensor.
10. Interfacing of an IMU (Inertial Measurement Unit) Sensor with a Controller Module.

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COURSE CODE	CATEGORY	COURSE NAME	TEACHING & EVALUATION SCHEME								
			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MTRA203		Robot Operating System	60	20	20	30	20	3	0	0	3

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit.
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):

1. To build advanced knowledge in robotics, automation, and control systems.
2. To enable practical implementation using ROS, simulation, and embedded platforms.
3. To develop research-oriented skills in emerging robotic technologies.

Course Outcomes (COs):

Students will be able to:

1. Model and analyze robotic systems for motion, control, and planning.
2. Develop ROS-based robotic applications with simulation and real hardware.
3. Integrate sensors, vision, and automation tools for autonomous robotic tasks.

Syllabus:

UNIT I

7 Hrs.

ROS Fundamentals and Architecture: ROS architecture and philosophy, ROS master, nodes, and topics, console commands, catkin workspace and build system, launch files, programming tools, overview of ROS 2 vs ROS 1, Docker and Singularity for ROS environment management, introduction to robotic middleware frameworks (e.g., DDS for ROS 2).

UNIT II

8 Hrs.

ROS Programming and Visualization: ROS package structure, integration and programming with Eclipse, ROS C++ client library (roscpp), ROS subscribers and publishers, ROS parameter server, RViz visualization, ROS with Python (rospy) for scripting and rapid prototyping, performance optimization in ROS, logging and monitoring tools (rqt_plot, rqt_console).

UNIT III

7 Hrs.

Robot Models and Simulation: TF Transformation System, rqt User Interface, robot models (URDF), simulation descriptions (SDF), Gazebo simulator, Custom robot simulation in Gazebo using plugins, integration of ROS with MATLAB & Simulink.

UNIT IV

6 Hrs.

Advanced Navigation, Manipulation and Vision: Map creation with G Mapping package, Autonomously navigate a known map with ROS navigation. Motion planning, pick and place behaviors using industrial robots with ROS. Robot Vision: Object detection, pose estimation.

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MTRA203		**Robot Operating System**	60	20	20	30	20	3	0	0	3

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***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

UNIT V **7 Hrs.**

ROS Services Debugging and ROS2: ROS services, ROS actions (action lib), ROS time, ROS bags, debugging strategies, Edge computing in ROS (Jetson Nano, Raspberry Pi), Real-time ROS (RT-ROS) for industrial applications, latest research trends in ROS (Swarm Robotics, Cloud Robotics).

Text Books:

1. Lentin Joseph, "Robot Operating Systems (ROS) for Absolute Beginners, Apress, 2018.
2. Aaron Martinez, Enrique Fernández, "Learning ROS for Robotics Programming", Packt Publishing Ltd, 2013.

Reference Books:

1. Jason M O'Kane, "A Gentle Introduction to ROS", CreateSpace, 2013.
2. A. Koubaa (Ed.), "Robot Operating System (ROS): The Complete Reference", Volume 3, Studies in Computational Intelligence, vol. 778. Cham, Switzerland: Springer, 2018.
3. Kumar Bipin, "Robot Operating System Cookbook", Packt Publishing, 2018.
4. Wyatt Newman, "A Systematic Approach to learning Robot Programming with ROS", CRC Press, 2017.
5. Patrick Gabriel, "ROS by Example: A do it yourself guide to Robot Operating System", Lulu, 2012.

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COURSE CODE	CATEGORY	COURSE NAME	TEACHING &EVALUATION SCHEME								
			THEORY			PRACTICAL					
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MTRM301	**AECC**	**Research Methodology in Engineering**	60	20	20	0	0	3	1	0	4

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***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):

1. The course has been developed with orientation towards research related activities and recognizing the ensuing knowledge as property.
2. To analyze and evaluate research works and to formulate a research problem to pursue research.
3. To develop skills related to professional communication and technical report writing.

Course Outcomes:

At the end of the course, students will demonstrate their ability to:

1. Understanding and formulation of research problem.
2. Apply quantitative and qualitative methods used in engineering research.
3. Analyze interpret and evaluate data that relate to engineering problems.
4. Develop skills related to professional communication, technical report writing and publishing papers.
5. Act professionally, autonomously, ethically and in teams to produce a professional product.

Syllabus

Unit-I

Introduction to Research Methodology: - An overview of Research process, Types of research; Approaches to research, Importance of criticism in Literature review, identifying research gaps; Formulation of research problem; Research design,

Data: Primary and secondary data-sources, advantages/disadvantages; Sampling and primary data collection, sampling size, random and structured sampling

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MTRM301	**AECC**	**Research Methodology in Engineering**	60	20	20	0	0	3	1	0	4

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;

***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Unit-II

Measurement and Scaling Techniques: - Types of scales, Criteria for good measurement, Attitude measurement - Likert's scale, Semantic differential scale, Thurstone-equal appearing interval scale.

Statistical Tools for Data Analysis: - Measure of central tendency, Measures of dispersion, Correlation and Regression, Formulation of hypothesis, Type I & Type II error, Parametric test, non-parametric test.

Unit-III

Research Methods I - Use of computer software in research and understanding the limitations. Multi-attribute decision making methods, Data envelopment analysis, Grey relational analysis etc., Multidisciplinary research problems, Synthesis of disciplinary research findings; Reliability and sensitivity analysis.

Unit-IV

Research Methods II - Modeling and simulation of engineering problem; Mathematical modeling-formulation, calibration, validation, application; measurement design – validity, reliability, scaling and sources of error. Mathematical programming methods, Numerical analysis, Optimization techniques, Design of laboratory experiments and field tests.

Unit-V

Academic Writing Skills and Presentation - Layout of a Research paper, research report, Thesis structure, Impact factor of Journals, Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Reference Management Software like Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism. Guidelines on how to write research papers. Content of Poster presentation, Power point presentation, Oral presentation

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MTRM301	**AECC**	**Research Methodology in Engineering**	60	20	20	0	0	3	1	0	4

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***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Text Books -

1. C.R. Kothari, 2012. Research Methodology Methods and Techniques, 3/e, Vishwa Prakashan,
2. Montgomary, Douglas C., 2007. Design and Analysis of Experiments (Wiley India).
3. Chawla, D. and Sodhi, N., 2011. Research methodology: Concepts and cases. Vikas Publishing House.

Reference:

1. Donald H.McBurney, "Research Methods", 5th Edition, Thomson Learning, ISBN: 81-315-0047.
2. Donald R. Cooper, Pamela S. Schindler, "Business Research Methods", 8/e, Tata McGraw-Hill Co. Ltd.,
3. Timothy J. Ross, "Fuzzy Logic with Engg Applications", , Wiley Publications, 2nd Ed[d]
4. Thiel D.V. "Research Methods for Engineering", Published by Cambridge University Press, UK
5. P.J. van Laarhoven & E.H. Aarts, "Simulated Annealing: Theory and Applications" (Mathematics and Its Applications).

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MTRA214		**Micro Manufacturing**	60	20	20	0	0	3	0	0	3

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit.
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):

1. To introduce students to principles of micro- and nanomanufacturing.
2. To familiarize them with major processes like micromachining, microforming, and microjoining.
3. To highlight applications of micro manufacturing in robotics, MEMS/NEMS, and biomedical devices.

Course Outcome (COs):

At the end of this course, students will be able to:

1. Understand fundamentals and classification of micromanufacturing processes.
2. Describe and compare key microfabrication and micromachining techniques.
3. Recognize applications of micro manufacturing in advanced robotic and industrial systems.

Syllabus:

UNIT I **6 Hrs.**

Introduction to Micro Manufacturing: Introduction and scope of micromanufacturing, Classification of meso-manufacturing, micro-manufacturing, and nano-manufacturing processes, Challenges in scaling from macro to micro/nano dimensions, Role of micromanufacturing in robotics and automation.

UNIT II **7 Hrs.**

Micromachining Processes: Traditional micromachining: microturning, micromilling, microgrinding, biomachining. Advanced micromachining: focused ion beam machining, EDM, ECM, abrasive water jet micromachining. Process capabilities, limitations, and industrial case studies.

UNIT III **7 Hrs.**

Microcasting and Micromolding: Concepts, materials, and applications. Soft lithography techniques for replication. Microforming processes: Nano plastic forming, roller imprinting, microextrusion, laser microbending. Surface micro/nano structuring for robotics and biomedical devices.

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			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MTRA214		**Micro Manufacturing**	60	20	20	0	0	3	0	0	3

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit.
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

UNIT IV **6 Hrs.**

Microjoining and Device Fabrication: Introduction to microjoining. Laser microwelding and electron beam microwelding. Applications in microelectronics and MEMS. Fabrication of microelectronic devices and precision sensors for robotic applications.

UNIT V **6 Hrs.**

Nanofinishing and Surface Engineering: Introduction to nanofinishing processes. Magnetorheological finishing (MRF) and allied processes. Abrasive flow finishing and CMP (Chemical Mechanical Planarization). Theoretical analysis of wafer surface evolution. Applications in high-precision robotics and automation.

Text Books:

1. R. K. Jain, *Micro-Manufacturing Processes*, 2nd ed., CRC Press, 2018.
2. V. K. Jain, *Introduction to Micromachining*, 2nd ed., Narosa Publishing, 2017.

Reference Books:

1. M. Madou, *Fundamentals of Microfabrication and Nanotechnology*, 4th ed., CRC Press, 2018.
2. N. S. Qu, W. J. Li, and G. X. Li, *Micromachining and Microfabrication Process Technology*, Springer, 2019.
3. M. C. Murphy, *Nanomanufacturing Handbook*, 1st ed., CRC Press, 2019.
4. T. Masuzawa, *Microfabrication: Towards Industrial Application*, Oxford Univ. Press, 2002.

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COURSE CODE	CATE-GORY	COURSE NAME	TEACHING &EVALUATION SCHEME								
			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MTRA224		**Robotics and Machine Vision**	60	20	20	0	0	3	0	0	3

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***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):
1. To understand the integration of robotic systems with vision capabilities.
2. To develop understanding of image processing, feature extraction, and pattern recognition.
3. To apply machine vision techniques to real-world robotic applications.

Course Outcome (COs):
At the end of this course, students will be able to:
1. Analyze and process digital images for feature extraction and pattern recognition.
2. Implement machine vision techniques in robotic applications.
3. Utilize advanced methods like deep learning and visual odometry in robotics.

Syllabus:

UNIT I **6 Hrs.**
Introduction to Robotics and Machine Vision
Basics of robotics and machine vision: Human, Machine, and Computer Vision, robot classification and workspace considerations, camera types (Analog, Digital, CCD, CMOS), camera calibration, frame grabbers, shutters, lighting parameters and techniques, digital camera and computer interfaces, and applications of vision control in robotic automation.

UNIT II **7 Hrs.**
Digital Image Processing and Analysis
Fundamentals of image processing, image formation, representation, sampling, quantization, and color models, filtering, enhancement, and noise reduction, segmentation, thresholding, connectivity, and edge detection, morphological operations, feature extraction, texture analysis, pattern recognition, template matching, decision-making, and visual odometry.

UNIT III **6 Hrs.**
Robotic Motion and Control
Forward and Inverse kinematics, homogeneous transformations, trajectory planning, robot dynamics and force analysis, control strategies, end effectors and sensors, and integration of sensors for precision robotic operations.

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			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MTRA224		**Robotics and Machine Vision**	60	20	20	0	0	3	0	0	3

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit.
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UNIT IV **6 Hrs.**
Modern Machine Vision Techniques

Deep learning for image classification, CNNs, transfer learning, and fine-tuning, visual odometry, SLAM, and vision-language-action models.

UNIT V **7 Hrs.**
Applications and System Integration

Automated visual inspection, real-time defect detection, vision-guided robotics in automotive, electronics, pharmaceutical, and manufacturing industries, system architecture, hardware requirements, and real-time processing, and integration of vision systems with robotic controllers.

Text Books:

1. Richard Szelinski, "Introduction to Computer Vision and its Application", Springer, 2010.
2. E. Trucco and A. Verri, "Introductory techniques for 3D Computer Vision", Prentice Hall, 1998.
3. B. K. P. Horn, "Robot Vision", McGraw-Hill.

Reference Books:

1. Marco Treiber, "An Introduction to Object Recognition Selected Algorithms for a Wide Variety of Applications", Springer, 2010.
2. D. Forsyth and J. Ponce, "Computer Vision - A modern approach", Pearson Education India; 2nd edition, 2015.
3. R. C. Gonzalez, R. E. Woods, "Digital Image Processing", Addison-Wesley, 2002.

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			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MTRA234		**Industrial Internet of Things**	60	20	20	0	0	3	0	0	3

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***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):
1. To identify the different sensors available and the concept of IoT networking.
2. To understand various IIoT analytics and data management.
3. To understand the Cyber physical system and cybersecurity.
4. To identify the applications of IIoT in various fields.

Course Outcome: At the end of this course, students will be able to:
1. Gain knowledge of theory and practice related to Industrial IoT Systems.
2. Formulate and solve engineering problems by using Industrial IoT.
3. Enhance cyber resilience in automated and interconnected systems.
4. Implement real field problem of Industrial applications with IoT capability.

Syllabus:

UNIT I **6 Hrs.**
Introduction to Industrial IoT (IIoT) Systems
Various Industrial Revolutions, Role of Internet of Things (IoT) & Industrial Internet of Things (IIoT) in Industry, Industry 4.0 revolutions, Smart Robotics, Smart Factories.

UNIT II **7 Hrs.**
Implementation Systems for IIoT
Sensors and Actuators for Industrial Processes, IoT Communication Protocols (802.15.4, Zigbee, 6LoWPAN, Wireless HART), IoT Networking Protocols (MQTT, CoAP, XMPP, AMQP).

UNIT III **6 Hrs.**
IIoT Analytics and Data Management
IIoT Analytics Types, Challenges, Integration of Machine Learning with IIoT, Data Management Technologies, Process, Industrial Data Management.

UNIT IV **7 Hrs.**
Cyber Physical Systems & Cyber Security
Introduction, Features, CPS Architecture for Industry 4.0, Challenges for CPS Development, Components of Cybersecurity, Types of Cybersecurity Threats, Cybersecurity for Industry 4.0, Cyberattack detection.

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			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MTRA234		**Industrial Internet of Things**	60	20	20	0	0	3	0	0	3

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit.
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

UNIT V **7 Hrs.**
IIoT Applications
Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management.

Text Books:

1. Gilchrist, *Industry 4.0: The Industrial Internet of Things*. Berkeley, CA: Apress, 2016.
2. J. Bartodziej, *The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics*. Wiesbaden: Springer Gabler, 2017.

Reference Books:

1. R. Rajkamal, *Embedded Systems: Architecture, Programming and Design*, 3rd ed. New Delhi: McGraw Hill Education, 2018.
2. O. Vermesan and P. Friess, *Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems*. Aalborg, Denmark: River Publishers, 2013.

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			THEORY			PRACTICAL					
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MTRA205		Robotics Lab	0	0	0	30	20	0	0	2	1

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit.
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):

1. To provide practical exposure to different types of industrial robots and their applications.
2. To impart hands-on training on Mitsubishi MELFA RV-4FRLD industrial robot using Teach Box and RTTOOLBOX3.
3. To develop programming and simulation skills for performing robotic operations.
4. To enable students to interface robots with software tools and perform real-time tasks.

Course Outcomes (COs):

After the successful completion of this course, the student will be able to:

1. Identify and classify different types of robots and their industrial applications.
2. Operate and control the MELFA RV-4FRLD industrial robot using Teach Box.
3. Demonstrate programming and simulation of robotic operations in RTTOOLBOX3.
4. Perform online interfacing of MELFA RV-4FRLD with RTTOOLBOX3 for real-time tasks.

List of Experiments:

1. To study various types of Robots.
2. To study Industry Robot-MELFA RV-4FRLD
3. To understand the working environment of RTTOOLBOX3 software.
4. To learn the different operations of Industry Robot-MELFA RV-4FRLD using Teach Box.
5. To learn the programming of Industry Robot-MELFA RV-4FRLD using RTTOOLBOX3 in simulation mode.
6. To perform the interfacing of the Industry Robot-MELFA RV-4FRLD using RTTOOLBOX3 in online mode.
7. To write a program for the robot to draw a circle.
8. To write a program for the robot to draw a rectangle
9. To perform the programming of Industry Robot-MELFA RV-4FRLD using Teach Box.

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