BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: BTECH **SEMESTER : VII**
BRANCH: CSE, PIE **SESSION : MO/2023**

SUBJECT: ME497 INDUSTRIAL ROBOTICS AND AUTOMATION

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	Name the different subsystems of a robotic system and describe their major components.	[5]	CO1	1
Q.1(b)	Find out the DH parameters of a two-link revolute jointed robotic arm in terms of the joint angles and link lengths. In terms of the DH parameters, derive the expressions of the homogeneous transformation matrix defining the position and orientation of the end effector.	[5]	CO1	4
Q.2(a)	Explain working principles of Linear Variable Differential Transformer (LVDT) as displacement sensor and strain gauge as force sensor.	[5]	CO2	2
Q.2(b)	Define workspace of a robotic manipulator. Draw the workspace of the robot shown in the figure (Fig. Q.2(b)).	[5]	CO2	3

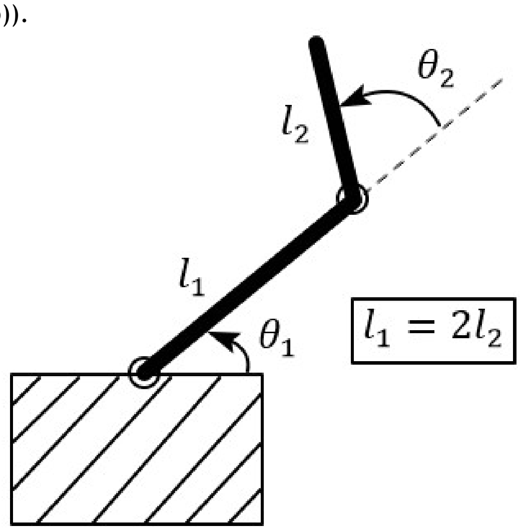

Fig. Q.2(b)

Q.3(a)	Define Jacobian for velocity and acceleration analyses of a robot system. Write down the expressions of end effector's velocity and acceleration in terms of Jacobian and joint angle rates.	[5]	CO3	1
Q.3(b)	A rotary joint of a robot moves from -15° to 45° in 4 seconds. Find the coefficients of a cubic polynomial trajectory $\theta = a + bt + ct^2 + dt^3$ when the initial velocity and acceleration are zero.	[5]	CO3	3

PTO

Q.4(a)	Derive the governing equation for the motion of the block of mass m which is attached to a spring of stiffness k and damper with coefficient b subjected to external dynamic force f as shown in the figure (Fig. Q.4(a)). Using the derived governing equation, find the motion for the moving block having m = 2, b = 6, k = 4, and is initially at rest when released from the position x = 1.	[5]	CO4	4

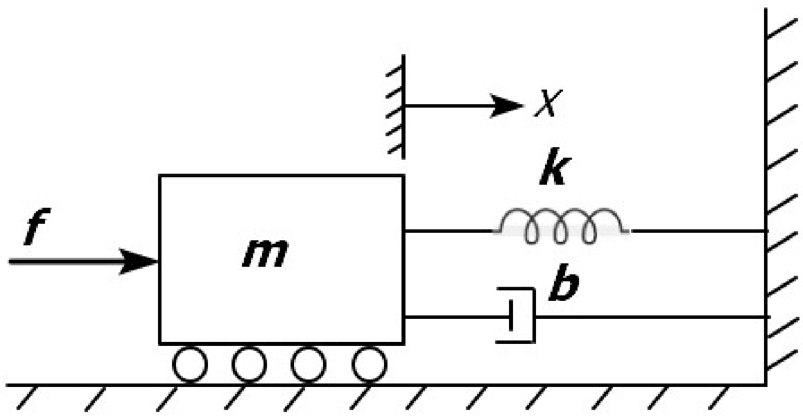

Fig. Q.4(a)

Q.4(b)	Illustrate PROPORTIONAL-DERIVATIVE-INTEGRAL (PID) control through net sketches for the damped mass-spring system shown in Fig. Q.4(a).	[5]	CO4	2
Q.5(a)	Briefly explain about major industrial automation applications. Explain economic and social aspects of such industrial automation applications.	[5]	CO5	2
Q.5(b)	For drawing a circle of radius 100 mm on a piece of paper by a marker fitted at the end effector of a KUKA KR-5 robot, formulate the parametric equations of the circle. Write a KRL (KUKA Robot Language) code to perform the task.	[5]	CO5	5

::::::29/11/2023::::::M