Menoufiya University Faculty of Engineering Shebin El- Kom Second Semester(Jun) Examination Academic Year: 2014-2015 Date: 7/6/2015	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): [25 Mark]

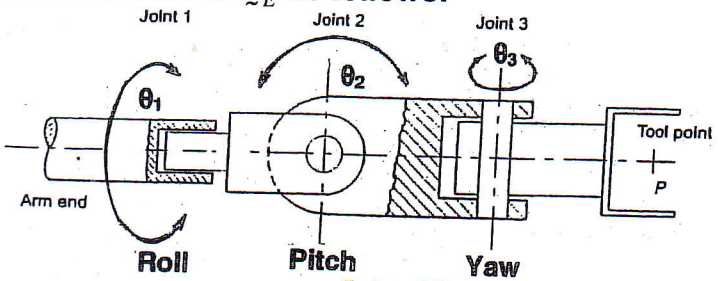
(a)- Robotic systems are generally classified to six groups according to different views. Investigate briefly.

(b)- 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.(2): [25 Mark]

(a)- Explain briefly: the Robot and Robotic- the main parts of an industrial robot.

(b)- For the 4-DOF manipulator arm shown in Fig.(2),and located in its home position.

1- Assign frames and tabulate the joint-link parameter,
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 position of the end-effector if the joint variable vector is :
$q = [\ 45^0\ \ 120^0\ \ 80\ mm\ \ 60^0\ ]^T$ with : $d_1 = 400$ mm, $d_2 = 300$ mm, $d_4 = 200$ mm.

Question No.(3): [25 Mark]

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

(b)- A simplified model of a three axes planar articulated manipulator in rigid domain, as shown in Fig.(3), connected by the three powered joints for the welded 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.(4): [25 Mark]

(a)- From the first principle , Derive the expressions of the mass and stiffness matrices for the single element in terms of the global reference system.

(b)- Fig.(4) shows the single flexible link manipulator of uniform cross-section diameter D, length L, mass per unit volume ρ and Young's Modulus E. The manipulator having flexible joint O_1 of stiffness coefficient (k_F) and payload of mass (m_P) welded at the tip of the link.

1- Write the local mass and stiffness matrices,
2- Derive the global mass and stiffness matrices,
3- Write-down the equation of motion of the manipulator in detail, and
4- Calculate the equivalent joint torque acting at the shoulder joint.

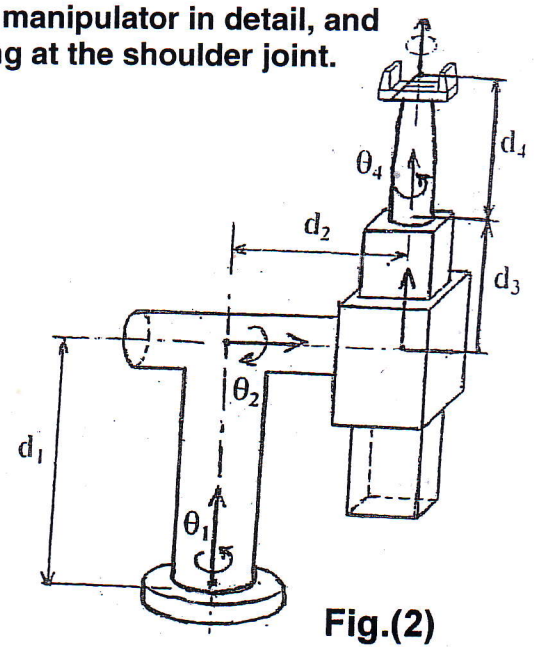


Fig.(2)

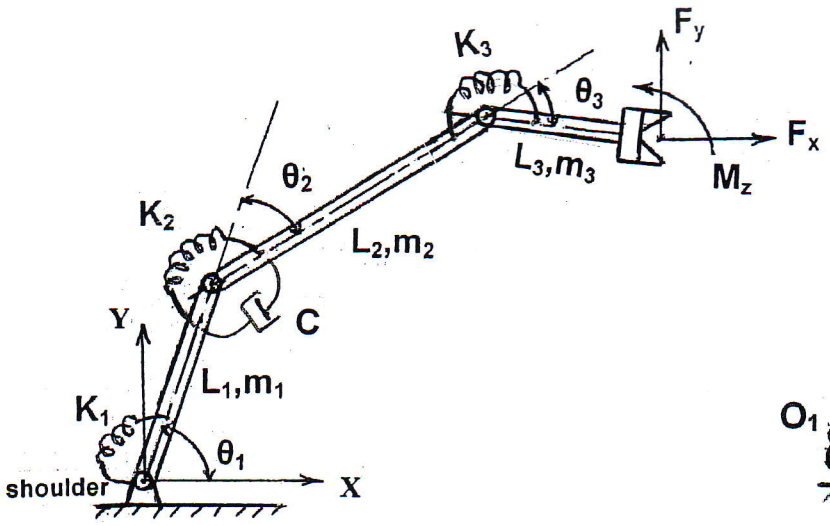


Fig.(3)

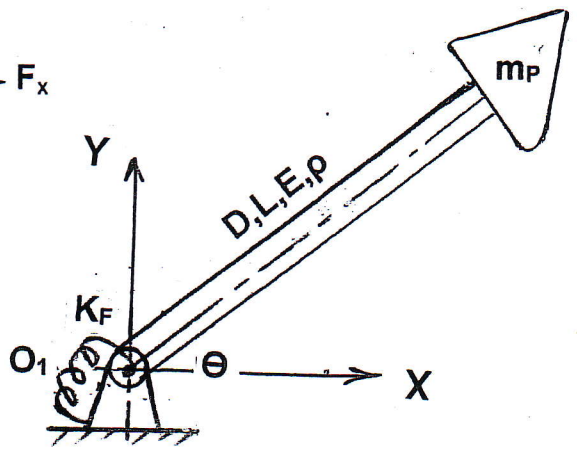


Fig.(4)

With my best wishes

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