JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

Supplementary Examination- 2026

B.Tech-VII Semester (OE)

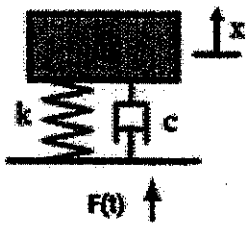
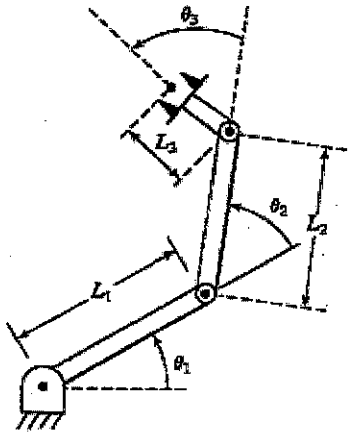
COURSE CODE(CREDITS): 20B1WEC731 (3) MAX. MARKS: 75

COURSE NAME: Automation and Robotics

COURSE INSTRUCTORS: Dr Emjee Puthooran MAX. TIME: 2 Hours

Note: *(a) All questions are compulsory.*
(b) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems (c) Use of nonprogrammable scientific calculator is allowed in the exam.

Q.No	Question	CO	Marks
Q1	List the various factors that contribute to the cost/unit and overall production time in an industry. Describe how industrial automation can maximize the profit of an industry.	CO-1	5
Q2	Describe the different layers of the industrial automation pyramid and explain their specific roles and functions within the overall automation framework. Provide a schematic representation of the pyramid, and discuss how these layers interact and collaborate to create efficient and effective automation solutions in an industrial environment.	CO-1	5
Q3	For a process control, it is desired to have the process start by turning ON a motor five seconds after a part touches a limit switch. The process is terminated automatically when the finished part touches a second limit switch. An emergency switch will stop the process any time when it is pushed. Design a ladder logic program for PLC and explain its working.	CO-2	5
Q4	Describe the structure of a Distributed Control System (DCS), identifying and briefly explaining the roles of its four primary architectural layers.	CO-2	5
Q5	The Remote Terminal Unit (RTU) is a critical component in SCADA systems. State two main functions of the RTU with respect to field devices and data communication. Furthermore, mention two significant industrial sectors where SCADA systems are widely deployed.	CO-2	5
Q6	Describe the operational principles of a strain gauge sensor. Using appropriate circuit diagrams, illustrate how force is measured with a single-element strain gauge versus a four-element strain gauge setup. Outline the benefits of employing four-element strain gauge sensors.	CO-4	10

Q7	Develop a Python program to model the behavior of a mass-spring-damper system depicted in the figure. The program should plot the system's response under unity feedback to a unit step input, incorporating a PID controller. 	CO-3	10
Q8	A frame *{C}* is rotated by 15° about y-axis to get frame *{B}*. Frame *{B}* is then rotated by 30° about z-axis to get frame *{A}*. A point *'P'* in frame *{C}* is given by $[3\ 2\ 5]^T$. What is its position vector with respect to frame *{A}*?	CO-3	10
Q9	A 3-DOF planar RRR manipulator has link lengths $L_1 = 500$ mm, $L_2 = 700$ mm, $L_3 = 300$ mm. Tabulate the DH parameters and find the forward kinematics equations and write the position of the end-effector (x, y) in terms of θ_1, θ_2, θ_3. The general form of the link transformation matrix is given as: $$ {}^{i-1}_{i}T = \begin{bmatrix} c\theta_i & -s\theta_i & 0 & a_{i-1} \\ s\theta_i c\alpha_{i-1} & c\theta_i c\alpha_{i-1} & -s\alpha_{i-1} & -s\alpha_{i-1}d_i \\ s\theta_i s\alpha_{i-1} & c\theta_i s\alpha_{i-1} & c\alpha_{i-1} & c\alpha_{i-1}d_i \\ 0 & 0 & 0 & 1 \end{bmatrix} $$ 	CO-3	10
Q10	A single-link robot with a rotary joint is motionless at $\theta = 10$ degrees. It is desired to move the joint in a smooth manner to $\theta = 30$ degrees in 15 seconds. Find the coefficients of a cubic polynomial that accomplishes this motion and brings the manipulator to rest at the goal. Plot the position, velocity, and acceleration of the joint as a function of time.	CO-5	10