Menoufiya University Faculty of Engineering Shebin El- Kom First Semester(Jan) Examination Academic Year: 2013-2014 Date: 21/1/2014	Minufiya University	Dept.: Production Engineering Year : Post-Graduate Diploma Subject: Robotics Code : PRE 514 Time Allowed: 3 hours Total Marks : 100 Marks
Allowed Tables and Charts: None *Examiner: Dr/ Mohamed Hesham Belal.*		

Answer All The Following Questions:

Question No.(1): [20 Mark]

(a)- Describe briefly the main parts of an industrial robot.

(b)- Robotic systems are generally classified to six groups according to different views. Investigate briefly.

(c)- Compare between the rigid domain and flexible domain for dynamic analysis of performance of industrial robot.

(d)- In practice, six major applications of industrial robot are usually take place in industrial fields. Explain using brief items.

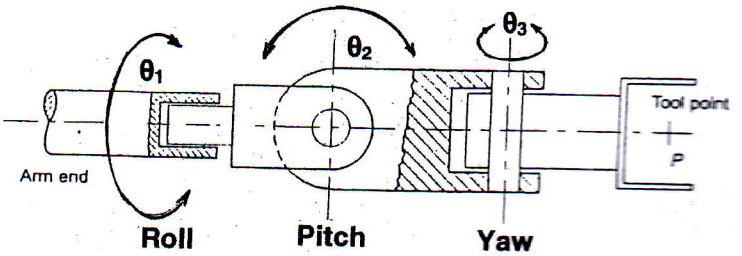
Question No.(2): [20 Mark]

The wrist of a manipulator is represented by three successive rotations (Roll- Pitch- Yaw) denoted by (θ_1, θ_2, θ_3) respectively as shown in Fig.(1) . It is assumed that the arm end-point is stationary and can be considered as the stationary base frame for the wrist.

1)- Obtain the direct kinematic model. 2)- Determine the solution for the three joint variables for a given tool point orientation matrix A_E as follows:

$$A_E = \begin{bmatrix} n_x & s_x & a_x & 0 \\ n_y & s_y & a_y & 0 \\ n_z & s_z & a_z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Fig.(1)



Question No.(3): [20 Mark]

For the 4-DOF- manipulator arm shown in Fig.(2).

1- Assign frames and tabulate the joint-link parameter, (Put $\theta_2 = 90^0$),
2- Determine the transformation matrices relating successive links,
3- Obtain the orientation and position of the end-effector relative to the base,
4- Check the correctness of the results and describe it at the home position,
5- Compute the orientation and position of the end-effector if the joint variable vector is : $q = [60^0 \ 400 \text{ mm} \ 500 \text{ mm} \ 45^0 \ ]^T$ with : $L_1 = 300$ mm, $L_2 = 200$ mm.

Question No.(4): [20 Mark]

Two link planar manipulator in rigid domain, as shown in Fig.(3), connected by the three powered joints for the flexible end-effector.

1)- Derive the general form of the Jacobian matrix,
2)- Derive the equations of motion of the system assuming small vibration about a reference position, and
3)- Calculate the equivalent actuating moments at the joints to keep the manipulator in static equilibrium.

Question No.(5): **[20 Mark]**

A simplified model of commercial robotic manipulator as a single degree of freedom system is shown in Fig.(4). The input is the motor magnetic torque T_m and the output is the angular speed ω_r of the robot arm. No external load torque at the robot arm is presented and the gear ratio is equal (1/r).

1)- **Derive the equations of motions of the system in terms of the motor rotation θ_m and the robot arm rotation θ_r,**

2)- **Compute the deformed natural frequency of the system and hence compute the ratio θ_r / θ_m.**

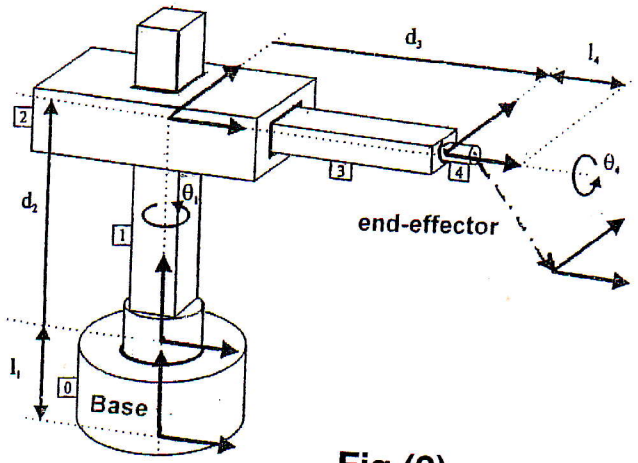


Fig.(2)

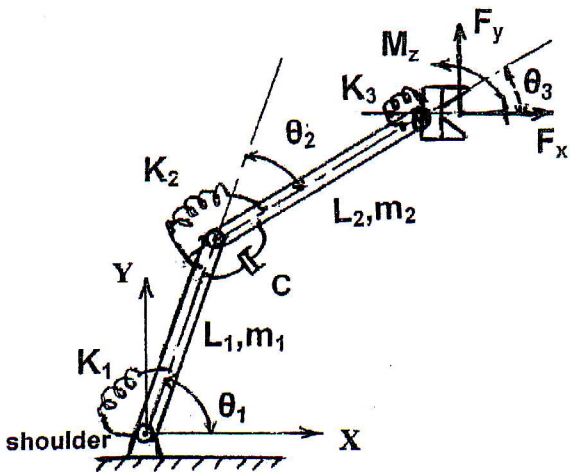


Fig.(3)

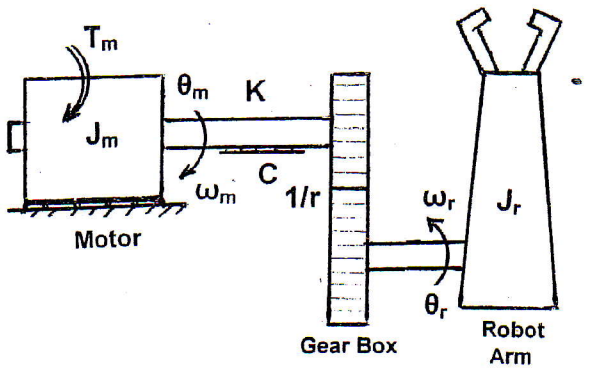


Fig.(4)

With my best wishes

This exam measure the following ILOs												
Question No.	Q1-a	Q1-b	Q1-c	Q1-d	Q2	Q3	Q4	Q5	Q2	Q3	Q4	Q5
Skills	a-2	a-3	a-4	a-3	b-2	b-5	b-2	b-5	c-1	c-2	c-2	c-1
	Knowledge & Understand				**Intellectual**				**Professional**			