Menoufia university
Faculty of Engineering
Mechanical Vibrations
Time: 3 hours

جامعة المنوفية

Mech .Design & Prod .Eng .Dept.
Date: June 2014 -2015
Post Graduate Master Level 500
Total marks: 100

Problem (1): (20 Marks)

I)- Use the finite element technique to find
(a) the nodal displacements, strain and stress induced in the axially loaded stepped bar shown in Fig.1-a
(b) Formulate the eigen-value problem of the system.
A3=2A2=4A1=16cm2. ρ1=ρ2=ρ3=7.8x103 kg/ m3

II) Determine the global stiffness matrix for a two element model for the system shown in Fig.1-b .

Problem (2): (20 Marks)

A precision grinding machine (fig.2) is supported on an isolator that has a stiffness of 1 MN/m and a viscous damping constant of 1 KN-s /m . The floor on which the machine is mounted is subjected to a harmonic disturbance due to the operation of an unbalanced engine in the vicinity of the grinding machine . Find the maximum acceptable displacement amplitude of the floor if the resulting amplitude of vibration of the grinding wheel is to be restricted to 10^{-6} m .Assume that grinding machine and the wheel are one rigid body of weight 5000 N.

Problem (3): (20 Marks)

For the shown autombile determine the natural frequencies and natural modes of its linear and angular motions. Given that:
m_o= 1500 kg , J_o= 2000 kg.m^2 , L_f =1.5 m , L_r =1.6 m ,
k_f = 36 KN/m , k_r = 40 KN/m .

If the autombile pulls a trailer of mass 400 kg as shown in Fig.b, determine the natural frequencies and natural modes of the system, knowing that the stiffness coefficient of the hitch is 150 KN/m.

Problem (4) (20 Marks)

a-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.4 derive the frequency equation of the present continuous system.

(b)- If (ρ = 0), the beam becomes one degree of freedom system, the motor having a mass of 300 kg and an unbalance of 2 kg.cm. The beam is observed to vibrate with large amplitudes at the operating speed of 1500 r.p.m of the motor. It is proposed to add a vibration absorber to reduce the vibration of the beam. Determine the mass and stiffness of the absorber needed in order to have the lower frequency of the resulting system equal to 75% of the operating speed of the motor.

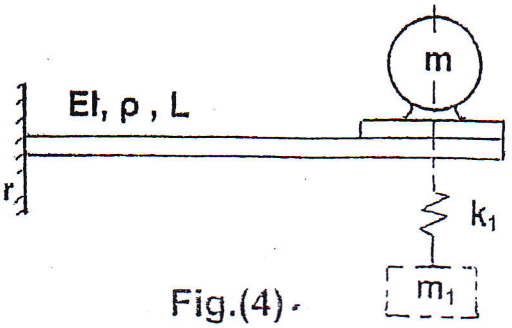

Fig.(4).

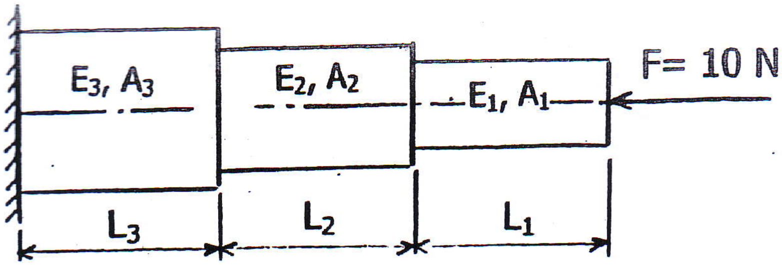

Fig 1-a

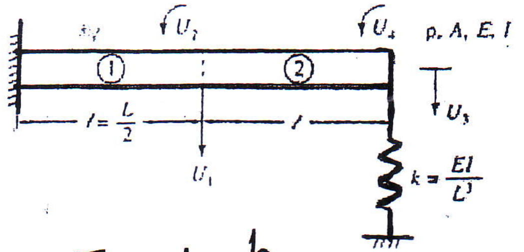

Fig 1-b

Problem. 5 **(20 Marks)**

A marine propulsion is shown in Fig. 5. For the analysis of torsional vibration, the mass moments of inertia for the gearbox and propeller taken about the axis of rotation are $J_1 = 1.75$ J, $J_2 =$ J, and $J_P =$ J respectively, and the stiffnesses of the gearbox and propeller shafts are K_G = 5K and K_P = 4K respectively. If the gear ratio is (z_1/z_2 = 0.5), damping can be neglected and the moment : $M(t) = M_0 \sin \omega t$ acts on the first gear.

(1)- Derive in matrix form the equations governing the torsional vibration of the system

(2)- Determine the natural frequencies and corresponding mode shapes, and sketch these modes, then check the correctness of the results,

(3)- Find the proper value of J_P of the propeller such that the first gear J_1 becomes at rest,

(4)- If the propeller is very large and modeled as built in, find the new natural frequency.

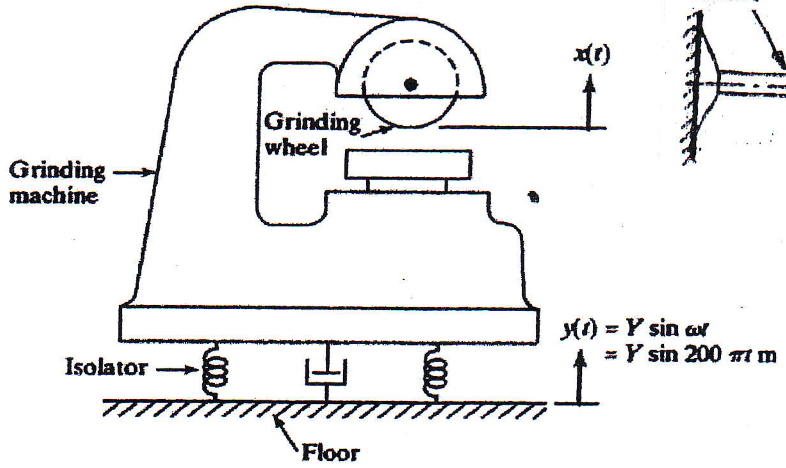

Fig. 2

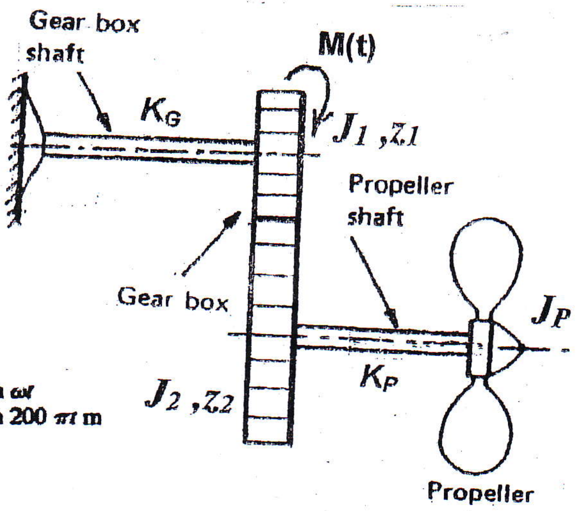

Fig. 5

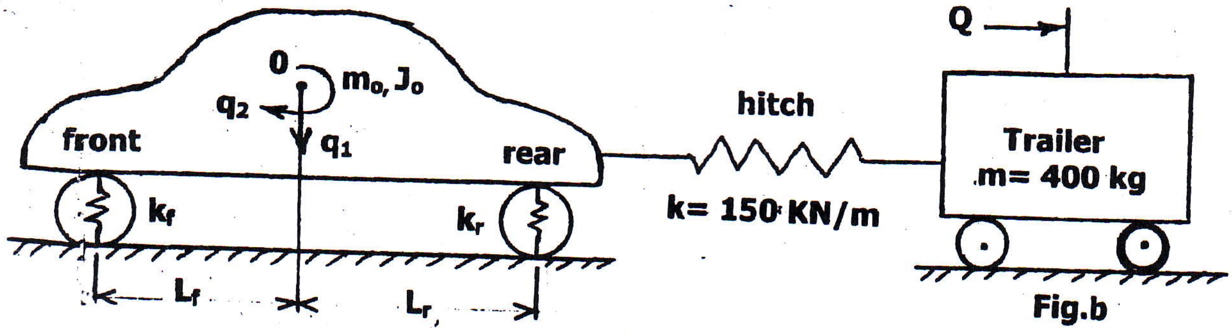

Fig. 3

With our best wishes

This exam measures the following ILOs															
Question Number	1-(a-c)	1-d				4-a	4-b	3-a	3-b	2,6	3-1'	3-11			
Skills	a-1	a-19				b17-1	b17-2	b17-1	b17-2	b17-2	c1	c1			
	Knowledge &Understanding Skills					Intellectual Skills					Professional Skills				