Reg. No. : | | | | | | | | | | | |

Question Paper Code : Q 2734

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2009.

Seventh Semester

Aeronautical Engineering

AE 1006 — VIBRATION AND AERO ELASTICITY

(Regulation 2004)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Explain D'Alembert Principle.

2. List the main causes of vibration and the methods to reduce them.

3. When is a vibratory system said to be critically damped?

4. What do you understand by transient vibration and steady state response?

5. What is logarithmic decrement? How will you find the ratio of successive amplitudes?

6. Explain Coordinate coupling in a multi degree of freedom system.

7. Define : eigen function, eigen vector and eigen value.

8. What do you understand by Rayleigh's stationary principle?

9. Write down the Lagrange's general equation of motion in the generalised coordinates.

10. List down various aeroelastic problems and the methods to prevent them.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Define simple Harmonic Motion.

(ii) Derive necessary expressions and obtain the natural frequency of vibration of a spring mass system (in the vertical position) using

(1) Newton's law and

(2) Energy method.

Or

(b) (i) Obtain the expressions for the equivalent spring constants of springs when they are set in parallel and in series. (8)

(ii) A helical spring has a mean coil diameter D = 25 mm, wire diameter d = 2 mm and contains 20 coils. If G = 80 GPa and the suspended weight W = 150 N, Calculate the period of free vibrations. (8)

12. (a) (i) What are the various vibration measuring instruments and how do they work? (8)

(ii) Two ends of a string of length 'l' are rigidly fixed. It carries a lumped mass 'm' at a distance 'a' from left end. Find its natural frequency of transverse vibration of the string. (8)

Or

(b) (i) What is resonance? (2)

(ii) A vibrating system having a mass of 1 kg is suspended by a spring of stiffness 1000 N/m and is put to harmonic excitation of 10 N. Assuming viscous damping with C = 40 N sec/m, determine

(1) the resonance frequency and amplitude (6)

(2) the frequency corresponding to peak amplitude (4)

(3) damped frequency. (4)

13. (a) (i) Explain the orthogonality relationship among the natural modes of vibrations. (6)

(ii) Determine the natural frequencies and amplitude ratios for the system shown in Fig. 1. (10)

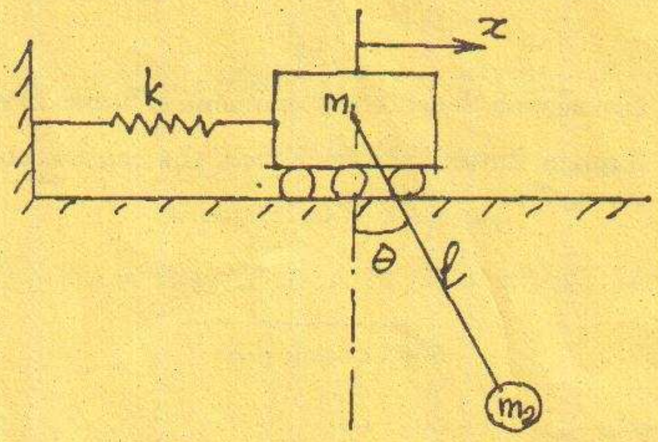

Fig. 1.

Or

(b) An air foil section undergoes combined bending – torsional modes of vibration. It is represented by a linear and torsional springs. Obtain the equations of motion and the frequencies.

Mass of the section = 5 kg

Mass moment of inertia = 0.12 kg m^2

Stiffness of linear spring = 5 kN/m

Stiffness of torsional spring = 0.04 kN/rad

Distance between the mass centre and the elastic centre = 0.1 m.

14. (a) (i) State Hamilton's Principle. (2)

(ii) Using Hamilton's Principle, obtain the governing equation of motion of bending vibration of a uniform simply supported beam of length l and constant EI. (14)

Or

(b) Describe an approximate method for determining the frequencies and mode shapes of a simply supported beam of arbitrary mass distribution undergoing flexural vibrations.

15. (a) Write short notes on the following aeroelastic phenomena :

(i) Loss of aileron control (6)

(ii) Divergence of a 2d using (5)

(iii) Stall flutter. (5)

Or

(b) (i) Distinguish clearly the phenomena of 'Resonance' and 'Flutter'. (8)

(ii) Explain flutter behaviour from the consideration of extraction of energy from airstream. (8)

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Question Paper Code : C 1524

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2010.

Seventh Semester

Aeronautical Engineering

AE 1006 — VIBRATION AND AERO ELASTICITY

(Regulation 2004)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. A spring having a spring constant 'k' is suspended vertically. When a 2 kg mass is attached to the spring, the extension is 3 mm. What is the natural frequency of the system?

2. Define the coefficient of viscous damping and state its S.I. units.

3. The amplitude of oscillations of a damped system decreases by 50% after 8 cycles. Calculate the associated damping factor.

4. A spring-mass system having a natural frequency w_n is subject to a harmonic excitation of frequency w. The response will be in-phase with the input when —————. (Fill in the blanks)

5. Briefly explain the working of Frahm's reed tachometer.

6. Sketch and label the parts of a piezoelectric accelerometer.

7. Define static coupling.

8. What are 'normal modes' of vibration?

9. Define the stiffness influence coefficient.

10. Aeroelasticity is the study of —————. (Fill in the blanks)

———

PART B — (5 × 16 = 80 marks)

11. (a) (i) Using the energy method, obtain the equation governing free vibrations for a simple pendulum system. Deduce the natural frequency of the same. (10)

(ii) Obtain the natural frequency of the system indicated in Fig. 1. (6)

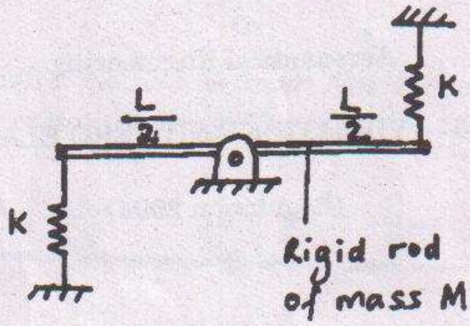

Fig. 1

Or

(b) (i) Refer Fig. 2. The mass M is subject to a periodic force as indicated. Obtain the general solution for the displacement of the mass. (10)

(ii) With the example of the system shown in Fig. 2, discuss resonance. Sketch the frequency response curve of the system. If a viscous damping unit is now added to the system, how would it change the frequency response of the system? (6)

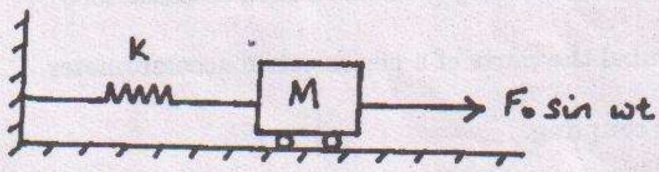

Fig. 2

12. (a) (i) The 30 kg electric motor shown in Fig. 3 is supported by 4 springs, each having a spring constant of 200 N/m. The rotor R is unbalanced and the effect of unbalance is equivalent to a 4 kg mass located 4 mm from the axis of rotation. The damping factor of the system is 0.15. Determine the amplitude of vibration when the rotor is rotating at ω = 10 rad/s. (10)

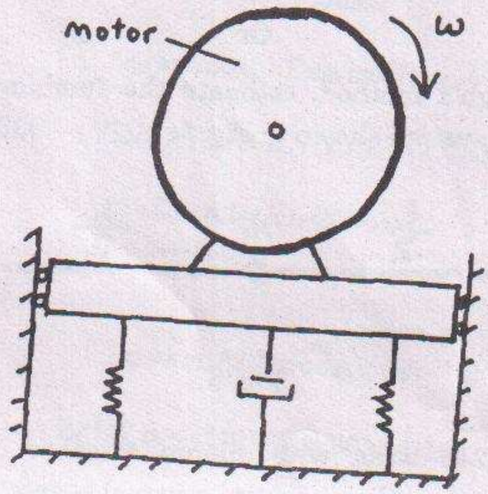

Fig. 3

(ii) Explain the working principle of Frahms reed tachometer. (6)

Or

(b) Discuss the design of a dynamic vibration absorber unit.

13. (a) (i) Using an example of your choice, explain the application of Lagrange's equations in vibrations. (10)

(ii) Consider a bar undergoing free axial vibrations. Derive and obtain the governing differential equation. (6)

Or

(b) Derive and obtain the governing differential equation for a beam undergoing free bending vibrations. Solve the same in order to the obtain the natural frequencies and mode shapes of a simply-supported beam.

14. (a) Obtain the natural frequencies and modes shapes of the system indicated in Fig. 4. $M_1 = 10$ kg $= M_2$. $K_1 = 300$ N/cm and $K_2 = 200$ N/cm.

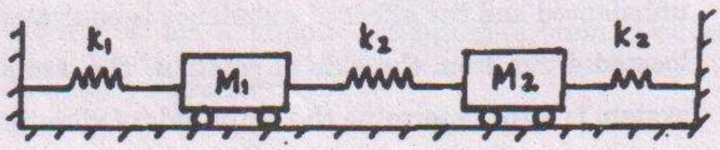

Fig. 4

Or

(b) Using Rayleigh's method, estimate the fundamental frequency of the lumped mass system shown in Fig. 5.

Fig. 5

15. (a) Consider a 2-D wing with aileron attached. Derive and obtain an expression for the aileron control reversal speed.

Or

(b) (i) With the help of Collar's triangle, give an account of the different aeroelastic phenomena. (10)

(ii) Briefly discuss the different methods of flutter prevention. (6)
