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Register Number: ………………..

B.E DEGREE EXAMINATIONS: NOV 2015

(Regulation 2009)

Seventh Semester

AERONAUTICAL ENGINEERING

AER141**:** Vibrations and Aeroelasticity

Time: Three Hours   **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. The distinct number of frequencies for a 'n' degree of freedom system can be

    a) One
    b) Infinity
    c) n
    d) n+1

2. Number of cycles per unit time is termed as _____

    a) Time period
    b) Frequency
    c) Natural Frequency
    d) Periodic motion

3. When there is a reduction in amplitude in every cycle of vibration, then the body is said to have _____ vibration

    a) Forced
    b) Free
    c) Undamped
    d) Damped

4. Free vibrations without damping are the result of interaction between the forces of _____ and _____

    a) Inertia force and aerodynamic force
    b) Elastic force and friction force
    c) Inertia force and elastic force
    d) Aerodynamic force and elastic force

5. Negative damping leads to

    a) Instability
    b) Oscillations
    c) Fast Convergence
    d) Harmonic motion

6. A multi degree of freedom system having one of their natural frequencies zero is called

    a) Coupled degree of freedom
    b) Semi-infinite system
    c) Semi-definite system
    d) Vibration absorber

7. For critically damped single degree of freedom spring-mass-damper system with a damping constant 'C' of 4N/m, the system mass 'm' is
    a) 0.5Kg   b) 0.25Kg
    c) 2.0Kg   d) 4.0Kg

8. The logarithmic decrement measured for a viscously damped single degree of freedom system is 0.125. The value of the damping factor in % is closest to
    a) 0.5   b) 1.0
    c) 1.5   d) 2.0

9. The quantities *EI* and *GJ* are called the _____ and _____, respectively.
    a) Young's modulus and rigidity modulus   b) Torsional and flexural rigidity
    c) Flexural and Torsional rigidity   d) Mass and polar moment of inertia.

10. Wing divergence is caused by the interaction of _____ and _____.
    a) Inertia force and Elastic force   b) Inertia force and aerodynamic force
    c) Elastic force and aerodynamic force   d) Inertia force, Elastic force and Aerodynamic force

PART B (10 x 2 = 20 Marks)

11. How are Time period, Angular frequency and Natural frequency related to each other?

12. Explain energy method of vibration analysis.

13. A vehicle wheel (Tire and suspension assembly) can be modeled crudely as a SDOF spring-mass system. The mass of the assembly is measured to be about 30kg. Its frequency of oscillation is observed to be 10Hz. What is the approximate stiffness of the suspension assembly?

14. Mention the types of damping.

15. Write the fundamental form of Lagrange's equation.

16. What is an eigenvalue problem?

17. Differentiate continuous system and discrete system.

18. State the possible boundary conditions at the ends of a string.

19. Explain: Flutter and its types.

20. Define wing divergence.

PART C (5 x 14 = 70 Marks)

21. a) (i)   Find the natural frequency of the system shown in figure 1.   (8)

Fig.1

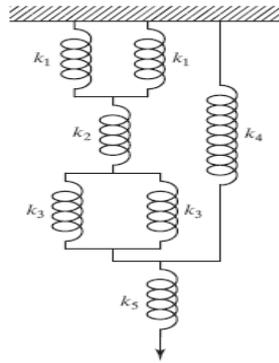(ii) Determine the equivalent spring constant of the system shown in Figure 2. (6)

Fig.2

(OR)

b) Derive the General equation of motion for Spring-Mass-Damper system under free oscillation and the equation for overdamped motion.

22. a) Derive the response of undamped system under harmonic excitation and explain magnification and amplification factors.

(OR)

b) A vehicle is moving on the road surface which is considered as sinusoidal in cross section providing a base motion displacement of $y(t) = (0.01m)\sin\omega_b t$ where,

$\omega_b = v(km/h)(1/0.006km)(hour/3600s)(2\pi rad/cycle) = 0.209 rad/s$

where,

v denotes the vehicle's velocity in km/h. Thus the vehicle's speed determines the frequency of the base motion. Determine the effect of speed on the amplitude of displacement of the automobile as well as the effect of the value of the vehicle's mass. Assume that the suspension system provides an equivalent stiffness of 4×10^4N/m and damping of 2×10^2N.s/m.
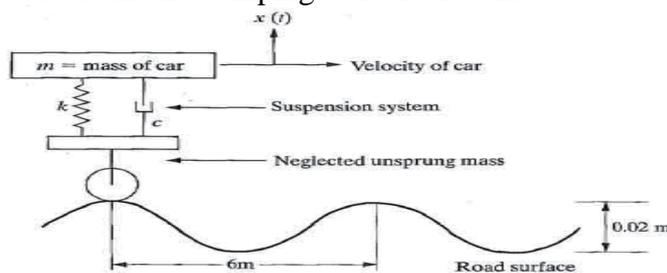
Fig.2

23. a) Set up the differential equation of motion for the system shown in figure 3 and hence derive the frequency equation and obtain the two natural frequencies of the system. Sketch the mode shapes.
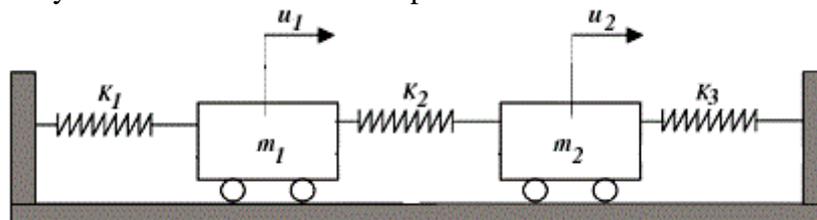

Fig.3

b)   Find the natural frequencies of the car with the following conditions:
Total mass of the car = 300kg
Wheel base = 3.0m
C.G is 1.50m from front axle
Radius of gyration is 1.0m
Spring constants of front and rear springs are 70×10^3 N/m each.
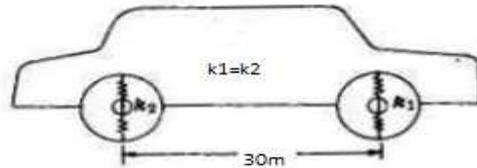

Fig.4

24. a)   Obtain the governing equation for transverse vibration of a beam and investigate its general solution.

(OR)

b)   Find the natural frequencies and the free-vibration solution of a bar fixed at one end and free at the other end under longitudinal vibration.

25. a)   Discuss about any seven types of aeroelastic instabilities and methods to prevent them in detail.

(OR)

b)   What is control reversal? (4)

Consider a 2-D wing with aileron attached. Derive and obtain an expression for the aileron control reversal speed. (10)

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