Ref. No. : Ex/PG/CE/T/111A/2018

**Name of the Examinations: M.E. Civil Engineering First Year First Semester - 2018**

**Subject: DYNAMICS OF STRUCTURES (SE)** **Time : Three hours** **Full Marks : 100**

**Instructions : Answer any four questions**

1. Develop the shock spectrum for a rectangular pulse shown in Figure 1. What is the maximum displacement of an undamped 1000 kg mass attached to a spring of stiffness 5 x $10^6$ N/m subjected to the pulse with $F_o$ = 2000 N and $t_0$ = 0.09 seconds. 25

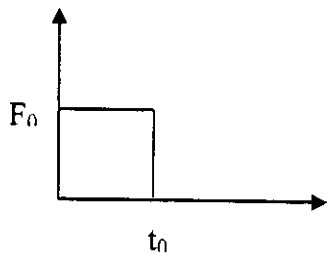


Figure 1

2. a) From the extended Hamilton's principle develop the Lagrange's equation of motion for a MDOF system.

   b) Develop the equation of motion for the system shown in Figure 2. Also find the expression for its natural frequencies. 20 + 5

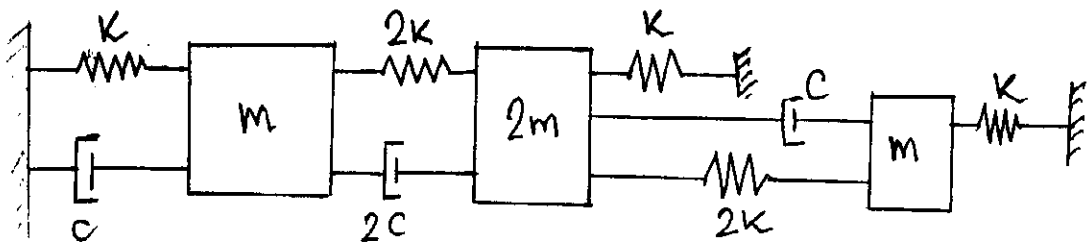


Figure 2

3. Develop the governing differential equation describing the transverse vibration of a Euler-Bernoulli beam using the Hamiltonian Principle. Also find the solution to obtain the frequencies of the beam shown in Figure 3 stating clearly the nature of the boundary conditions. (25)

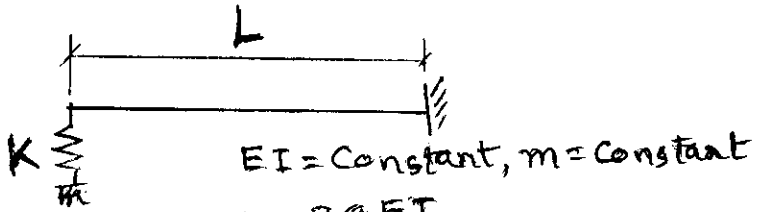


Figure 3

4. a) Using Laplace Transform, obtain the response of a Single Degree of Freedom system subjected to a constant load shown in Figure 4. (10)

b) Obtain the power spectral density (PSD) of response for a LTI system subjected to a stationary random excitation f(t). (15)

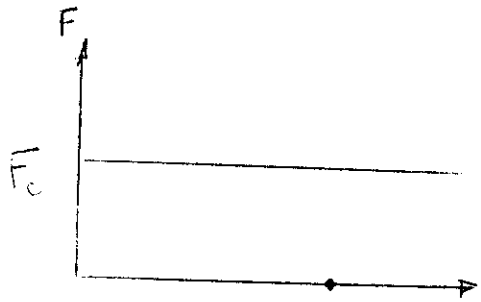

Figure 4

5. a) Classify Geostrophic wind, Gradient wind and Cyclostrophic wind based on the forces acting on them. (6)

b) What is Ekman Spiral effect? (5)

c) Develop the expression for (i) Effective Modal Mass and (ii) Modal Participation Factor for a MDOF system (2 + 2)

d) Using Fourier Integral method obtain the response of a SDOF system subjected to a load (10)

$$f(t) = \begin{cases} \frac{F_0}{k}; -T < t < T \\ 0; \textit{everywhere} \end{cases}$$

stem
(10)

to a
(15)

ces
6)

(5)

tor
2)

a
)

TABLE OF LAPLACE TRANSFORM PAIRS

| | |
|---|---|
| $e^{-\omega t}$ | $\frac{1}{s+\omega}$ |
| $te^{-\omega t}$ | $\frac{1}{(s+\omega)^2}$ |
| $\cos \omega t$ | $\frac{s}{s^2+\omega^2}$ |
| $\sin \omega t$ | $\frac{\omega}{s^2+\omega^2}$ |
| $\cosh \omega t$ | $\frac{s}{s^2-\omega^2}$ |
| $\sinh \omega t$ | $\frac{\omega}{s^2-\omega^2}$ |
| $1-e^{-\omega t}$ | $\frac{\omega}{s(s+\omega)}$ |
| $1-\cos \omega t$ | $\frac{\omega^2}{s(s^2+\omega^2)}$ |
| $\omega t-\sin \omega t$ | $\frac{\omega^3}{s^2(s^2+\omega^2)}$ |
| $\omega t \cos \omega t$ | $\frac{\omega(s^2-\omega^2)}{(s^2+\omega^2)^2}$ |
| $\omega t \sin \omega t$ | $\frac{2\omega^2 s}{(s^2+\omega^2)^2}$ |