EL-MANSOURA UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENG.DEPT.

DATE: 11/9/2013

VIBRATION OF STRUCTURES
MASTER DEGREE
TIME ALLOWED: 3.0 HOURS.

Question 1: 20= (5+4+3+8) points

1)Put right symbol (✓) or wrong symbol (✗) for the following statements ,explaining why , and giving your comment.

i. All real structures posses an infinite number of degrees of freedom.

ii. The derivation of a simple mathematical model to represent of a real structure is not easy.

iii. The effect of damping may be ignored if only resonance frequencies are needed.

vi. Considering an infinite number of degrees of freedom in the analysis of real structure leads to elaborate equations of motions.

v. All real structures dissipate energy when they vibrate.

2) For random function x(t) , write the mean value, the variance, the R.M.S., the standard deviation, the Normal and Rayleigh distributions, spectral density function , and Narrow-Band and wide-band random processes.

3)Complete the missing words:

- Types of damping are -----,------,and ------
- The causes of structural vibrations are -----, and -----.
- The response of the structure to exication depends on ----, and -----

4)Write as you can about free damped vibrations.

Question 2: (15) points

Find the period of vibration in case of no-damping and with 15% damping for the frame shown in Fig.(1).

E= 2000 t/cm2 , I = 0.001 m4.

KS1= 100 t/m, KS2 = 150 t/m

KS3= 200 t/m, KS4 = 250 t/m

KS5= 200 t/m

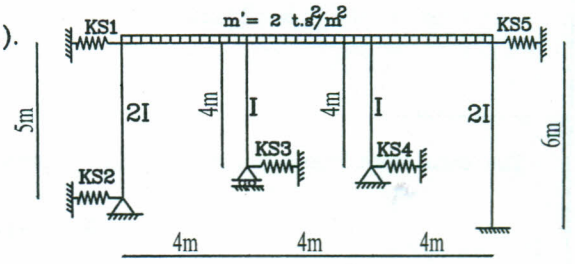


Fig.(1)

Question 3: 25 points

For the shear building frame shown in Fig.(2) , use the static condensation method to determine the transformation matrix and the reduced stiffness matrix and mass matrix corresponding to the elimantion of the coordinates y1, y3, and y5 as indicated in the figure , and then determine the natural frequencies and corresponding normal modes for the reduced system.

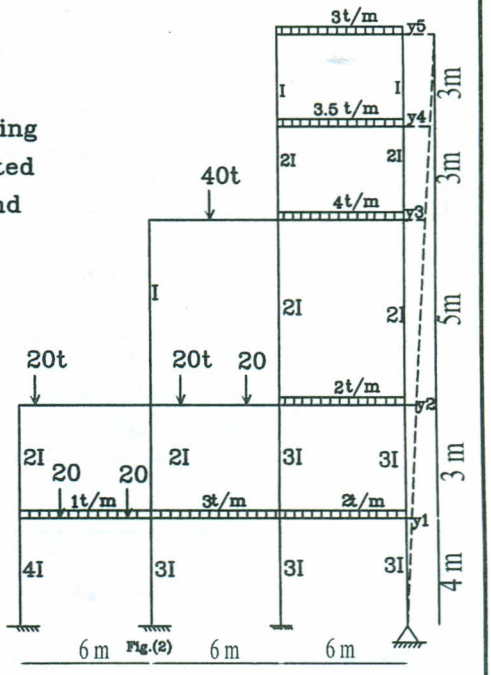
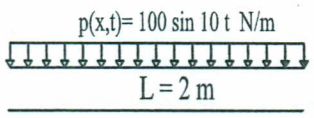


Fig.(2)

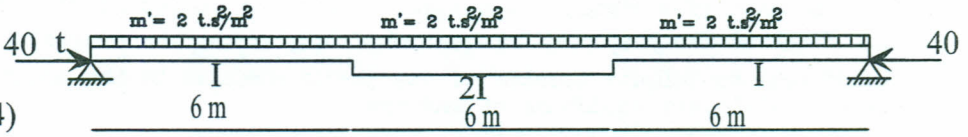
Question 4: (15+5) points

I–For the beam shown in Fig.(3) , and using the consistent mass matrix , compute the natural frequencies and corresponding mode shapes.

II–For the beam segment shown in Fig.(4) ,write the end forces. and give the definitions of stiffness, damping and mass coefficients.



Beam segment Fig.(4)



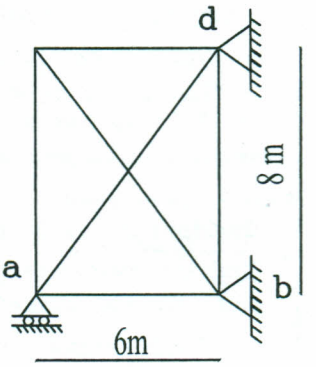
Beam Fig.(3) E = 2000 t/cm2 , I = 0.0001 m4

Question 5: 20 points

For the plane truss shown in Fig.(5) , and using the consistent mass matrix, compute the frequencies and corresponding mode shapes.

ALL members have A = 20 cm2, E =2000 t/cm2 and m' = 0.5 t.sec2/m2

Fig.(5)



The consistent mass matrix [M] and geometric stiffness matrix [K_c] for beam element are given as :

$$[M] = \bar{m}L/420 \begin{vmatrix} 156 & 22L & 54 & -13L \\ 22L & 4L^2 & 13L & -3L^2 \\ 54 & 13L & 156 & -22L \\ -13L & -3L^2 & -22L & 4L^2 \end{vmatrix} \qquad [K_c] = N/30L \begin{vmatrix} 36 & 3L & -36 & 3L \\ 3L & 4L^2 & -3L & -L^2 \\ -36 & -3L & 36 & -3L \\ 3L & -L^2 & -3L & 4L^2 \end{vmatrix}$$

The stiffness matrix[K] in Global and mass matrix [M] in local for truss element are given as :

$$[K] = EA/L \begin{vmatrix} C_x^2 & C_xC_y & -C_x^2 & -C_xC_y \\ C_xC_y & C_y^2 & -C_xC_y & -C_y^2 \\ -C_x^2 & -C_xC_y & C_x^2 & C_xC_y \\ -C_xC_y & -C_y^2 & C_xC_y & C_y^2 \end{vmatrix}$$

and

$$[M] = m'L/6 \begin{vmatrix} 2 & 0 & 1 & 0 \\ 0 & 2 & 0 & 1 \\ 1 & 0 & 2 & 0 \\ 0 & 1 & 0 & 2 \end{vmatrix}$$

The stiffness matrix[K] in Global for beam element is:

$$[K] = \begin{vmatrix} 12EI/L^3 & 6EI/L^2 & -12EI/L^3 & 6EI/L^2 \\ 6EI/L^2 & 4EI/L & -6EI/L^2 & 2EI/L \\ -12EI/L^3 & -6EI/L^2 & 12EI/L^3 & -6EI/L^2 \\ 6EI/L^2 & 2EI/L & -6EI/L^2 & 4EI/L \end{vmatrix}$$

GOOD LUCK PROF. DR. ENG. Mohamed Naguib.