CEL 724
Earthquake Engg.

Answer all questions.

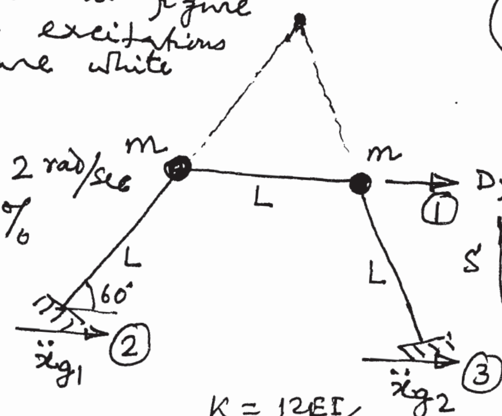
FM 100
Time 2hrs

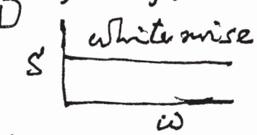
1. Inclined portal frame shown in figure below is subjected different base excitations as shown. Two excitations are white (16)

$$\begin{array}{c} \\ \left[\begin{array}{c|cc} \sqrt{3}K & -\frac{2}{\sqrt{3}}K & -\frac{2}{\sqrt{3}}K \\ \hline -\frac{2}{\sqrt{3}}K & \frac{28}{15}K & -\frac{2}{15}K \\ -\frac{2}{\sqrt{3}}K & -\frac{2}{15}K & \frac{28}{15}K \end{array}\right] \end{array}\begin{array}{c} 1 \\ 2 \\ 3 \end{array}$$

$\sqrt{\frac{K}{m}} = 2$ rad/sec

$\eta = 5\%$





$K = \frac{12EI}{L^3}$

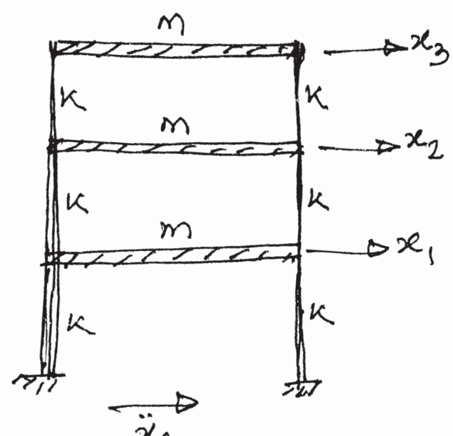
-noises of intensity S_0 and S_2 respectively. The correlation function between the two excitations are $\rho_{23} = e^{-5\omega}$. Find

(i) Effective mass corresponding to Dyn. d.o.f

(ii) r matrix

(iii) ordinate of the PSDF of response ① for $\omega = 3$ rad/sec.

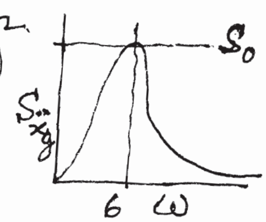
2. A Three storey frame as shown below is subjected single point excitation with PSDF given alongwith the figure. Find the PSDF of the top displacement using modal spectral analysis for $\omega = 6$ rad/sec (18)



Mode shapes I	II	III	Freq.
1	1	1	5 rad/sec (1)
·6	−·5	−·4	15 rad/sec (2)
·2	−·3	·2	20 rad/sec (3)

$K/m = 4 \text{ (rad/sec)}^2$

$\eta = 2\%$

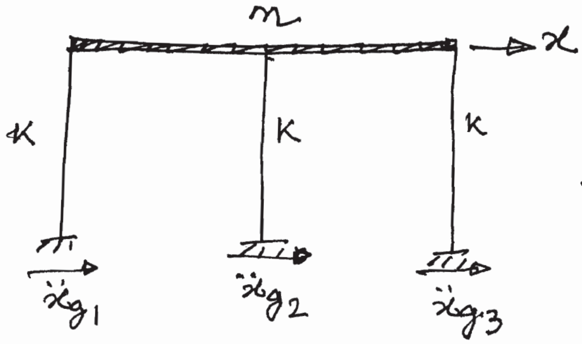


3. For the above frame, find the rms values of the bending moment at the base of any column (bottom) and the top displacement using response spectrum method of analysis. Assume S_a/g values at 1st, 2nd and 3rd freq. as 2, 1.5, 0.6, and the inverse of [K] as (18)

$$\frac{1}{K}\begin{bmatrix} 0.5 & -0.1 & -0.1 \\ -0.1 & 0.2 & -0.05 \\ -0.1 & -0.05 & 0.2 \end{bmatrix}$$

Assume any other value you require

4. For the frame shown below, three different excitations are applied at the three supports. Find the response of x at $t = \Delta t = 0.2$ sec. given that $\dot{x}(0)$ and $x(0) = 0$ using time integration scheme (Newmarks method). Assume $\eta = 5\%$. $\beta = 1/4$; $\delta = 1/2$ (16)



$K/m = 4\ (\text{rad/sec})^2$

	0	0.02
$\ddot{x}_{g1}$	0.1	−0.07
$\ddot{x}_{g2}$	0.05	0.01
$\ddot{x}_{g3}$	0.03	−0.05

(16)

5. For the frame shown in Problem 2, find the frequency component (complex) of response x_3 at $\omega = 2$ rad/sec, given that frequency component (FFT) of $\ddot{x}_g(t)$ at $\omega = 2$ rad/sec is $2+3i$ using modal frequency domain analysis. Note that frequency component (complex) of x_3 is put to IFFT to obtain $x_3(t)$.

(16)

6. Write a short note on ductility in connection with the seismic design of structures covering the following points:

(i) ductility definition and its requirement in the seismic design using reduction factor

(ii) Inelastic response spectrum for given ductility; relation between ductility factor and Reduction factor.

(iii) Ductility in multi storey frame.