Menoufia University **Faculty of Engineering** **Depart. of Prod. Eng. & Mechanical Design** **Final Exam (Prod. & Design).**	Minufiya University	**Subject: Mechanical Vibrations** **Diploma level (500) PRE513** **Academic year: 2017 / 2018** **Time allowed: 3 Hours** **Date:3/1/2018**

Answer the following questions

Q1: (25 Marks)

Determine each of the following:

1. The equivalent mass of the lever shown in figure (1-a) at point (A) if:
   $m_1 = m_2 = m_3 = 5\ Kg$ *and* $l_1 = 5, l_2 = 10, l_3 = 15\ m.$
2. The equivalent moment of inertia of the rack and pinion arrangement shown in figure (1-b) if:
   $m = 20\ Kg,\quad R = 200mm$ *and the radius of gyration* $= R.$
3. The equivalent stiffness of the boom shown in figure (1-c) if:
   Young's modulus of material $E = 2.1x10^{11}\ N/m^2$
   Lengths $l_1 = l_2 = l_3 = 3\ m.$
   Cross sectional areas $A_1 = 20\ cm^2,\quad A_2 = 10\ cm^2,\ A_3 = 5\ cm^2$

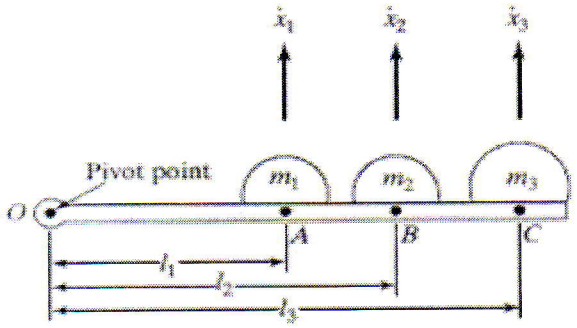

Figure (1-a)

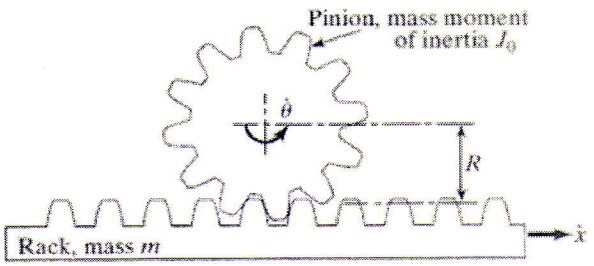

Figure (1-b)

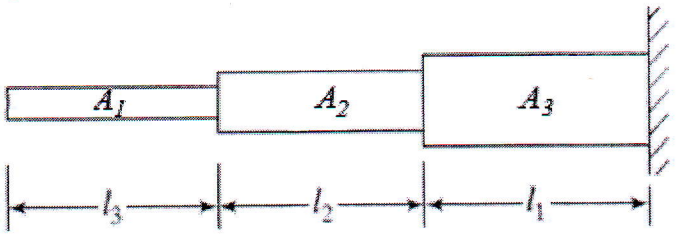

Figure (1-c)

Q2: (25 Marks)

If the mechanical system shown in figure (2) is subjected to a periodic force in the form: $f(t) = \frac{a_o}{2} + \sum_{j=1}^{\infty} a_j \cos(j\omega t) + \sum_{j=1}^{\infty} a_j \cos(j\omega t)$.

Determine the equation of the time response, assuming zero initial conditions.

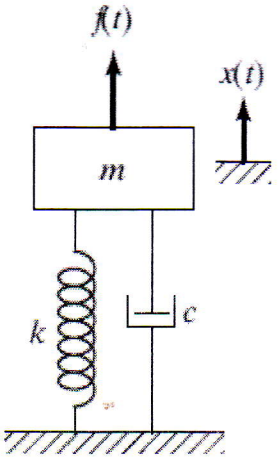

Figure (2) Mechanical System.

Q3: (25 Marks)

State the equations of motion of the system shown in figure (3).

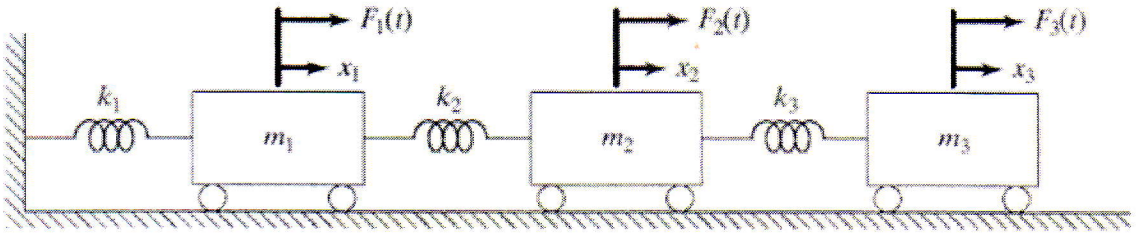

Figure (3) Un-damped Mechanical System.

If the masses $m_1 = m_2 = m_3 = m$ and the stiff nesses $k_1 = k_2 = k_3 = k$, find out the natural frequencies and mode shapes of the given system.

Q4: (25 Marks)

An electric motor of mass M, mounted on an elastic foundation, is found to vibrate with a deflection of 0.15 m at resonance. The unbalanced mass of the motor is 8% of the mass of the rotor and the damping ratio of the foundation is $\zeta = 0.25$, determine:

a. the eccentricity of the unbalanced mass (e),
b. the peak deflection of the motor when the frequency ratio varies from resonance, and
c. the additional mass to be added uniformly to the motor if the deflection of the motor at resonance is to be reduced to 0.1 m.

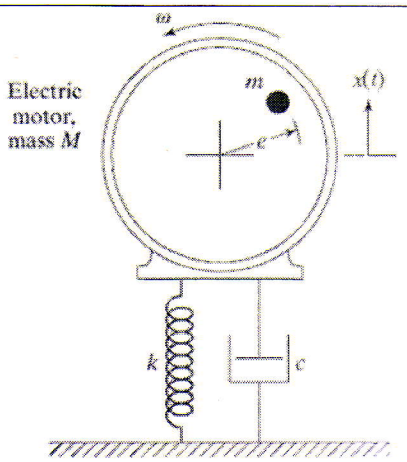

Figure (4)

Best Wishes