Reg. No. :

Question Paper Code : 40529

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018

Sixth Semester

Aeronautical Engineering

AE 6602 : VIBRATIONS AND ELEMENTS OF AEROELASTICITY

(Regulations 2013)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

1. Find the ratio between the damped natural frequency and undamped natural frequency of a single degree of freedom system with mass = 5 kg, stiffness K = 20N/cm and damping co-efficient C = 1 Nsec/cm.

2. What are stiffness, damped and mass controlled regions in single degree of freedom subjected to forced vibration ?

3. What is meant by amplitude modulated motion ?

4. Write down the equations of motion in matrix form for a two degree of freedom system when :

   i) it does not have static and dynamic couplings,

   ii) it has only dynamic coupling,

   iii) it has only static coupling and

   iv) it has both static and dynamic couplings.

5. Using Lagrange's equation, derive the equation of motion for a simple pendulum.

6. What are normalized eigen vectors and what are their characteristics ?

7. In what way, continuous systems are different from discrete systems ?

8. Using Dunkerly's method, find the approximate fundamental frequency of the system shown in Figure 8.

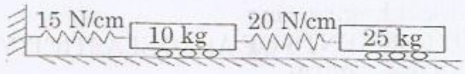

Figure 8

9. What is dynamical matrix in matrix iteration method ?

10. What is meant by bending torsion coupling ?

PART – B (5×13=65 Marks)

11. a) i) Derive expressions for displacement for various values of the damping co-efficient (over damped, critically damped and under damped) when a single degree of freedom system is executing free vibration. (8)

ii) A single degree of freedom system with m = 10 kg, stiffness K = 1000 N/m and damping co-efficient C = 100 Nsec/m is subjected to 2 cm displacement and 0.5 m/sec velocity at t = 0. Find the displacement after 5 sec. (t = 5 sec.) (5)

(OR)

b) i) A single degree of freedom system is subjected to harmonic base excitation. Derive expression for the response of the system. (8)

ii) An instrument of mass 20 kg located in an airplane cabin supported on four springs of equal stiffness is to be isolated from engine vibrations which vary in the range of 45 Hz to 60 hz. Neglecting damping, determine the stiffness of each spring so that the displacement transmissibility is 0.1. Also determine the force developed in the springs and the maximum acceleration on the instrument. The cabin vibration amplitude is 200 micron. (5)

12. a) i) Using Newton's law of motion, derive the equation of motion for the system shown in Figure 12 (a). (5)

ii) If K = 10 N/cm, and m = 25 kg, find the natural frequencies and the associated eigen vectors. (8)

Figure 12 (a)

(OR)

b) i) Derive the equation of motion for a two rotor system and explain with necessary equation, how the frequency is extracted. (5)

ii) Find the diameter of the portion CD of the two rotor system shown in Figure 12(b) when the node is at a distance 90 cm from the rotor A. Assume G = 70 GPa. (8)

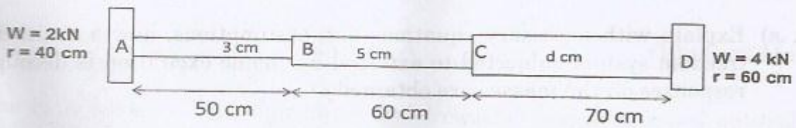

Figure 12(b)

13. a) i) Derive the equation of motion for the transverse vibration of a stretched string. (7)

ii) A stretched string fixed at x = I is subjected to an oscillatory displacement w (0, t) = A sin ωt. Determine the response of the system. (6)

(OR)

b) i) Derive the equation of motion for the transverse vibration of a beam. (5)

ii) Find the first two natural frequencies of a cantilever beam from the above equations. (8)

14. a) Using Rayleigh's method, find the fundamental frequency of a simply supported beam shown in figure 14 (a) including its self weight. E = 200 GPa, $I = 4 \times 10^{-7}$ m^4, mass per unit length = 0.1×10^4 kg/m.

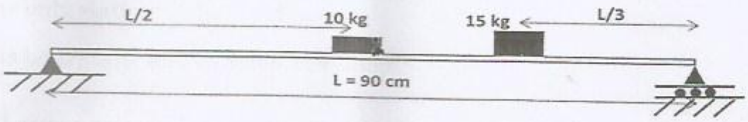

Figure 14 (a)

(OR)

b) The mass and stiffness matrices of a two degree of freedom system are as given. Find the natural frequencies and the mode shapes using matrix iteration. $[m]=\begin{bmatrix}20 & 0\\ 0 & 30\end{bmatrix}$ and $[K]=\begin{bmatrix}3000 & -2000\\ -2000 & 1000\end{bmatrix}$.

Mass is in kg and the stiffness is in N/m.

15. a) Explain in detail various aeroelastic problems by the use of Aeroelastic Collar's triangle.

(OR)

b) Derive the expression for divergence speed of a two dimensional wing and indicate the modifications required in the structural design to increase the divergence speed.

PART – C (1×15=15 Marks)

16. a) Explain with necessary equations and assumptions, how a multi degree of freedom system subjected to external harmonic excitation is decoupled and responses on the masses are obtained.

(OR)

b) i) Derive the Lagrange's equation for vibration analysis. (7)

ii) Using Lagrange's equation, derive the equation of motion for the system shown in figure 12(a). (8)

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