Menofia University
Faculty of Engineering Shebien El-kom
Basic Engineering Science Dept.
First semester Examination, 2016-2017
Date of Exam: 31 / 5 / 2017

Subject: Principles of Mechanical Vibrations.
Code: BES 516
Year: Master (Grade 500).
Time Allowed: 3 hrs.
Total Marks: 100 Marks

Answer the following questions

Question 1 (30 marks)

(A) Write short notes on:

i) Basic concepts of vibration

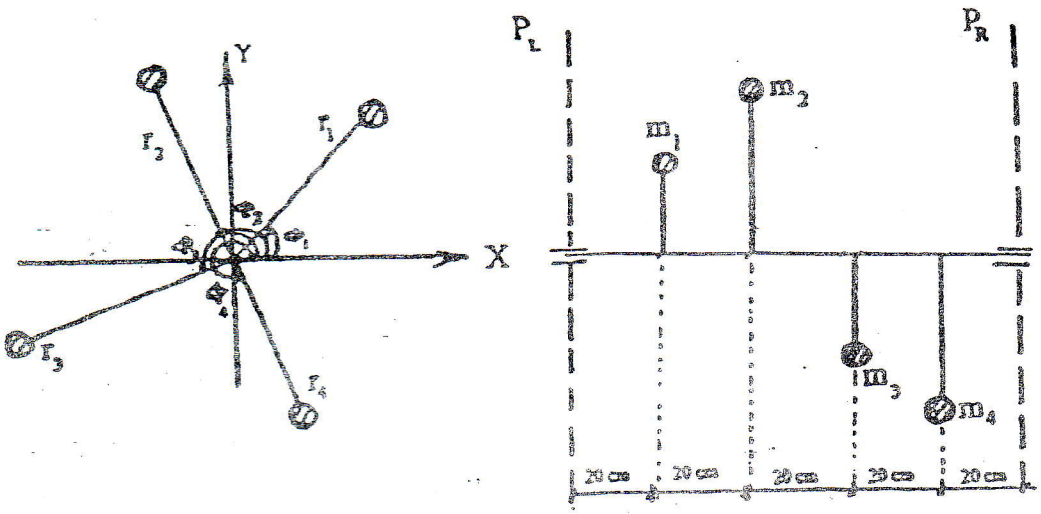
ii) Classification of vibration

iii) Mass (inertia) elements

iv) Damping elements

v) Harmonic motion

(B) A shaft with four unbalanced masses should be completely balanced by two masses situated on the radius r_0 in two respective planes δ_L and δ_R as shown, find these masses m_L and m_R as well as their angular locations $\emptyset_L$ and $\emptyset_R$.



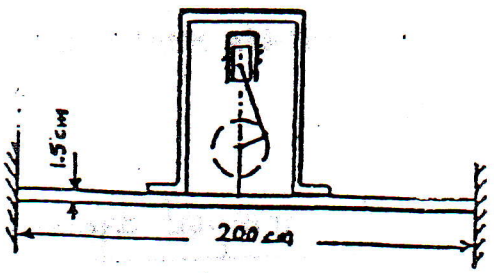
Question 2 (40 marks)

(A) A reciprocating engine, weighting 75 kg, is mounted at middle of a steel plate of thickness 1.5 cm, width 40 cm and length 200 cm, clamped along two edges as shown in figure. If $E = 2.114\times10^6\ kg/cm^2$ during the operation of the engine, the plate is subjected to a harmonic unbalanced vertical force:

$$F(t) = 1000 \sin 80\, t \ N$$

i) Determine the steady-state amplitude and if the damping is introduced with damping factor 0.3 to the system, determine the steady state amplitude,

ii) In the absence of the damping, design the proper undamped dynamic absorber to be fitted to the system in order to obtain zero amplitude (r_1) of machine, and also the corresponding amplitude (r_2) in this case, taken into the account the mass ratio is $1/3$.

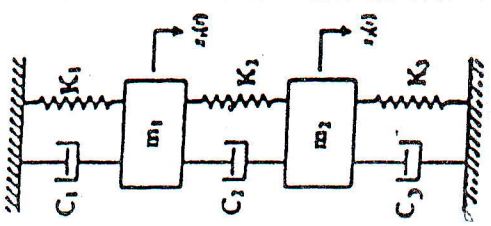


(B) The shown system in figure performs small vibration about its stable equilibrium position.

Given $K_1 = K_2 = 0.5\, K_3 = 10.000\ N/m$, and $C_1 = C_2 = C_3 = 2000\ N - s/m$, $2\, m_1 = m_2 = 2\ kg$, Determine:

i) Derive the equations of motion of the system,

ii) Determine the natural frequencies and mode shapes, and sketch these modes, then check the correctness of the results.



Question 3 **(30 marks)**

(A) The governing equation of a uniform Bernoulli-Euler beam under pure bending resting on fluid layer under axial force is:

$$EI\frac{\partial^4 v}{\partial x^4} + p\frac{\partial^2 v}{\partial x^2} + k_f v + F(x,t) = 0, \quad 0 \le x \le L_e.$$

with boundary conditions (Clamped-Simply supported):

$$at\ x = 0, \qquad W(x) = \frac{dW(x)}{dx} = 0$$

$$at\ x = L_e, \qquad W(x) = \frac{d^2W(x)}{dx^2} = 0$$

Solve the Riccati equation problem using the adomian decomposition method (ADM). Then compared the results with exact solutions.

(B) The governing equation of a non-uniform Bernoulli-Euler beam under axial force resting on fluid layer is:

$$\rho A\frac{\partial^2 v}{\partial t^2} + p\frac{\partial^2 v}{\partial x^2} + k_f v + \frac{\partial^2}{\partial x^2}\left(EI\frac{\partial^2 v}{\partial x^2}\right) = 0, \quad 0 \le x \le L_e.$$

For any combination of the clamped and simply supported conditions at the two ends

Solve using the adomian decomposition method (ADM).

This exam measures the following ILOs											
Question Number	Q1-1	Q1-2	Q1-3	Q1-4	Q3-1,2,3	Q4-1,2,3			Q2-a	Q2-b	
Skills	Q1-5										
	Knowledge &understanding skills				Intellectual Skills				Professional Skills		

With my best wishes

Dr. Eng. Ramzy M. Abumandour