Menoufiya University Faculty of Engineering Shebin El- Kom Second Semester(June) Examination Academic Year: 2013-2014 Date: 14/6/2014	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): [25 Mark]

(a)- *[10]* -Define the terms: Robots and Robotics, then explain briefly the main parts of an industrial robot.

(b)- *[15]* -A three axes planar robot of a base frame (B) and of a gripper (G) is utilized to pick up a work piece (W) from the moving conveyor as shown in Fig.(1). The work piece and the end-effector are monitored by camera (C) while the controls of joints are performed based on the parameters defined in the base frame. If at certain instant the following matrices are:

$$A_B^C = \left[\begin{array}{ccc|c} 0.5 & 0 & 0.866 & 5 \\ 0 & 1 & 0 & 0 \\ -0.866 & 0 & 0.5 & 3 \\ \hline 0 & 0 & 0 & 1 \end{array}\right], \quad A_C^W = \left[\begin{array}{ccc|c} 0.866 & 0 & 0.5 & 2 \\ 0 & 1 & 0 & 0 \\ -0.5 & 0 & 0.866 & 4 \\ \hline 0 & 0 & 0 & 1 \end{array}\right], \quad A_C^G = \left[\begin{array}{ccc|c} 0.707 & 0 & 0.707 & 20 \\ 0 & 1 & 0 & 0 \\ -0.707 & 0 & 0.707 & 30 \\ \hline 0 & 0 & 0 & 1 \end{array}\right]$$

Compute and explain the physical meaning of the H.T.M. representing the orientations and locations of the moving work piece (W) : 1- w.r.t. the base frame (B), and 2- w.r.t. the gripper (G).

Question No.(2): [25 Mark]

(a)- *[8]* -Robotic systems are generally classified to six groups according to different views. Investigate briefly.

(b)- *[17]* - 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.

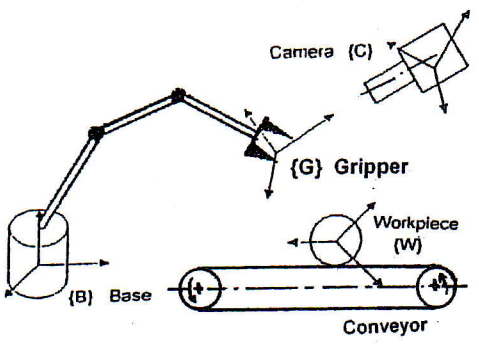

Fig.(1)

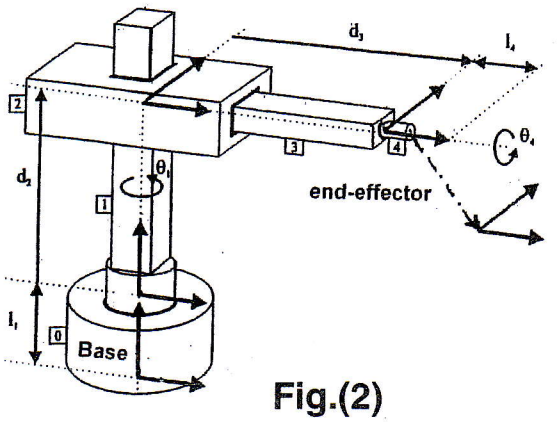

Fig.(2)

Question No.(3): [25 Mark]

(a)- *[8]* - Compare between the rigid domain and flexible domain for dynamic analysis of performance of industrial robot.

(b)- *[17]* -Two link planar manipulator in rigid domain, as shown in Fig.(3), connected by the three powered joints for the flexible end-effector.

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

3)- If the position of the end-effector is given by $P = [P_x \ P_y]^T$, Find the magnitude of angle θ_2 in terms of the link length and the position of the end-effector.

Question No.(4): [25 Mark]

(a)- *[8]* -List the features of the basically three types of power sources for robots.

(b)- *[17]* - A 3- DOF robotic sewing system consist of cloth panel of mass (m_s), robotic hand of mass (m_h) and a robot system formed from of mass joined (m_r) with robotic hand of mass moment inertia (J_r). Applied force (F) by a feeder element on the cloth panel and driving torque (T_r) acting on robotic hand is shown in Fig.(4). The flexibility of various elements is modeled by discrete springs of constants (K_c, K_r). The energy dissipation is modeled by a linear viscous damping constant (C) as indicated.

Given that: $x_r = r\,\varphi_r$, m_s, m_h, m_r, J_r , K_c, K_r, C, F, T_r.

1- Derive the equations of motion and hence express the eigenvalue problem.

2- Is the system has rigid body mode? Prove your answer. And then sketch the expected mode shapes.

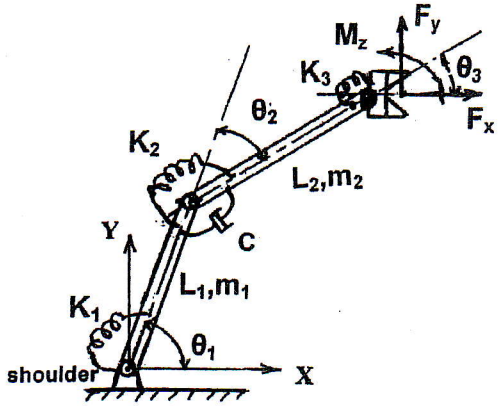

Fig.(3)

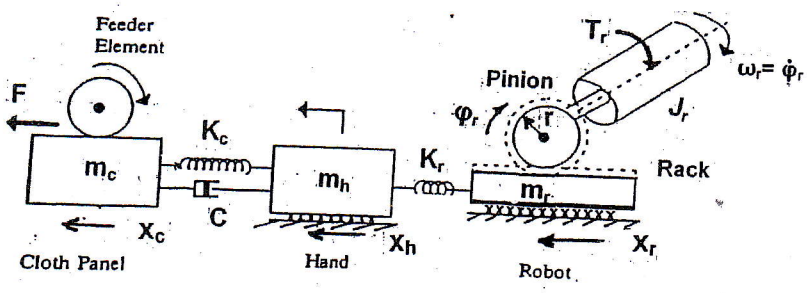

Fig.(4)

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
Skills	a-2	a-3	a-4	a-2	b-2	b-5	b-2	b-5	c-1	c-2	c-1	c-2
	Knowledge & Understand				Intellectual				Professional			