Menoufiya University
Faculty of Engineering

Shebin EL-Kom
Final First Term Examination
Academic Year: -2017/2018
Date of Exam: 19/5/2018

Prod. Eng and Mech. Design Dep.

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

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)

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

(c) Rayleigh,s method

(d) Dunkarly,s formula

(e) Bound method

Problem (3): (20 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.

All data are given

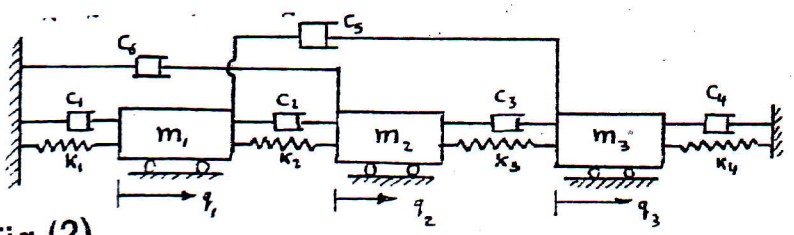


Fig.(2)

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,

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

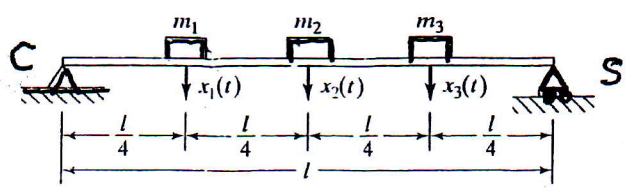


Fig.(3)

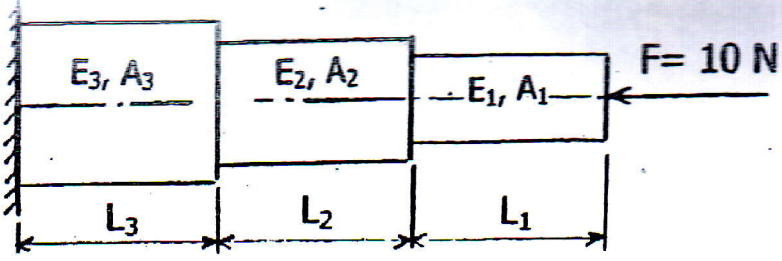


Fig.(1) - a

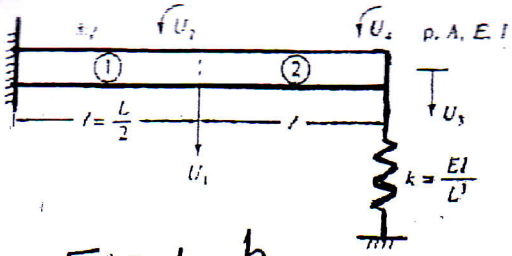
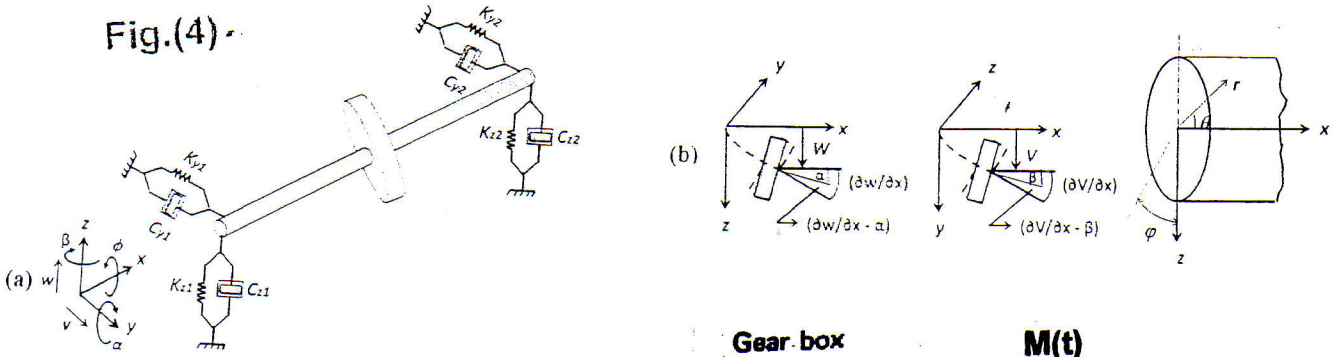


Fig 1-b

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

A) Write down the equations of motion of the shown system (rotor, disc and bearing).
B) Express the mass and stiffness matrices.
C) Calculate the natural frequencies and mode shapes of the system.

Fig.(4) -



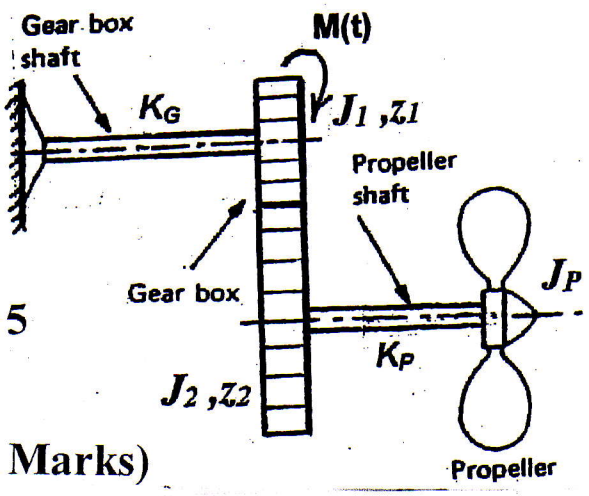


Fig. 5

Problem. 5 **(20 Marks)**

For the analysis of torsional vibration system, shown in Fig .The mass moments of inertia for the gearbox and propeller are J1=1.75J, J2=J, and Jp=J respectively, and the stiffness of the gearbox and propeller shafts are KG=5K and Kp=4K respectively ,if the gear ratio is Z1/Z2=0.5, and the moment: M(t)=Mo sin ω t acts on the first gear. 1-Derive in matrix form the equations of torsional system.2-determine the natural frequencies and mode shapes ,and sketch these modes, then check of the results 3-Find the proper value of Jp of the propeller if the first gear J1 becomes at rest,4-If the propeller is very large and modeled as built in find the new natural frequency.

This exam measures the following ILOs							
Question Number	1-a	1-b	2-a	2-b	2-c	3	2
Skills	a-1	a-19	b 17-1	b17-2	b17-1	c 1	c 2
	Knowledge & Understanding Skills		Intellectual Skills			Professional Skills	