Course Syllabus
Gyanmanjari Diploma Engineering College
Semester-5(Diploma)

Subject: Automation and robotics-DETME15221

Type of course: Professional Elective Courses

Prerequisite: Basic Electrical & Electronics Engineering, Hydraulics & Pneumatics

Rationale: In near future, robots will be used widely in the fields of manufacturing, medicine, search and rescue, service, and entertainment. So, it is very much important to teach robotics as the synergistic integration of mechanics, electronics, controls and computer science. This subject is intended to make students aware with basics of robot sensors, controls, transformations along with essential kinematics and dynamics, robot programming language and Industrial automation system & Industry 4.0.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks		Practical Marks		CA	
CI	T	P	C	ESE	MSE	V	P	ALA	
3	0	2	4	60	30	10	20	30	150

Legends: CI-Classroom Instructions; T – Tutorial; P - Practical; C – Credit; ESE - End Semester Examination; MSE- Mid Semester Examination; V – Viva; CA - Continuous Assessment; ALA- Active Learning Activities.

Course Content:

Unit No	Course content	Hrs.	% Weightage
1	**Introduction to Robotics:** Brief History of Robotics, Definition of a Robot, Laws of Robotics, Advantages and Disadvantages of Robots, Components of an Industrial Robot, Robot Terminology, Robotic Joints, Classification of Robots (Based on Coordinate Systems, Based on Power Source, Based on Method of Control, Based on Programming Method), Industrial Applications of Robots, Safety Practices with Robots.	8	20
2	**Actuators and Grippers:** Introduction to Robotic Actuators, Block Diagram of an Actuator System, Subsystems of Actuator System (Power Supply, Power Amplifier, Servomotor, Transmission System), Classification of Actuators (Pneumatic Actuators, Hydraulic Actuators, Electric Actuators: DC Motor, AC Motor, Induction Motor, Stepper Motors, Linear Actuators), Factors Affecting Selection of Actuators, Introduction to Grippers, Classification of Grippers (Mechanical Grippers, Magnetic Grippers, Vacuum Grippers, Adhesive Grippers, Tools as Grippers), Factors Affecting Design and Selection of Grippers. **Robot Kinematics:** What is Kinematics, Types of Kinematic Links (Rigid Link, Flexible Link, Floating Link), Kinematic Pair/Constraints (Types of Constraints, Classification of Kinematic Pairs), Common Types of Robotic Joints, Kinematic Chain (Closed Chain Mechanism, Open Chain Mechanism), Degree of Freedom (DOF), Position and Orientation of Rigid Body in Space (Configuration Space, Coordinate Systems: Cartesian Coordinate System, Cylindrical Coordinate System, Spherical Coordinate System), Representation of Points and Vectors in Coordinate Systems.	13	30
3	**Robot Programming** Introduction, Requirement for Robot Language, Structure of Robot Language, Different Robot Languages, Robot Programming Techniques (Manual Programming Method, Walk-Through Programming Method, Teach Pendant or Lead-Through Programming Method, Off-Line Programming Method). **Robotic Sensors:** Types of Sensors in Robots, Position and Displacement Sensor (Potentiometers, Optical Encoders: Absolute, Incremental, LVDT), Touch or Tactile Sensor (Binary Sensor, Analog Sensor), Proximity Sensor (Contact Proximity, Non-Contact Proximity, Optical, Ultrasonic, Eddy Current, Inductive, Hall Effect, Capacitive), Procedure to Choose the Right Sensor for a Particular Application.	11	25

4	**Industrial Automation:** Introduction, Advantages and Limitations of Automation, Application of Automation, Elements of Automation, Mechanization vs Automation, Types of Automation (Fixed (or Hard) Automation, Programmable Automation, Flexible (or Soft) Automation), Assembly Automation Equipment (Material Handling System: Classification of Material Handling System, Transportation System: Transfer Systems, Transfer Machines, Transfer Devices, Feed System: Introduction, Characteristics of Feeder, Types of Feeders), Automated Guided Vehicles (AGVs), Automated Storage Systems: Introduction, Automated Storage/Retrieval Systems, Flexible Manufacturing System (FMS): Introduction, Flexible Manufacturing Cell and FMS, Components of FMS, Requirement of FMS, Advantages and Limitations of FMS, Group Technology: Introduction, Advantages and Limitations of Group Technology, Part Families Formation and Establishment of Component Family, Collection of Production Data, Computer Aided Process Planning System, Computer Integrated Manufacturing (CIM), Industry 4.0.	13	25

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1	**Summary on Types of Actuators and Grippers** Prepare a tabulated summary of different types of actuators and grippers used in robotics. Include their working principle, advantages, disadvantages, and common applications. Upload the report on the GMIU web portal.	10
2	**Case Studies on Industrial Robots** Identify any one industrial robot used in manufacturing and one robotic gripper available in the market. Gather detailed specifications, applications, and current prices. Upload a report on the GMIU web portal.	10
3	**Presentation on Robot Kinematics** Faculty will assign specific topics related to subject Students must prepare a presentation to enhance their understanding and improve communication skills. Upload the presentation on the GMIU web portal.	10
	Total	30

Suggested Specification table with Marks (Theory):60

Distribution of Theory Marks (Revised Bloom's Taxonomy)						
Level	**Remembrance (R)**	**Understanding (U)**	**Application (A)**	**Analyze (N)**	**Evaluate (E)**	**Create (C)**
Weightage	35%	35%	30%	-	-	-

Course Outcome:

After learning the course, the students should be able to:	
CO1	Explain the fundamentals of robotics, including its history, classification, components, applications, and safety practices.
CO2	Analyze the working principles, classifications, and selection criteria of robotic actuators, grippers, and kinematic systems.
CO3	Demonstrate knowledge of robot programming techniques and sensor selection for efficient robotic operation.
CO4	Explain the principles, types, and applications of industrial automation, including automated systems and Industry 4.0 concepts.

List of Practical:

Sr. No	Descriptions	Unit No	Hrs.
1	**Study of Industrial Robots and Their Classification** Observe and classify different types of industrial robots based on coordinate systems, power sources, method of control, and programming methods.	1	2
2	**Identification of Robot Components and Joints** Examine the key components of an industrial robot and study different types of robotic joints used in various applications.	1	4
3	**Demonstration of Actuators in Robotics** Analyze the working principles, advantages, and applications of different types of actuators (pneumatic, hydraulic, electric).	2	2
4	**Study of Robotic Grippers** Identify and compare various gripper types (mechanical, magnetic, vacuum, adhesive) based on their working principles and selection criteria.	2	2

5	**Kinematic Study of a Robotic Manipulator** Analyze the degree of freedom (DOF), types of links, and kinematic chains in a given robotic arm.	2	4
6	**Introduction to Robot Programming Methods** Study different robot programming techniques (manual, teach pendant, walk-through, offline programming) and discuss their applications.	3	2
7	**Demonstration of Robotic Sensors** Observe and compare different types of robotic sensors (position, displacement, proximity, and touch sensors) and their industrial applications.	3	2
8	**Study of Automated Guided Vehicles (AGVs)** Examine the working principles, navigation methods, and sensor integration in Automated Guided Vehicles (AGVs).	4	4
9	**Introduction to Flexible Manufacturing System (FMS)** Study the components, working principles, advantages, and applications of Flexible Manufacturing Systems (FMS).	4	4
10	**Overview of Industry 4.0 and Smart Manufacturing** Discuss IoT-enabled automation, cyber-physical systems, and cloud computing in modern manufacturing systems.	4	4
		Total	30

Instructional Method:

The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory

The internal evaluation will be done on the basis of Active Learning Assignment

Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

Reference Books:

[1] Robotics and Industrial Automation by R.K. Rajput

[2] Industrial Automation and Robotics by A.K. Gupta & S.K. Arora

[3] Introduction to robotics by Prof. Subair kumar Shah

[4] Fundamentals of Robotics by Prof. Dilip Kumar Pratihar