Course Title: Robotics and Automation (PG Diploma)

Semester - I (PG Diploma)

1. Robotics Engineering
2. Automation and Controller
3. Sensor Technology and Communication
4. System Engineering
5. Electromechanical Systems and Components

Subject 1: Robotics Engineering

Basics of robotics: History, Definition, Components, Building a robot, The Robot drive mechanism.

Robot simulation: Mathematical modelling of the robot-Robot Kinematics-Concepts of ROS and Gazebo.

Designing chef-bot hardware: Specifications - Block diagram - Working with Robotic Actuators and Wheel Encoders Interfacing DC geared motor with Tiva C Launchpad - Interfacing quadrature encoder with Tiva C Launchpad - Working with Dynamite actuators.

Working with robotic sensors: Working with ultrasonic distance sensors - Working with the IR proximity sensor – Working with Inertial Measurement Unit. Python and ROS: Introduction to OpenCV, ROS, and PCL. Robot vision: Basic introduction to Robotic Operating System (ROS)-installing and testing ROS camera Drivers, ROS to OpenCV-The cv_bridge Package. Introduction to OpenCV image processing library.

Subject 2: Automation and Controller

Nature of Industrial Process: Continuous & discrete state sequential process, process variables and their classification.

Introduction to Process Control Philosophies: Type of relays, ladder logic methodology, ladder symbols.

Introduction to Programmable Logic Controllers: Advantages & disadvantages of PLC with respect to relay logic, PLC architecture, Input Output modules, PLC interfacing with plant, memory structure of PLC. PLC programming methodologies: ladder diagram, STL, functional block diagram, creating ladder diagram from process control descriptions. PLC functions: bit logic instructions, ladder diagram examples, interlocking, latching, inter dependency and logical functions, PLC Timer & Counter functions on-delay timer, off-delay timers, retentive on-delay timers, pulse timers, timer examples, up-counter, down-counter and up-down counter, counter examples, register basics. PLC Data Handling: data move instructions, table and register moves, PLC FIFO & LIFO functions. PLC arithmetic and logical functions: addition, subtraction, multiplication, division instructions, increment decrement, trigonometric and log functions, AND, OR, XOR, NOT functions, PLC compare and convert functions. PLC program control and interrupts: jumps, subroutine, sequence control relay, watchdog.

Analog value processing: Types of analog modules, analog input and output examples, PID control of continuous process.

Subject 3: Sensor Technology and Communication

Introduction to sensors: Anatomy of Sensor System, Transduction principles, Smart Sensors.

Thermal sensors: Definition of Temperature: Thermal Energy, absolute and relative Temperature, Metal resistance versus temperature devices: Resistance versus Temperature Approximations, Resistance-Temperature Detectors (RTD). Thermistors: Semiconductor Resistance versus Temperature, Thermistor Characteristics.

Mechanical Sensors: Displacement, Location, or Position Sensors: Resistive-, Capacitive-, and Inductive Sensors, Variable-Reluctance Sensors, Motion sensors: Types of Motion, Accelerometer Principles, Types of Accelerometers, Pressure sensors: Pressure Principles, Pressure Sensors: ($p > 1$ atmosphere), Pressure Sensors ($p < 1$ atmosphere).

Optical Sensors: Fundamentals of EM radiation Nature of EM Radiation, Characteristics of Light, Photometry, Photodetectors.

Communication: Routers, Hubs, repeaters, Network Topologies, Transmission Media, Digital to Digital Conversion, Digital to Analog Conversion, Analog to Analog Conversion, Analog to Digital Conversion, Error Detection and Correction.

Subject 4: System Engineering

System analysis: Characteristics, Problems in system, Development, System Level project Planning, System Development Life cycle (SDLC), computer system engineering & system analysis, modelling the architecture, system specification.

Software & its characteristics: Software Development, Process Model, Prescriptive model, The waterfall model, Incremental Process Modes, Evolutionary process model, specialized process model.

Requirement analysis: Requirement analysis tasks, Analysis principles, Software prototyping and specification data dictionary finite state machine (FSM) models. Structured Analysis: Data and control flow diagrams, control and process specification behavioural modelling, extension for data intensive applications.

Software design: Design fundamentals, Effective modular design: Data architectural and procedural design, design documentation, coding – Programming style, Program quality, quantifying program quality, complete programming example**.**

Object oriented analysis: Object oriented Analysis Modelling, Data modelling, Object Oriented Design: OOD concepts and methods class and object definitions, refining operations, Class and object relationships, object modularization, Introduction to Unified Modelling Language.

Subject 5: Electromechanical Systems and Components

Introduction: Integrated design issues in automation systems, the Mechatronics design process- benefits, modelling of electromechanical systems, building blocks of automation systems.

Motion control in automation: Selection of motor for automation system, sizing of servo motor for a specific application, importance of sizing, selection of mechanical components, load cycle definition, load inertia and torque calculations, selection of motors.

Selection of precision motion automation: LM Guide ways, Ball screws, bearings, Types, Selection, from the manufacturer ‘s catalogue based on the applications, fixing arrangements and assembly.

Material handling systems: Overview of material handling equipment, AGVs, ASRS, grippers-types- design -selection, considerations in material handling system design, principles of material handling.

Belt conveyors: Information required for designing, angle of incline, belt conveyor elements, selection of belt, drive, greasing of idlers, Plow Vs Trippers, magnetic pulley, skirt boards, training of belt conveyors, weighing material in motion, shuttle belt conveyor, pinion –swivel arrangement, troughing, suspended idlers, belt cleaners, transfer of material from belt to belt, cover, safety protection at pulleys, belt speeds and widths, design of a belt conveyor, belt conveyor calculation, minimum pulley diameters, enclosures for conveyors, idler selection, conveyor belt troubles.

System integration: Issues and systematic approaches, case study- integration of machine tending robot with a CNC machine, design and simulation using CIROS software, economics of automation systems design and implementation.