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Question Paper Code : 11285

M.E./M.Tech. DEGREE EXAMINATIONS, APRIL/MAY, 2019.

First Semester

Structural Engineering

ST 5102 — DYNAMICS OF STRUCTURES

(Regulation 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define single degree of freedom systems.

2. What is viscously damped free vibration?

3. How the vibration absorber works?

4. List out the sequence of steps in model analysis.

5. Differentiate : free and forced vibration.

6. Give some information about normalisation of matrix

7. Determine the velocity of wave propagation in an underwater cable of mass m = 10 kg/m and the applied tension T = 6000 N.

8. What is vibration of membranes?

9. Define substructure technique.

10. Mention the factors governing dynamic response of structures.

PART B — (5 × 13 = 65 marks)

11. (a) A free vibration test is conducted on an empty elevated water tank. A cable attached to the tank applied a horizontal force of 75 kN and pulls the tank horizontally by 5 cm. The cable is suddenly cut and the resulting free vibration is recorded. At the end of 4 complete cycles the time is 2 sec and the amplitude is 25 mm. From these data compute the following:

(i) Damping ratio

(ii) Natural period of undamped vibration

(iii) Damping coefficient

(iv) Number of cycles required for displacement amplitude to decrease to 5 mm.

Or

(b) Show that for an undamped system in free vibration the logarithmic decrement is expressed $\delta = \frac{1}{K_0} ln \frac{X_1}{X_{i+k}}$. Where K_0 is the number of cycles separating two measured peak amplitudes X_i and X_{i+k}.

12. (a) A vehicle has a mass of 2000 kg and a wheelbase of 3.5 m. The mass centre is 1.5 m from the front axle. The radius of gyration of the wheel about the centre of gravity is 1.5 m. The spring constants of the front and rear springs are 40 kN/m and 50 kN/m respectively. Determine

(i) The natural frequencies

(ii) Principle modes of vibration

(iii) The motion X(t) and q(t).

Or

(b) A coupled system has the following equations of motion

$\ddot{X} + 1000\,X - 100\,\theta = 0$

$\ddot{\theta} + 1000\,X - 100\,\theta = 0$

Given that at $t = 0, X = 0, \theta = 0, \dot{X} = 5$ and $\dot{\theta} = 2$ determine the resultant motion of system.

13. (a) Using Dunkerley method, determine the fundamental frequency of a uniformly loaded cantilever beam with a concentrated mass M at the end equal to the mass of the uniform beam having flexural rigidity EI. The frequency of the beam due to uniform load is $P_1 = 3.515^2\left(\frac{EI}{ML^3}\right)$.

Or

(b) Write in detail about response spectrum method and its applications.

14. (a) Determine the frequency equation of a uniform beam pinned at one end and elastically supported at the other.

Or

(b) A cantilever beam under the action of a force P applied at the free end deflects the end by 30 mm. What will be the amplitude of forced vibration produced by a pulsating force P $\sin \omega t$ applied at the free end, if the frequency W is equal to half the fundamental frequency of the beam?

15. (a) Explain the various conditions for damping uncoupling.

Or

(b) Explain the step-by-step numerical integration algorithms.

PART C — (1 × 15 = 15 marks)

16. (a) Due to a rotating machine installed at the beam level, the frame sways violently. What steps would you suggest to reduce the vibration without changing the frequency of the machine?

Or

(b) Determine an approximate frequency of rectangular membrane supported along all edges by Rayleigh's method with $W(x, y) = C_1 xy(x-a)(y-b)$.
