Birla Institute of Technology and Science, Pilani, K.K.Birla Goa Campus

FIRST SEMESTER 2019-2020
ME G511 MECHANISMS & ROBOTICS
MIDTERM EXAMINATION (Open Book)

DATE: 28/09/2019   Duration: 90min   Maximum Marks:60

1. Solve Questions on main answer sheet and upload the MATLAB codes on moodle.
2. Your answers should be self-explanatory and diagrams should be neatly drawn.

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Question 1: A standard robot is shown in **Figure 1. The maximum limits of rotary joints are mentioned in figure.**

   a) Take a suitable home position and sketch it neatly. Assign link numbers and joint numbers. Assign the frames as per DH algorithm. The final frames should be drawn on the home position sketch. **(Enumeration / steps are not expected)**
   b) Make a table of joint link parameters.
   c) Assume suitable link lengths such that the robot can work in a work volume of maximum 1000 X 1000 X 1000 mm^3. **State your assumptions clearly.**
   d) Prepare the ^0T_n matrix and show your solution with MATLAB for the home position and one more position in the work volume. Write your final numerical answer in the answer- sheet for both positions. **Please upload your code to verify the results as idno_Q1.m file on moodle.**   **(20+ 10+5+5= 40M)**
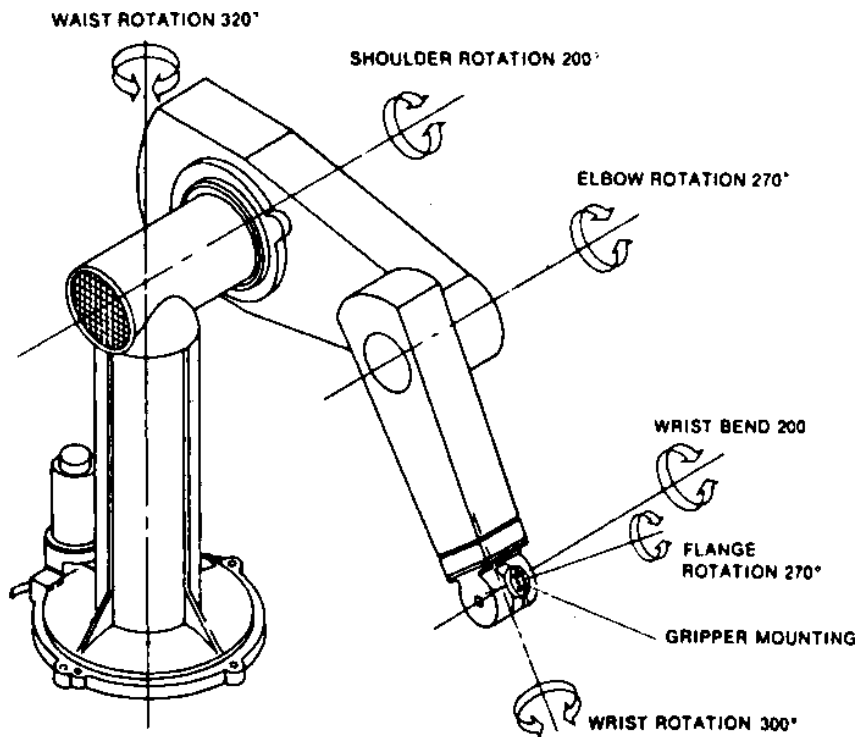

Figure 1

Question 2: The transformation matrices of arm of a robot shown in **Figure 2** are found as follows.

$$T_1^0 = \begin{bmatrix} c_1 & -s_1 & 0 & 0 \\ s_1 & c_1 & 0 & 0 \\ 0 & 0 & 1 & d_1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad T_2^1 = \begin{bmatrix} -s_2 & -c_2 & 0 & a_1 \\ 0 & 0 & -1 & 0 \\ c_2 & -s_2 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad T_3^2 = \begin{bmatrix} c_3 & -s_3 & 0 & a_2 \\ s_3 & c_3 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

The symbols have usual meaning. Assume d_1 as constant.

1. Find the inverse kinematic solution of the given robot arm only. (First 3 joints)
2. State if the inverse kinematic solution exists or not. Also see if there is a multiple solution or not? **[15+5=20 M]**

OR

1. Find the joint velocities of all three joints of the arm.
2. Find the Jacobian of the arm and discuss its singularities. **[6+14=20M]**
   If you are using MATLAB code, please upload your code to verify the results as idno_Q2.m file on moodle.
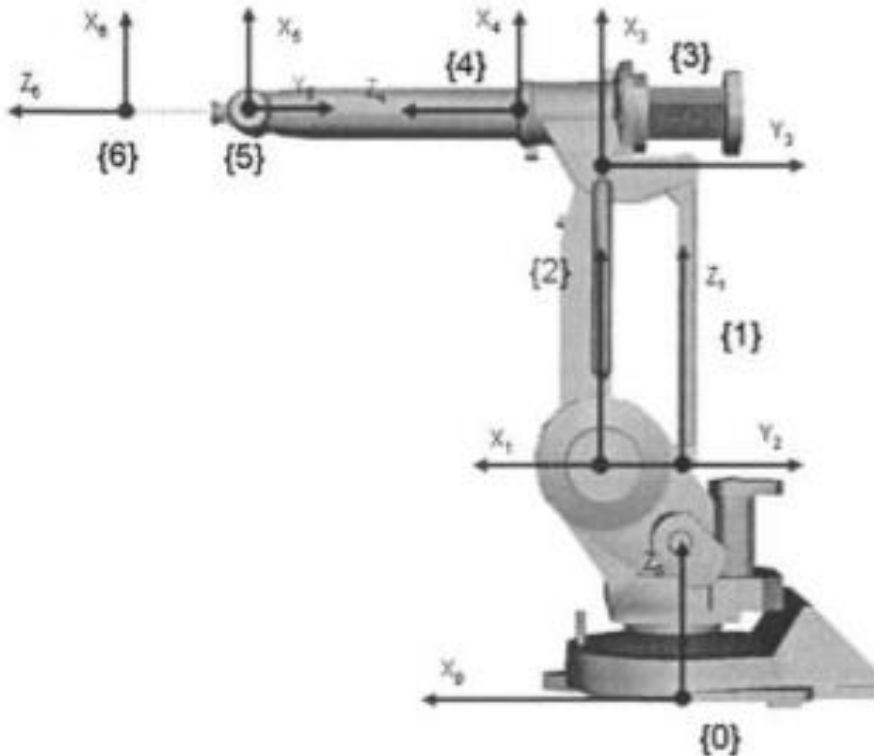

Figure 2