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: Planar Kinematics of Multiple Rigid Bodies Code : BES521 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]

For the 3-DOF (RRP) SCARA arm of a manipulator shown in Fig.(1) .

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 orientation and position of the end-effector if the joint variable vector *Is* $q = [60^0 \ \ 120^0 \ \ 20 \text{ cm}]^T$ with $d_1 = 10$ cm, $a_1 = 50$ cm, $a_2 = 30$ cm.

Question No.(2): [20 Mark]

Derive the Hamilton's canonical equations of the shown system in Fig.(2). All data are given.

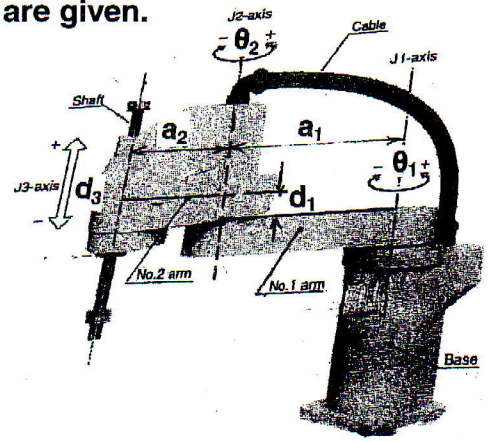

Fig.(1)

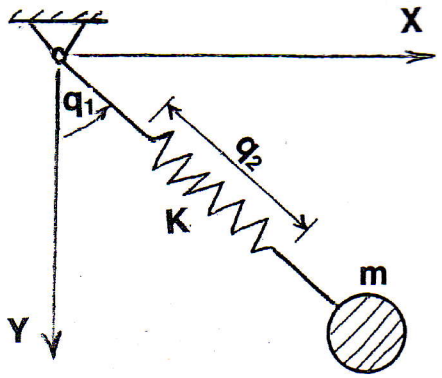

Fig.(2)

Question No.(3): [20 Mark]

A cantilever of flexural rigidity EI, length L and mass per unit length ρ performs a transverse vibration. If the free end of the beam is fastened to a motor of mass m as shown in Fig.(3), derive the frequency equation of the present continuous system.

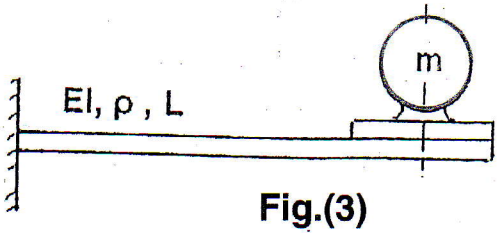

Fig.(3)

Question No.(4): [20 Mark]

Consider the stepped bar shown in Fig.(4), when its free end is subjected to the axial load F = 500 N. The bar has the following data:

$E_1 = E_2 = 2x10^{11}$ N/m^2, $\rho_1 = \rho_2 = 7.8x10^3$ kg/m^3

$A_1 = 2A_2 = 20$ cm^2, $L_1 = L_2 = 80$ cm.

Use the finite element technique to obtain the natural frequencies and plot the corresponding mode shapes.

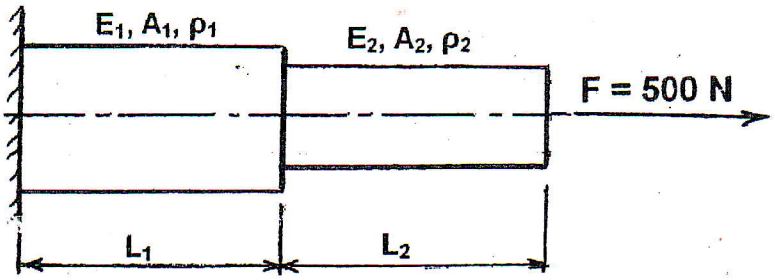

Fig.(4)

Question No.(5): [20 Mark]

A marine propulsion is shown in Fig.(5). For the analysis of torsional vibration, the installation can be modeled as the system shown, where the mass moments of inertia for the engine, gearbox, and propeller taken about the axis of rotation are I_E, I_G, and I_P respectively, and the stiffnesses of the gearbox and propeller shafts are K_G and K_P respectively. If damping can be neglected, the numerical values are:

$I_P = 5I_G = 2.5\ I_E = 2.0$ kg.m^2, $K_G = 3\ K_P = 360$ kN.m/rad,

(a)- Derive in matrix form the differential Equations governing the torsional vibration of the system,

(b)- State whether the system has rigid body mode. Give reasons.

(c)- Calculate the natural frequencies and corresponding mode shapes, and give the position of the node for each frequency.

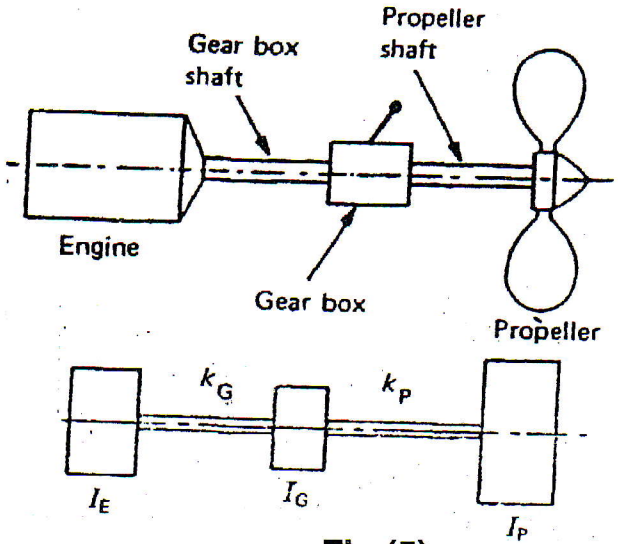

Fig.(5)

With my best wishes