D. Y. PATIL
COLLEGE of ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering

D. Y. Patil College of Engineering and Technology

Kasaba Bawada, Kolhapur

(An Autonomous Institute)

Accredited by NAAC with 'A' Grade

Department of Mechanical Engineering

Program Structure

Robotics and Industry 4.0 (Minor)

(To be implemented from academic year **2022-23)**

Sr. No	Course Code	Course Type	Name of the Course	Sem	Teaching Scheme Per Week			Credits	Total Marks	Evaluation scheme			
1	201MEMIL223	PCC	**Elements of Robotic Systems**	IV	3	-	-	3	100	ISE	20	20	40
										MSE	30		
										ESE	50	20	
2	201MEMIL319	PCC	**Basics of Robot Design**	V	3	-	-	3	100	ISE	20	20	40
										MSE	30		
										ESE	50	20	
3	201MEMIL322	PCC	**Robot Programming and Machine Vision Systems**	VI	3	-	-	3	100	ISE	20	20	40
										MSE	30		
										ESE	50	20	
4	201MEMIL421	PCC	**Industry 4.0**	VII	3	-	-	3	100	ISE	20	20	40
										MSE	30		
										ESE	50	20	
6	201MEMIP223	LC	**Elements of Robotic Systems Lab**	IV	-	-	2	1	50	ISE	25	10	10
										ESE (POE)	25	10	10
7	201MEMIP320	LC	**Robot Simulation Lab**	V	-	-	2	1	50	ISE	25	10	10
										ESE (POE)	25	10	10
8	201MEMIP322	LC	**Robot Programming and Machine Vision Lab**	VI	-	-	2	1	50	ISE	25	10	10
										ESE (POE)	25	10	10
9	201MEMIP421	LC	**Industry 4.0 Lab**	VII	-	-	2	1	50	ISE	25	10	10
										ESE (POE)	25	10	10
10	201MEMIP423	PROJ	**Mini Project**	VIII	-	-	2	2	100	P-I	50	40	40
										P-II	50		
				Total	**12**	**-**	**10**	**18**	**700**	**Total Credits: 18**			
										Total Contact Hrs.: 5/week			

Course Code	Definition
BSC	Basic Science Course
ESC	Engineering Science Course
HSMC	Humanity and Social Science including Management Course
PCC	Professional Core Course
PEC	Professional Elective Course
OEC	Open Elective Course
LC	Laboratory Course
MC	Mandatory Course
PROJ	Project

Abbreviations:

ISE: In Semester Evaluation,
MSE: Mid semester Examination,
ESE: End Semester Examination

Note:
ESE will be conducted for 100 marks and converted to 50 marks

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Course Plan:

Course Title: **Elements of Robotic Systems**	
Course Code: **201MEMIL223**	**Semester: IV**
Teaching Scheme: L-T-P: **3-0-0**	Credits :**3**
Evaluation Scheme: ISE + MSE Marks: **20 + 30**	ESE Marks :**50**

Course Description:

This course aims to familiarise students with basic terminologies of the robotics sciences and essential knowledge required to get started in the field of Robotics.

Course Objectives:

1. To provide Basic knowledge of Robots, their types and operations
2. To provide information about Sensors Used in Robotics
3. To make students aware of various types of actuators for robotics
4. To develop student knowledge about Various drives and motors used in robots
5. To provide overview of Controllers and basics of Programming Languages for Robotics
6. To provide overview of Grippers, Manipulators and Various types of accessories used in Robots

Course Outcomes:

At the end of the course the student should be able to

CO	Statement	BTL
CO223.1	Understand basics of Robots and its Anatomy	L2
CO223.2	Select Suitable Sensors for Robotics	L2
CO223.3	Understand Various types of Drives used in Robotics	L2
CO223.4	Discuss Different Control Systems and Controllers	L2
CO223.5	Discuss Grippers or Manipulators used in Robots	L2
CO223.6	Explain Allied fields related to Robotics	L2

Course Content

Content	Hours
Unit 1: Introduction to Robotics Brief History, Basic Concepts of Robotics such as Definition, three laws, Robot anatomy, DOF, Misunderstood devices etc., Evolution of Robots, Classification of Robotic systems on the basis of various parameters such as work volume, type of drives, applications etc. etc, Industrial applications of robot.	08
Unit 2: Sensors Used in Robotics Basics of Sensors, Classification of Sensors based on sensing entity, operating parameters, output parameters etc., Applications of Sensors, Characteristics of Sensing Devices, Selection of Sensors, Need for Sensors.	07
Unit 3: Drives and Actuators used in Robotics Drive - Types of Drives, Types of transmission systems, Actuators – Hydraulic Actuators, Pneumatic Actuators, selection of Actuators while designing a robot system. Motors – DC Motors, Servo Motors, Stepper motors etc.	06
Unit 4: Control for Robotics Control Systems: introduction to Open loop and Closed loop control systems, Types of Controllers, PLC – Introduction, Types, applications, advantages, disadvantages and selection, NC Controller- Introduction, Types, applications, advantages, disadvantages and Selection	05
Unit 5: Grippers and Manipulators for Robotics: Grippers for Robotics - Types of Grippers, Guidelines for design and selection of robotic gripper. Manipulators for Robotics- Types of manipulators, Guidelines for design and selection of manipulators	06
Unit 6: Allied Topics in Robotics Socio-Economic aspect of robotization. Economical aspects for robot design, Safety for robot and standards, Introduction to Artificial Intelligence, AI techniques, Need and application of AI, New trends & recent updates in robotics.	08

Text Books/References:

1 "Introduction to Robotics" 2nd edition, S. K. Saha, TATA McGraw Hills Education (2014)

2. "Robotics: Fundamental concepts and analysis", Asitava Ghoshal, Oxford University Press (2006)

3. "Fundamentals of Robotics", Dilip Kumar Pratihar, Narosa Publishing House, (2019)

4. "Robotics and Control", R. K. Mittal, I. J. Nagrath, , TATA McGraw Hill Publishing Co Ltd, New Delhi (2003)

5. "Introduction to Robotics – Analysis, Control, Applications", S. B. Niku, John Wiley & Sons Ltd., (2020)

6. "Fundamentals of Robotic Mechanical Systems Theory Methods and Algorithms", J. Angeles, Springer (1997)

7. "Industrial Robotics 2nd edition", Mikell Groover, Mitchell Weiss, Roger N. Nagel, Nicholas Odrey, Ashish Dutta, SIE, McGraw Hill Education (India) Pvt Ltd (2012)

8. "Robotic Engineering – An Integrated Approach", R. D. Klafter, Thomas A. Chmielewski, and MechaelNegin, EEE, Prentice Hall India, Pearson Education Inc. (2009)

NPTEL Courses:

NPTEL Course Name	Instructor	Host Institute
Introduction to robotics	Dr. Krishna Vasudevan, Dr.Balaraman Ravindran, Dr. T Asokan	IIT Madras
Sensors and Actuators	Prof. Hardik Jeetendra Pandya	IISc Bangalore

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Course Plan:

Course Title: **Elements of Robotic Systems Lab**	
Course Code: **201MEMIP223**	**Semester: IV**
Teaching Scheme: L-T-P: **0-0-2**	Credits :**1**
Evaluation Scheme: ISE Marks: **25**	ESE (POE) Marks :**25**

Course Description:

The course is focused on study, demonstration and hands on experience on Basic Robotic Systems, Anatomy of Robots, various sensors, actuators and drives used in Robotics.

Course Objectives:

1. To teach Basics of Robots, their types and operations
2. To demonstrate various Sensors Used in Robotics
3. To demonstrate various types of actuators for robotics
4. To demonstrate Various drives and motors used in robots

Course Outcomes:

At the end of the course the student should be able to

CO	Statement	BTL
CO223.1	Understand Robot basics of Robots and its Anatomy	L2
CO223.2	Select Suitable Sensors for Robotics	L2
CO223.3	Understand Various types of Drives used in Robotics	L2
CO223.4	Discuss Different Control Systems and Controllers for Robots	L2
CO223.5	Discuss Grippers or Manipulators used in Robots	L2

	List of Experiment		
Sr. No.	**Name of Experiment**	**Type**	**Hrs**
1	Study of 6-axis Robotic Arm And its Anatomy	S	4
2	Demonstration of Proximity Sensors	S	4
3	Demonstration of Pressure Sensor	S	2
4	Demonstration of Temperature Sensor	S	2
5	Demonstration of Magnetic Sensors	S	2
6	Demonstration of Magnetic Switches	S	2
7	Demonstration of Hydraulic Actuators	S	2
8	Demonstration of Pneumatic Actuators	S	2
9	Demonstration of Various Drive Motors	S	4

Text Books/References:

1 “Introduction to Robotics” 2nd edition, S. K. Saha, TATA McGraw Hills Education (2014)

2. “Robotics: Fundamental concepts and analysis”, Asitava Ghoshal, Oxford University Press (2006)

3. “Fundamentals of Robotics”, Dilip Kumar Pratihar, Narosa Publishing House, (2019)

4. “Robotics and Control”, R. K. Mittal, I. J. Nagrath, , TATA McGraw Hill Publishing Co Ltd, New Delhi (2003)

5. “Introduction to Robotics – Analysis, Control, Applications”, S. B. Niku, John Wiley & Sons Ltd., (2020)

6. “Fundamentals of Robotic Mechanical Systems Theory Methods and Algorithms”, J. Angeles, Springer (1997)

7. “Industrial Robotics 2nd edition”, Mikell Groover, Mitchell Weiss, Roger N. Nagel, Nicholas Odrey, Ashish Dutta, SIE, McGraw Hill Education (India) Pvt Ltd (2012)

8. “Robotic Engineering – An Integrated Approach”, R. D. Klafter, Thomas A. Chmielewski, and MechaelNegin, EEE, Prentice Hall India, Pearson Education Inc. (2009)

NPTEL Courses:

NPTEL Course Name	Instructor	Host Institute
Introduction to robotics	Dr. Krishna Vasudevan, Dr.Balaraman Ravindran, Dr. T Asokan	IIT Madras
Sensors and Actuators	Prof. Hardik Jeetendra Pandya	IISc Bangalore

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Course Plan:

Course Title: **Basics of Robot Design**	
Course Code: **201MEMIL319**	**Semester: V**
Teaching Scheme: L-T-P: **3-0-0**	Credits :**3**
Evaluation Scheme: ISE + MSE Marks: **20 + 30**	ESE Marks :**50**

Course Description:
This course aims to make students able to understand various design considerations and calculations used in Robotic Systems. It also aims to make students able to Design any Robotic System and Select appropriate Control system for Robots.

Course Objectives:
1. To develop the student's knowledge in various robot structures and their workspace
2. To develop student's skills in performing spatial transformations associated with rigid body motions and robot systems
3. To make students understand Various aspects and calculations of Robot Dynamics
4. To provide development skills associated with trajectory planning and robot control.

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

CO	Statement	BTL
CO319.1	Understand Mathematical Requirements of Robot Design	L2
CO319.2	Select Suitable Control System for Robots	L2
CO319.3	Calculate Kinematic interpretations	L3
CO319.4	Interpret forces in Robots and Design Mechanical Linkages of robots	L3
CO319.5	Interpret Dynamic calculations in Robots	L3
CO319.6	Develop motion path for a Robotic System	L3

Course Content

Content	Hours
Unit 1: Mathematical Preliminaries of Robotics Spatial Descriptions: positions, orientations, and frame, mappings: changing description from frame to frame, Operators: translations, rotations and transformations, transformation arithmetic, compound Transformations, inverting a transform, transform equations, Degree of Freedom.	07
Unit 2: Introduction to Robot Kinematics Manipulator Kinematics: Yaw, Pitch, Roll, Link Description, Link to reference frame connections, Denavit-Hartenberg Approach, D-H Parameters, Position Representations, Forward Kinematics. Inverse Kinematics.	07
Unit 3: Velocities & Statics: Cross Product Operator for kinematics, Jacobians - Direct Differentiation, Basic Jacobian, Jacobian Jv / Jw, Jacobian in a Frame, Jacobian in Frame {0}, Kinematic Singularity, Kinematics redundancy, Force balance equation.	07
Unit 4: Introduction to Robot Dynamics Introduction to Dynamics, Velocity Kinematics, Acceleration of rigid body, mass distribution Newton's equation, Euler's equation, Iterative Newton –Euler's dynamic formulation, closed dynamic, Lagrangian formulation of manipulator dynamics, dynamic simulation.	06
Unit 5: Trajectory Planning Trajectory planning: Path versus Trajectory, Joint space versus Cartesian space Descriptions, Basics of trajectory Planning, Joint space trajectory, Cartesian space Trajectories, Continuous trajectory, Workspace Design.	05
Unit 6: Basics of Robot Control Control of manipulators: open and closed loop control, Linear control schemes. Model of manipulator joint, Joint actuator, Partitioned PD control Schemes, PID control schemes, Computed Torque Control, Force control of Robotics Manipulators tasks, Force control strategy	08

Text Books/References:

1. “Introduction to Robotics” , S. K. Saha, 2e, TATA McGraw Hills Education (2014).
2. “Fundamentals of Robotics”, Dilip Kumar Pratihar, Narosa Publishing House, (2019)
3. “Robotics: Fundamental concepts and analysis”, Asitava Ghoshal, Oxford University Press (2006)
4. “Robot Modeling and Control”, M. Spong, M. Vidyasagar, S. Hutchinson, Wiley & Sons, (2005).
5. “Introduction to Robotics: Mechanics and Control”, 3rd edition J. J. Craig, , Addison-Wesley (2003).
6. “Introduction to Robotics: Mechanics and Control”, Craig John J., Pearson

NPTEL Courses:

NPTEL Course Name	Instructor	Host Institute
Mechanism and Robot Kinematics	Prof. Anirvan Das Gupta	**IIT Kharagpur**
Robotics and Control : Theory and Practice	Prof. M. Felix Orlando, Prof. N. Sukavanam	**IIT Roorkee**
Robot Motion Planning	Prof. Ashish Dutta	**IIT Kanpur**

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Course Plan

Course Title: **Robot Simulation Lab**	
Course Code: **201MEMIP320**	**Semester: V**
Teaching Scheme: L-T-P: **0-0-2**	Credits :**1**
Evaluation Scheme: ISE Marks: **25**	ESE (POE) Marks :2**5**

Course Description:

This course aims to make students able to design and simulate various operations and working conditions of Robotic Systems using FANUC ROBOGUIDE software

Course Objectives:

1. Understand Robot Simulation Techniques
2. Learn FANUC ROBOGUIDE with its Basics
3. Design Robotic System for various applications
4. Simulate different applications using Robotic Systems in ROBOGUIDE

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

CO	Statement	BTL
CO320.1	Understand Mathematical Requirements of Robot Design	L2
CO320.2	Understand Dynamic calculations in Robots	L2
CO320.3	Interpret forces in Robots and Design Mechanical Linkages of robots	L3
CO320.4	Calculate Kinematic interpretations of Robotic System	L3
CO320.5	Analyse Motion Trajectory for Robots	L4
CO320.6	Simulate Robot operation	L4

	List of Experiment		
Sr. No.	**Name of Experiment**	**Type**	**Hrs**
1	Introduction to FANUC: ROBOGUIDE software	S	4
2	Demonstration of Basic Features of ROBOGUIDE	S	4
3	Create a new work cell	S	4
4	Edit robot properties	S	2
5	Add a part and objects to the work cell	S	2
6	Add End-of-arm Tooling to the robot	S	2
7	Add a pick fixture to the work cell	S	2
8	Add a place fixture to the work cell	S	2
9	Calibrating objects to those in a real-world environment	S	2

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Course Plan

Course Title: **Robot Programming and Machine Vision Systems**	
Course Code: **201MEMIL322**	**Semester: VI**
Teaching Scheme: L-T-P: **3-0-0**	Credits :**3**
Evaluation Scheme: ISE + MSE Marks: **20 + 30**	ESE Marks :**50**

Course Description:

The course aims to teach students basics of different programming languages used in Robot Control. It also aims to teach Machine vision systems with its basics and make student able to perform different operations in image processing

Course Objectives:

1. To develop student knowledge about various programming methods and languages used n Robotics
2. To make students able to develop program in various programming languages
3. To develop student knowledge about machine vision systems
4. To make students able to perform various operations in image enhancement and processing

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

CO	Statement	BTL
CO322.1	Explain Robot Programming Methods	L2
CO322.2	Understand Machine Vision System Fundamentals	L2
CO322.3	Develop Simple Programs using VAL language	L3
CO322.4	Develop Simple program using RAPID language and AML	L3
CO322.5	Develop simple program for Image Enhancement	L3
CO322.6	Develop Simple programs for Image Processing	L3

Course Content

Content	Hours
Unit 1: -Introduction to Robot Programming Robot programming-Introduction, Types- Flex Pendant, Lead through programming, Coordinate systems of Robot, Interpolation-Interlock commands Operating mode of robot, Jogging-Types, Robot specifications- Motion commands, end effectors and sensors commands. Robot cycle time analysis	07
Unit 2: -VAL Language Robot Languages-Classifications, Structures **VAL language-** commands motion control, hand control, program control, pick and place applications, WAIT, SIGNAL and DELAY commands. **VAL-II programming**-basic commands, applications- Simple problem using conditional statements-Simple pick and place applications	06
Unit 3: RAPID Language and AML **RAPID language** basic commands- Motion Instructions-Pick and place operation using Industrial robot- manual mode, automatic mode. **AML Language**-General description, elements and functions, Statements, constants and variables-Program control statements-Operating systems, Motion, Sensor Commands-Data processing.	07
Unit 4: Introduction to Vision System Comparison with human visual system and perception level, digital image presentation, Definitions of digital image, elements and applications of digital image processing systems, image acquisition, storage, processing, communication and display **Digital Image Fundamentals**- Elements of visual perception – brightness adaption and discrimination, light and electromagnetic spectrum, image sensing and acquisition, sampling and quantization, pixels, connectivity, adjacency, distance measures, image sensors, different types of file formats.	06
Unit 5: Basics of Image Enhancements: **Enhancement in Spatial Domain**: Point and mask Processing, Basic gray level transformations, histogram- processing, equalization, matching, statistics. Image subtraction, averaging. Basics of spatial filtering-smoothing, sharpening filters other statistical filters **Enhancement in Frequency Domain**: introduction, 2-D Fourier transform, smoothing frequency domain filters- ideal, butter worth, Gaussian low pass filter, Sharpening Filters-ideal, butter worth, Gaussian	06
Unit 6: Introduction to Image Processing **Restoration**- Model for image degradation/restoration, noise models – probability density functions of noise, periodic noise and estimation of noise parameters; Band pass and band reject filters **Compression**- Fundamentals of image compression and types of redundancy, error free and lossy compression, variable length coding – Huffman coding, arithmetic coding, LZW coding. **Image Processing:** Basic concept, Dilation and Erosion process for binary and gray image with applications, Opening & Closing for binary and gray image with applications.	08

Text Books/References:

1. "Introduction to Robotics: Mechanics and Control", Craig John J., Pearson
2. "Industrial Robotics, Technology programming and Applications", Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, , McGraw Hill, 2012.
3. "Robotics control, sensing, vision and intelligence", Fu. K. S., Gonzalez. R. C. & Lee C.S.G., McGraw Hill Book co, 1987.
4. "Digital Image Processing", Refael C. Gonzalez and Richard E, Woods Addison Wesley ISBN: 9780133356724
5. "Digital Image Processing Using MATLAB," Refael C. Gonzalez and Richard E. Woods, AddisonWesley, ISBN: 9780070702622
6. "Digital Image Processing and Analysis: Applications with MATLAB and CVIP tools" Scott E Umbaugh, , Taylor and Francis, ISBN: 1498766072
7. "Programming Languages for Industrial Robots", Christian Blume, Wilfried Jakob, Springer Berlin, Heidelberg, **ISBN:** 978-3-642-82747-1

NPTEL Courses:

NPTEL Course Name	Instructor	Host Institute
Computer Vision	Prof. Jayanta Mukhopadhyay	**IIT Kharagpur**
Computer Vision and Image Processing - Fundamentals and Applications	Prof. M. K. Bhuyan	**IIT Guwahati**

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Course Plan

Course Title: **Robot Programming and Machine Vision Lab**	
Course Code: **201MEMIP322**	**Semester: VI**
Teaching Scheme: L-T-P: **0-0-2**	Credits :**1**
Evaluation Scheme: ISE Marks: **25**	ESE (POE) Marks :2**5**

Course Description:

The course aims to teach students basics of different programming languages used in Robot Control. It also aims to teach Machine vision systems with its basics and make student able to perform different operations in image processing

Course Objectives:

1. To develop student knowledge about various programming methods and languages used n Robotics
2. To make students able to develop program in various programming languages
3. To develop student knowledge about machine vision systems
4. To make students able to perform various operations in image enhancement and processing

Course Outcomes:

At the end of the course the student should be able to

CO	Statement	BTL
CO322.1	Explain Robot Programming Methods	L2
CO322.2	Understand Machine Vision System Fundamentals	L2
CO322.3	Develop Simple Programs using VAL language	L3
CO322.4	Develop Simple program using RAPID language and AML	L3
CO322.5	Develop simple program for Image Enhancement	L3
CO322.6	Develop Simple programs for Image Processing	L3

	List of Experiment		
Sr. No.	**Name of Experiment**	**Type**	**Hrs**
1	Learning and implementing basic MATLAB commands	S	4
2	Forming script file and function file in MATLAB	S	4
3	Understanding different image classes	S	4
4	Use of arithmetic and logical operators on images	S	4
5	Image Segmentation	S	2
6	Blurring the given image.	S	4
7	Blurring and sharpening of image with built in command and performing scaling of the image	S	2

Assignments:

1. Assignment 1: Programming for Pick and Place Robot Using VAL / VAL-II Language
2. Assignment 2: Programming for Pick and Place Robot Using RAPID Language
3. Assignment 3: Programming for Pick and Place Robot Using AML Language

Text Books/References:

1. “Introduction to Robotics: Mechanics and Control”, Craig John J., Pearson
2. “Industrial Robotics, Technology programming and Applications", Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, , McGraw Hill, 2012.
3. “Robotics control, sensing, vision and intelligence”, Fu. K. S., Gonzalez. R. C. & Lee C.S.G., McGraw Hill Book co, 1987.
4. “Digital Image Processing”, Refael C. Gonzalez and Richard E, Woods Addison Wesley ISBN: 9780133356724
5. “Digital Image Processing Using MATLAB,” Refael C. Gonzalez and Richard E. Woods, AddisonWesley, ISBN: 9780070702622
6. “Digital Image Processing and Analysis: Applications with MATLAB and CVIP tools” Scott E Umbaugh, , Taylor and Francis, ISBN: 1498766072
7. “Programming Languages for Industrial Robots”, Christian Blume, Wilfried Jakob, Springer Berlin, Heidelberg, **ISBN:** 978-3-642-82747-1

NPTEL Courses:

NPTEL Course Name	**Instructor**	**Host Institute**
Computer Vision	Prof. Jayanta Mukhopadhyay	**IIT Kharagpur**
Computer Vision and Image Processing - Fundamentals and Applications	Prof. M. K. Bhuyan	**IIT Guwahati**

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Course Plan

Course Title: **Industry 4.0**	
Course Code: **201MEMIL421**	**Semester: VII**
Teaching Scheme: L-T-P: **3-0-0**	Credits :**3**
Evaluation Scheme: ISE + MSE Marks: **20 + 30**	ESE Marks :**50**

Course Description:

This course aims to provide knowledge about Industrial Automation from its basics making students aware of various Industrial Automation Systems, its Design and selection of various components in automation system design. It also aims to make students able to understand various technologies as IoT, Big data, Industry 4.0 and SCADA.

Course Objectives:

1. To provide basic knowledge about Industrial Automation Systems,
2. To make students aware about Industry 4.0, Big Data, Artificial Intelligence, Machine Learning
3. To provide knowledge about Internet of Things for Industries
4. To make students able to understand basic concepts in SCADA and develop programs for SCADA systems.

Course Outcomes:

At the end of the course the student should be able to

CO	Statement	BTL
CO421.1	Understand Fundamentals of Industrial Automation	L2
CO421.2	Understand Various Industrial Automation Systems in detail	L2
CO421.3	Understand Basics of Industry 4.0	L2
CO421.4	Understand Basics of IoT and Industrial IoT	L2
CO421.5	Discuss Various applications and new technologies related to Industry 4.0	L2
CO421.6	Explain SCADA system architecture and Software used	L2

Course Content

Content	Hours
Unit 1:Introduction to Industrial Automation Introduction: Definition, automation principles and strategies, scope of automation, socio considerations, low cost automation, basic elements of automation system, opportu automation and computerization, types of automation, levels of automation, reasons for a automation principles and strategies, ten strategies for automation	07
Unit 2: Industrial Automation Systems continuous and discrete control systems, computer process control, common measuring devices used in automation, desirable features for selection of measuring devices, : Material handling equipment, design considerations for material handling system, material transport equipment, conventional and automated storage systems, overview of automatic identification and data capture, bar code technology, RFID	07
Unit 3: Industry 4.0 Definition, Development from Industry 1.0 to Industry 4.0, Main characteristics and advantages, Steps in implementing digital transformation, Common roadblocks in implementation, Requirements of Industry 4.0, Technologies, Processes, and Terms of Industry 4.0	05
Unit 4: Internet of Things (IoT) Internet of Things – Definition, Concept and History, IoT network, architecture and design and their comparison, Sensors in IoT, Wireless technologies for IoT – Bluetooth, Zigbee and Wi-Fi, IoT platforms – Arduino and Raspberry Pi, Benefits of IoT to organizations, Advantages and limitations of IoT, Security issues in IoT, IoT Data Management, IoT functional stack	06
Unit 5: Industry 4.0 and IoT Applications and Technologies Applications of Industry 4.0 and IoT with special reference to Smart Factory, Smart Cities, Smart Home, Smart Autonomous Cars, Smart Retail, Energy Management, IoT in Healthcare, 3 D printing **Technologies**-Big Data – Definition, Types, Characteristics, Benefits of Big data processing, Artificial Intelligence and Machine Learning – Definition, Types, Advantages and Applications, Augmented Reality – Introduction and Applications, Cloud Computing – Introduction, Types and Applications, Cyber Physical Systems – Introduction, Advantages and Applications.	07
Unit 6: Supervisory Control and Data Acquisition (SCADA) Introduction, Objectives, Functions, Advantages, Typical SCADA system hardware and software, Human Machine Interface (HMI) and Machine to Machine Interface Network Topology, Open System Interconnection, Applications of SCADA to industry with special reference to power plant, process control, foundry and forging, Introduction to Real Time Systems and Applications	08

Text Books/References:

1. "Industrial Automation Using PLC SCADA & DCS", R.G. Jamkar, Global Education
2. "Robotic Technology and Flexible Automation", S. R Deb, Tata Mc Hill
3. "Internet of Things: A Hands-On Approach", Arshdeep Bahga, Vijay Madisetti, Orient Blackswan Private Limited - New Delhi; First edition (1 January 2015), ISBN-10 : 8173719543
4. "Internet of Things : Architecture and Design Principles", Rajkamal, McGraw Hill Education; First edition (10 March 2017), ISBN-10 : 9352605225
5. "Quick Start Guide to Industry 4.0: One-stop reference guide for Industry 4.0", Kiran Kumar Pabbathi, Createspace Independent Publishing Platform (11 May 2018), ISBN-10 : 1718978618

NPTEL Courses:

NPTEL Course Name	Instructor	Host Institute
Industrial Automation and Control	Prof. S. Mukhopadhyay, Prof. S. Sen	**IIT Kharagpur**
Industrial Automation and Control	Prof. S. Mukhopadhyay	**IIT Kharagpur**
Introduction to Industry 4.0 and Industrial Internet of Things	Prof. Sudip Misra	**IIT Kharagpur**

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Course Plan

Course Title: **Industry 4.0 Lab**	
Course Code: **201MEMIP421**	**Semester: VII**
Teaching Scheme: L-T-P: **0-0-2**	Credits :**1**
Evaluation Scheme: ISE Marks: **25**	ESE (POE) Marks :**25**

Course Description:

This course aims to provide knowledge about Industrial Automation from its basics making students aware of various Industrial Automation Systems, its Design and selection of various components in automation system design. It also aims to make students able to understand various technologies as IoT, Big data, Industry 4.0 and SCADA.

Course Objectives:

1. To provide basic knowledge about Industrial Automation Systems,
2. To make students aware about Industry 4.0, Big Data, Artificial Intelligence, Machine Learning.
3. To provide knowledge about Internet of Things for Industries
4. To make students able to understand basic concepts in SCADA and develop programs for SCADA systems.

Course Outcomes:

At the end of the course the student should be able to

CO	Statement	BTL
CO421.1	Understand basic functions of Industrial Automation system	L2
CO421.2	Understand operation of various Industrial Automation Systems	L2
CO421.3	Understand Operations of Smart Factory Cell	L2
CO421.4	Explain SCADA system architecture and Software used	L2
CO421.5	Develop simple programs for HMI	L3
CO421.6	Develop basic programs for SCADA system	L3

	List of Experiment		
Sr. No.	**Name of Experiment**	**Type**	**Hrs**
1	Demonstration of Material Handling Cell	S	4
2	Demonstration of Welding Cell	S	4
3	Study and Demonstration of Smart Factory Cell	S	4
4	HMI Basic programming	S	4
5	SCADA basic Programming	S	4
6	Assignment on SCADA	S	4

Text Books/References:

1. "Industrial Automation Using PLC SCADA & DCS", R.G. Jamkar, Global Education
2. "Robotic Technology and Flexible Automation", S. R Deb, Tata Mc Hill
3. "Internet of Things: A Hands-On Approach", Arshdeep Bahga, Vijay Madisetti, Orient Blackswan Private Limited - New Delhi; First edition (1 January 2015), ISBN-10 : 8173719543
4. "Internet of Things : Architecture and Design Principles", Rajkamal, McGraw Hill Education; First edition (10 March 2017), ISBN-10 : 9352605225
5. "Quick Start Guide to Industry 4.0: One-stop reference guide for Industry 4.0", Kiran Kumar Pabbathi, Createspace Independent Publishing Platform (11 May 2018), ISBN-10 : 1718978618

NPTEL Courses:

NPTEL Course Name	Instructor	Host Institute
Industrial Automation and Control	Prof. S. Mukhopadhyay, Prof. S. Sen	**IIT Kharagpur**
Industrial Automation and Control	Prof. S. Mukhopadhyay	**IIT Kharagpur**
Introduction to Industry 4.0 and Industrial Internet of Things	Prof. Sudip Misra	**IIT Kharagpur**

D. Y. PATIL
COLLEGE of ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering

Course Plan

Course Title: **Mini Project**	
Course Code: **201MEMIP423**	**Semester: VIII**
Teaching Scheme: L-T-P: **0-0-2**	Credits :**2**
Evaluation Scheme: Phase I: **50**	Phase II :**50**

Course Description:
This is a project course which aims to make students apply knowledge gained during entire course to develop a system and demonstrate any Automation or Robotic System.

Course Objectives:

1. To make students able to apply knowledge gained throught the program to work independently on project of their choice under guidance of faculty
2. To engage students in development activities such as literature research, planning and execution of work plan adhering to academic calendar.

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

CO	Statement	BTL
CO423.1	Identify Problems in applications related to Automation and Robotics	L2
CO423.2	Apply theoretical concepts to provide solution for identified problem	L3
CO423.3	Analyse result of provided solution	L4

A detailed report to be prepared based on any one of the following topics

1. Manufacturing / Fabrication of a prototype Robotic / Automated system including selection, concept, design, material, manufacturing the components, assembly of components, testing and performance evaluation.
2. Improvement of existing Robotic / Automated system.
3. Design and fabrication of end effectors for robot
4. Computer aided design, analysis *of* components such as stress analysis.
5. Modelling and Simulation of Robotic and Automation systems
6. Robot Kinematics and Dynamic analysis
7. Low cost automation, Computer Aided Automation in Manufacturing.
8. Ergonomics and safety aspects of robotic systems
9. Management Information System.
10. Product design and development.
11. Problems related to Productivity improvements / Value Engineering / Automated Material Handling Systems

Two copies of Final Project Report shall be submitted to the college. The students shall present their Final Project report. Before the examiners. The oral examination, shall be based on the term work submitted and jointly conducted by an internal and external examiner from industry, at the end of second semester.