Menoufiya University
Faculty of Engineering

Minufiya University

Prod. Eng and Mech. Design Dep.

Shebin EL-Kom

Final First Term Examination
Academic Year: 2016-2017
Date: 8-1-2017

Subject: Vibration of Machines
Code: PRE 617
Time Allowed: 3 hours
Total Marks:100 Marks

This exam measures ILOS no:($a_1, a_{13}, b_2, b_6, b_{17}, c_1, c_3$)

Answer all the following Questions:

Problem (1): (20 Marks)

Explain the following parameters and illustrate your answer by Using the experimental and Finite element analysis:-

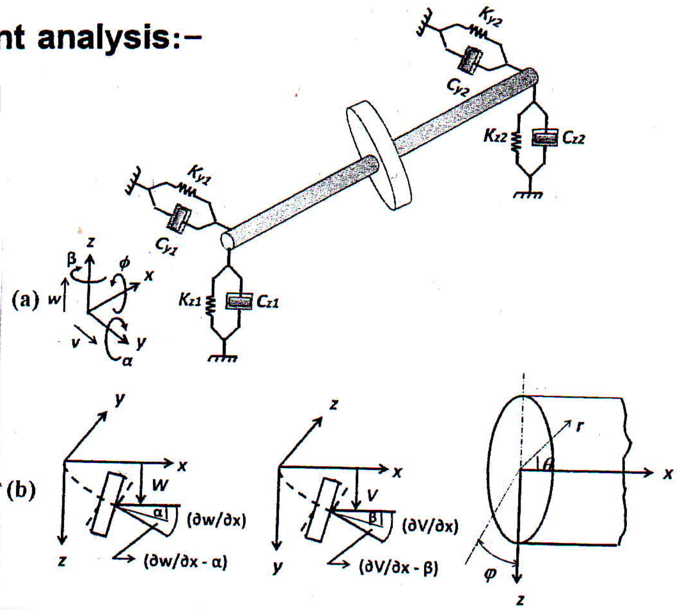
A- Rotor – bearing system model

i- Strain energy

ii- Kinetic energy

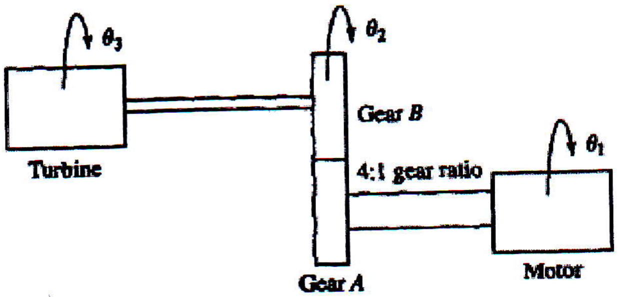
B- Quadratic eigenvalue problem

$$-\Omega^2 \lceil M \rfloor + I\Omega \lceil C \rfloor + \lceil k \rfloor \quad X = \lceil 0 \rfloor$$



Problem (2): (20 Marks)

Derive the differential equations governing the torsional oscillations of the turbomotor of Fig. The motor operates at 800 rpm and the turbine shaft turns at 3200 rpm.



Moments of inertia:
Motor 1800 kg · m²
Turbine 600 kg · m²
Gear A 400 kg · m²
Gear B 80 kg · m²

Turbine shaft
$G = 80 \times 10^9$ N/m²
$L = 2.1$ m
$d = 180$ mm

Motor shaft
$G = 80 \times 10^9$ N/m²
$L = 1.4$ m
$d = 305$ mm

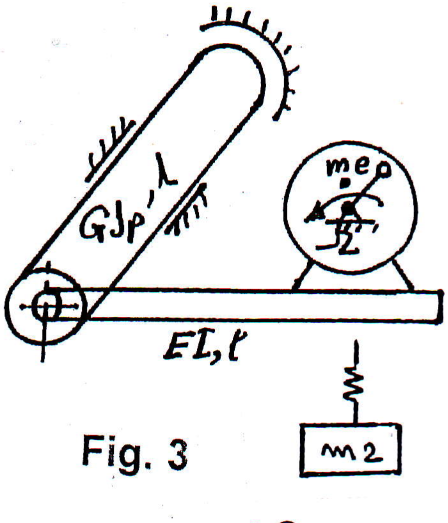


Fig. 3

Problem (3):

b- A rotor of mass 10 kg and unbalance mo. e =0.01 kg .m of speed Ω =5 sec-1 is mounted at the end of a set of a two mass-less connected rods of equal length L= 1 m as shown in Fig . .If the torsion rigidity of the first rod GIp =1258 N.m2 and the flexural rigidity of the second rod EI =1625 N.m2 .Design the proper dynamic absorber such that the mass ratio

Problem 4): **(20 Marks)**

Determine the upper and Lower bounds of the fundamental frequency of the system shown in Fig.1 by using:

(c) Rayleigh,s method
(d) Dunkarly,s formula
(e) Bound method

Problem (5 : **(15 Marks)**

1- Express various forms types of Dunkarley,s on the multi-degree system.
2-Estimate the fundamental natural frequency of the beam shown in Fig.2
All data are given

Problem (6 : **(15 Marks)**

Find the eigenvalues and eigenvectors of the matrix using Jacobi method.

$$[D] = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 2 & 2 \\ 1 & 2 & 3 \end{bmatrix}$$

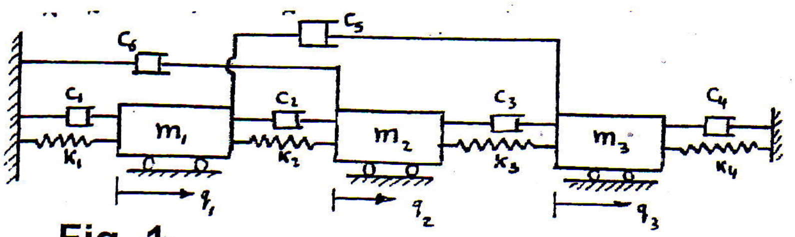


Fig. 1

Letting $m_1 = m_2 = m$ and $m_3 = 2m$, we obtain the inertia matrix

$$\underset{\sim}{m} = \begin{bmatrix} m_1 & 0 & 0 \\ 0 & m_2 & 0 \\ 0 & 0 & m_3 \end{bmatrix} = m \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 2 \end{bmatrix}.$$

If $k_1 = k_2 = k_3 = k$ and $k_4 = 2k$, the stiffness matrix takes the form,

$$\underset{\sim}{k} = \begin{bmatrix} 2k & -k & 0 \\ -k & 2k & -k \\ 0 & -k & 3k \end{bmatrix} = k \begin{bmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 3 \end{bmatrix}.$$

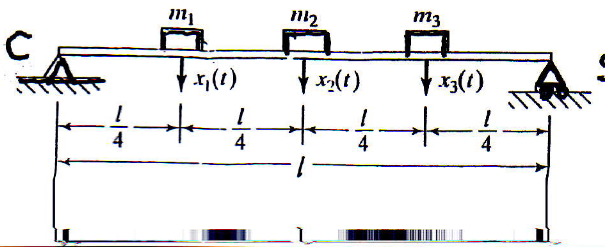


Fig. 2