Reg. No. :

Question Paper Code : 41158

M.E./M.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

First Semester

Structural Engineering

ST 5102 — DYNAMICS OF STRUCTURES

(Regulations 2017)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State D'Alembert's principle.

2. What do you mean by damping?

3. "Dynamics problems are of eigen value type". Is this statement true? Justify.

4. What do you mean by mode shape?

5. Name some applications of multi-degree of freedom systems in civil engineering.

6. State the orthogonal property of mode shapes.

7. Write down the equitation for transverse vibration of beams.

8. How will you adopt Rayleigh's method to find the fundamental frequency of a cantilever beam?

9. State the major parameters that influences in non-linear analysis.

10. Name any two methods of analysis of non-linear MDOF systems.

PART B — (5 × 13 = 65 marks)

11\. (a) For a SDOF system with mass 100 kg and spring constant 40 kN/m which was initially at rest i.e. $u(0) = \dot{u}(0) = 0$ when an excitation $F(t) = 10 \cos 10t$ commences, determine the expression for the resulting motion. Sketch the resulting motion.

Or

(b) A steel rigid frame of Fig. 1 supports a rotating machine, which exerts a horizontal force at the girder level of $50000 \sin 11t$ (in N). Assuming 4 percent of critical damping, what is the steady state amplitude of vibration? I for columns = 15×10^{-5} m^4, $E = 21 \times 10^7$ kN/m^2.

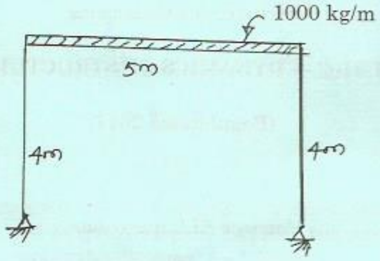

Fig. 1

12\. (a) Obtain the natural frequencies and mode shapes of the system shown in Fig. 2.

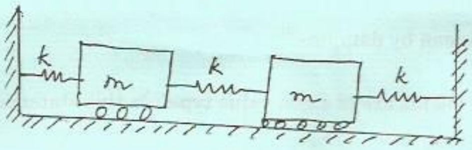

Fig. 2

Or

(b) Determine the natural frequencies and mode shapes of the two storey building shown in Fig. 3.

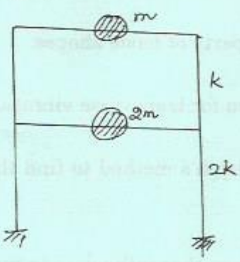

Fig. 3

13. (a) For a MDOF system with mass matrix

$$[m] = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

and stiffness matrix

$$[k] = \begin{bmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 2 \end{bmatrix}$$

Determine the frequencies and mode shapes.

Or

(b) Explain the step by step procedure involved in the mode superposition technique for a 3 DOF system.

14. (a) Determine from first principles, the first three natural frequencies and mode shapes of a simply supported beam subjected to free flexural vibrations.

Or

(b) Determine the first two natural frequencies of a uniform cantilever beam by Rayleigh-Ritz method assuming $\phi(x) = c_1x^2 + c_2x^3$.

15. (a) Explain with a 2 DOF system, the step by step procedure involved in finding displacement of a damped system with forcing function $F(t)$.

Or

(b) Explain the procedure involved in the step-by-step numerical integration technique for analysis of non-linear MDOF systems.

PART C — (1 × 15 = 15 marks)

16. (a) For a three storey frame shown in Fig. 4, an excitation force of $f_0 \cos wt$ acts at the top storey level. Determine its response at top storey level on the basis of :

(i) first mode only

(ii) first two modes only

(iii) all the three modes for $w = 0.5\ p_1$ where w = operating frequency, p_1 = first natural frequency. The modes and frequencies are as follows :

$$[\phi] = \begin{bmatrix} 1.000 & 1.000 & 1.000 \\ 0.760 & -0.805 & -2.427 \\ 0.336 & -1.157 & 2.512 \end{bmatrix}; \{p\} = \begin{Bmatrix} 43.87 \\ 120.16 \\ 167.00 \end{Bmatrix}$$

In Fig. 4, Take $m = 20{,}000$ kg, $k_1 = k_2 = 160$ kN/mm, $k_3 = 1.5\,k_1$.

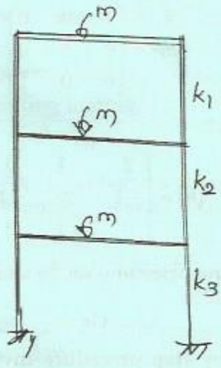

Fig. 4

Or

(b) A simply supported uniform beam is subjected to a time dependent concentrated load at quarter span. Express the dynamic displacement of the beam in terms of the dynamic load factor.