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

CLASS: MTECH **SEMESTER : II**
BRANCH: MECH. **SESSION : SP/2023**

SUBJECT: ME525R1 ROBOTICS MANIPULATOR DESIGN

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)	For given manipulator (see Fig. Q.1 (a)), assign appropriate frames for the Denavit-Hartenberg (DH) representation. Fill out the DH parameters table and write an equation in terms of a matrices that shows how ${}^{0}_{3}T$ can be calculated.	[5]	1	Write

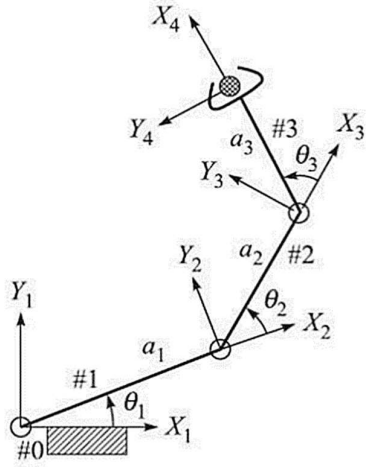

Fig. Q.1 (a)

Q.1(b)	Derive the inverse kinematics of thee arm shown in Fig. Q.1 (b).	[5]	1	Derive

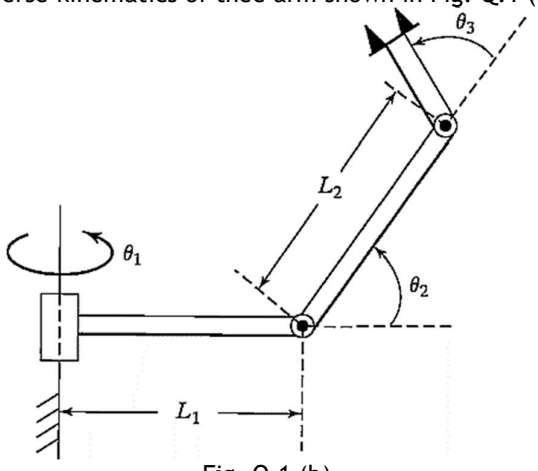

Fig. Q.1 (b)

PTO

Q.2(a) Derive equation of motion of a 2R planar manipulator shown in Fig. Q.2 (a). Assume all mass exists as a point mass at a distal end of each link. [10] 2 Derive

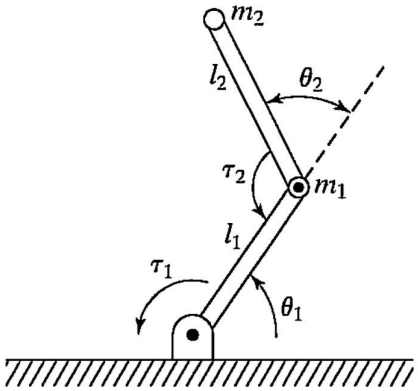

Fig. Q.2 (a)

Q.3(a) Write the name of the planar manipulators shown in Fig. Q.3 (a). [4] 3 Write

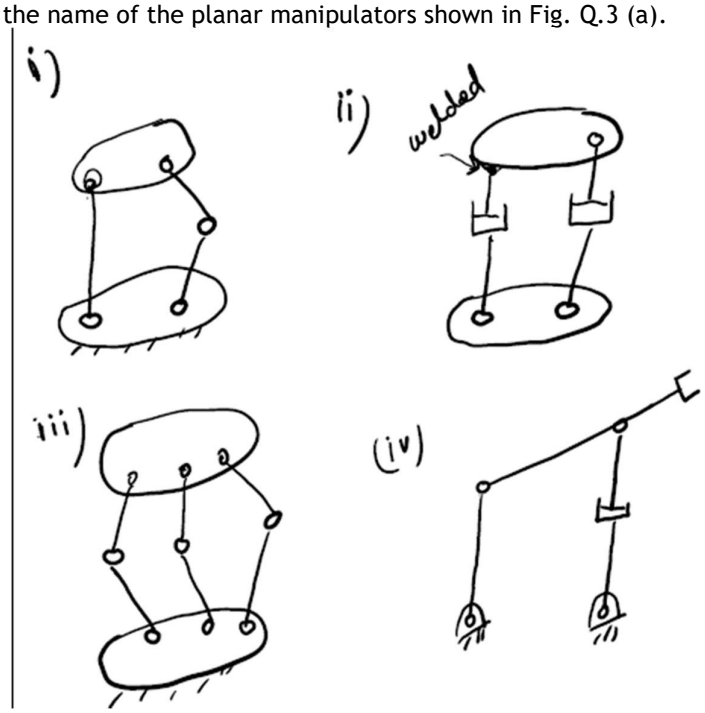

Fig. Q.3 (a)

Q.3(b) Fig. Q.3 (b) shows a planar robot with its associated dimensions and reference frame. Calculate the length of each prismatic actuator for *Px, Py, θ*. Assume suitable parameters such as side of the triangle, distance between origins of frames (1, 2, and 3), etc. [6] 3 Calculate

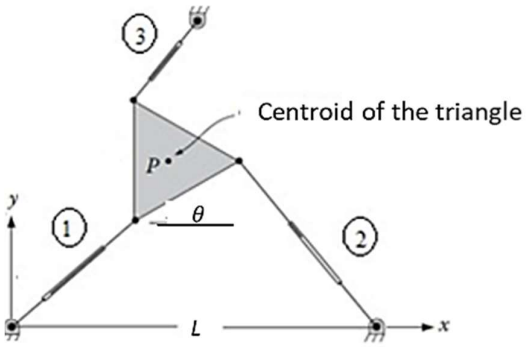

Fig. Q.3 (b)

PTO

Q.4(a)	Fig. Q.4 (a) shows a two-link planar arm with rotary joints. For this arm, the second link is half as long as the first—that is, $l_1 = 2l_2$. The joint range limits in degrees are $0^0 \leq \theta_1 \leq 180^0$ and $-90^0 \leq \theta_2 \leq 180^0$. Draw the approximate reachable workspace (an area) of the tip of link 2.	[5]	4	Draw

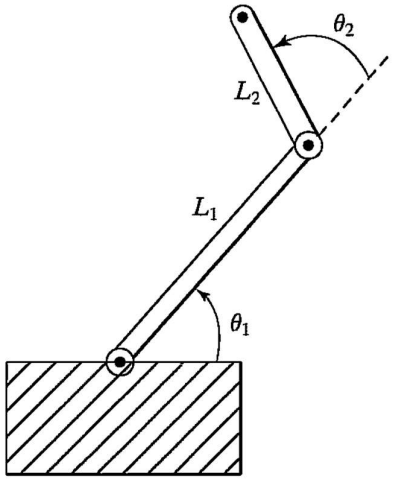

Fig. Q.4 (a)

Q.4(b)	Write a short notes on repeatability and accuracy.	[5]	4	Write
Q.5(a)	A single-link robot with a rotary joint is motionless at θ = 15 degrees. It is desired to move the joint in a smooth manner to θ = 75 degrees in 3 seconds. Find the coefficients of a cubic 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.	[5]	5	Find
Q.5(b)	Determine the motion of the system in Fig. Q. 5(b) if parameter values are $m = 1$, $b = 5$, and $k = 6$ and the block (initially at rest) is released from the position $x = -1$.	[5]	5	Determine

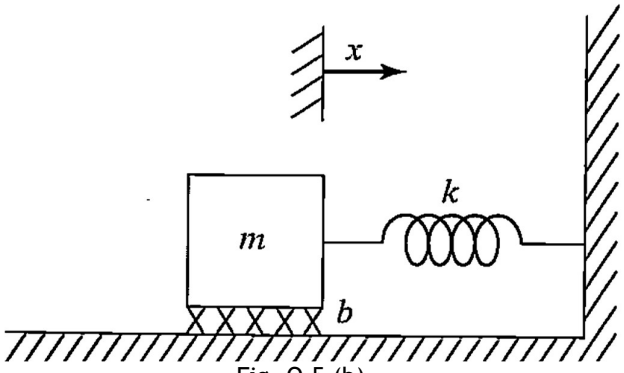

Fig. Q.5 (b)

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