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

CLASS: ME **SEMESTER : II**
BRANCH: AMS **SESSION : SP/18**

SUBJECT: MPE2001 ROBOTICS AND ROBOT APPLICATIONS

TIME: 3 HOURS **FULL MARKS: 60**

INSTRUCTIONS:
1. The question paper contains 7 questions each of 12 marks and total 84 marks.
2. Candidates may attempt any 5 questions maximum of 60 marks.
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.

Q.1(a) In a robot slide mechanism of total length 0.7m. The robot has control memory 10 bit capacity. The mechanical accuracy associated with the moving arm is a random variable with standard deviation 0.1 mm. Determine the control resolution, spatial resolution, accuracy and repeatability. [6]

Q.1(b) The largest axis of a Cartesian coordinate robot has a total range of 750 mm. It is driven by pulley system capable of a mechanical accuracy = 0.25 mm and repeatability = ±0.15 mm. Determine the minimum number of bits required in the binary register for the axis in the robot's control memory [6]

Q.2(a) What are the categories of end effector? Explain working principle of mechanical grippers with the help of neat sketch. [6]

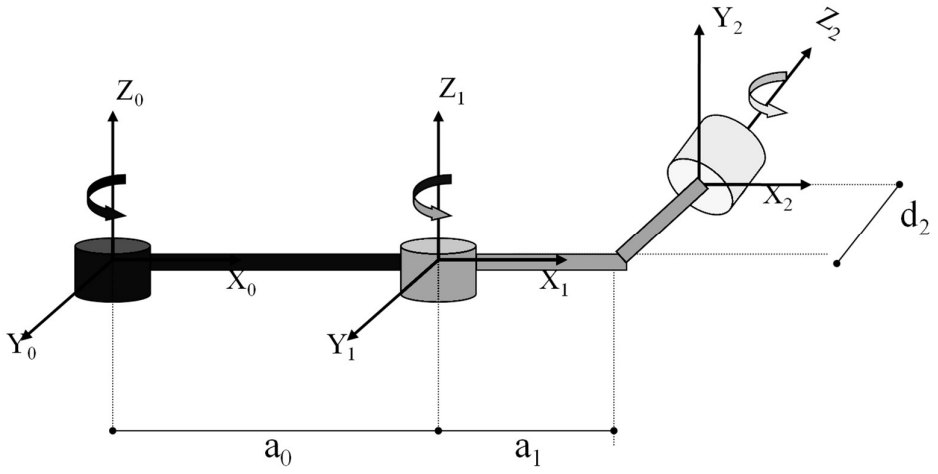
Q.2(b) A card board weighing 5 kg is held in a gripper using two opposing fingers. The coefficient of friction is 0.25. Determine the required griper force, if the factor of safety is 1.5. [6]

Q.3(a) An LL robot has two links of variable length. Assuming that the origin of the global coordinate system is defined at joint J1, determine the following: a) The coordinate of the end-effector point if the variable link lengths are 3m and 5 m. b) Variable link lengths if the end-effector is located at (3, 5). [6]

Q.3(b) Explain Euler angle systems with suitable sketches and table. Derive Eulerian rotation matrices for any one of the system. [6]

Q.4(a) What are the characteristics of the sensors used in robot? What classification of sensors can be applied to robot? How different type of sensor are applied for industrial robot. [6]

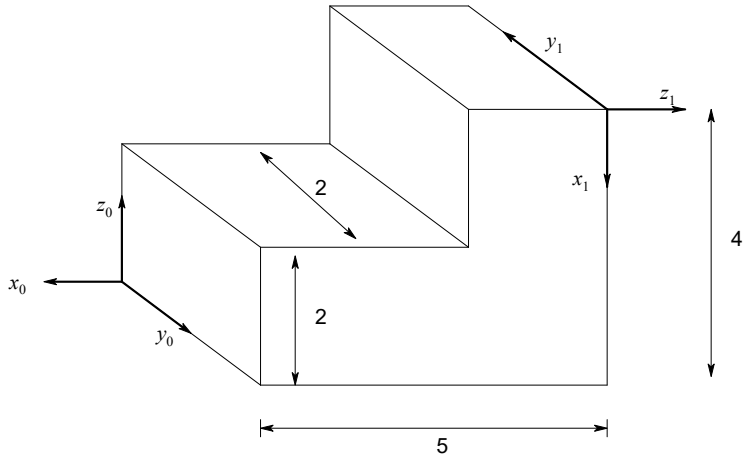
Q.4(b) Calculate the final denavit- hartenberg matrix with DH parameter table for the following figure. [6]



Q.5(a) Two plates of thickness 10 mm are to be arc welded with square butt joint. The length of the plate along which welding has to take place is 50 mm. The welding sequence is triangular weave for the first 10 mm, circular welding for 5 mm and rest is straight weld. The welding torch should start from home position. Write a VAL program in world coordinate. [6]

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Q.5(b) Consider the following diagram: [6]



a) Compute the linear translation between frame {0} and frame {1}.
b) Compute the rotation between frame {0} and frame {1}.
c) Write down the homogeneous transformation ${}^{0}\mathbf{T}_{1}$ (in matrix form) relating frame {0} and {1}.

Q.6(a) The activities are performed sequentially as listed. Every 30 work parts, the cutting tools in the machine must be changed. This irregular cycle takes 3.0 minutes to accomplish. The uptime efficiency of the robot is 97%; and the uptime efficiency of the machine tool is 98%, not including interruptions for tool changes. These two efficiencies are assumed not to overlap (i.e., if the robot breaks down, the cell will cease to operate, so the machine tool will not have the opportunity to break down; and vice versa). Downtime results from electrical and mechanical malfanctions of the robot, machine tool, and fixture. Determine the hourly production rate, taking into account the lost time due to tool changes and the uptime efficiency. [6]

Q.6(b) Describe the procedure for selection and operating of robot for the following application: [6]
a) Assembly
b) Inspection
c) Metal Working Applications

Q.7(a) Explain objectives, key selection criteria and major benefits of robot application in manufacturing. [6]

Q.7(b) Robot reaches and picks part from incoming conveyor and loads into fixture on machine tool. (Time=5.5 sec) Machining cycle (automatic). (Time=33.0 sec) .Robot reaches in, retrieves part from machine tool, and deposits it onto outgoing conveyor. (Time=4.8 sec) Move back to pickup position. (Time=1.7 sec) The activities are performed sequentially as listed. Every 30 workparts, the cutting tools in the machine must be changed. This irregular cycle takes 3.0 minutes to accomplish. The uptime efficiency of the robot is 97%; and the uptime efficiency of the machine tool is 98%, not including interruptions for tool changes. These two efficiencies are assumed not to overlap (i.e., if the robot breaks down, the cell will cease to operate, so the machine tool will not have the opportunity to break down; and vice versa). Downtime results from electrical and mechanical malfanctions of the robot, machine tool, and fixture. Determine the hourly production rate, taking into account the lost time due to tool changes and the uptime efficiency. [6]

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