



B.E DEGREE EXAMINATIONS : APRIL / MAY 2016

(Regulation 2013)

Sixth Semester

AERONAUTICAL ENGINEERING

U13AET602 : Vibrations and Aeroelasticity

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

- The free vibration of an undamped system represents interchange between
 - Internal and External energy
 - Mass and stiffness
 - Natural frequency & linear frequency
 - Kinetic and potential energy.
- Systems undergo dangerously large oscillations when its excitation frequency reaches _____.
- When a system vibrates in a fluid medium, the damping is
 - viscous
 - Coulomb
 - solid
 - No damping
- Any two successive displacements of the system, separated by a cycle, can be used to find the _____ decrement.
- The reduction of the amplitude ratio in the presence of damping is very significant
 - near $\omega = 0$
 - near $\omega = \infty$
 - near $\omega = \omega_n$
 - near $\omega = \omega_n/2$
- The matrix $[D]=[M]^{-1}[K]$ is known as _____ matrix.
- The system governed by the equation $m\ddot{x} + c\dot{x} + kx = 0$ is dynamically stable if
 - k is positive
 - c is positive
 - c and k are positive
 - c and k are negative
- Lagrange's equations are expressed in terms of _____ coordinates.
- Find the odd option
 - Flutter
 - Dynamic Stability
 - Buffeting
 - Dynamic Response
- From collar's triangle, Mechanical vibration occurs when the interaction between _____ and _____ force begins.

PART B (10 x 2 = 20 Marks)

(Answer not more than 40 words)

11. What are the common types of damping? Explain any one.
12. Define these terms: damping ratio, logarithmic decrement, and specific damping capacity.
13. How do you connect several springs to increase the overall stiffness? Explain.
14. If a vehicle vibrates badly while moving on a uniformly bumpy road, will a change in the speed improve the condition?
15. 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?
16. Define the term magnification factor. How is the magnification factor related to the frequency ratio?
17. Are the boundary conditions important in a discrete system? Why?
Are the boundary conditions important in a continuous system? Why?
18. State Lagrange's equations.
19. Explain: Wing divergence
20. Explain: Flutter

PART C (5 x 14 = 70 Marks)

(Answer not more than 400 words)

Q.No. 21 is Compulsory

21. Derive the General equation of motion for Spring-Mass-Damper system under free oscillation and the equation for over damped motion.

22. (a) A single-degree-of-freedom system(SDOF) has,
Mass $m = 10$ kg, Damping coefficient $c = 20$ N-s/m and Stiffness $k = 4000$ N/m.
The initial boundary conditions are:
Initial displacement, $x_0 = 0.01$ m
Initial velocity, $v_0 = 0$.
Find the total response of the system under the following conditions:
 - a. An external force $F(t) = F_0 \cos \omega t$ acts on the system with
 $F_0 = 100$ N and $\omega = 10$ rad/s
 - b. Free vibration with $F(t) = 0$

(OR)

- (b) Derive the response of undamped system under harmonic excitation and explain magnification and amplification factors.

23. (a) The arrangement of compressor – turbine and generator in a thermal power plant is shown in figure below. Find the natural frequencies and mode shapes of the system.

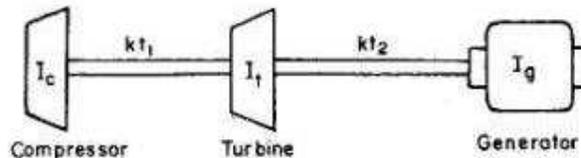
Stiffness $K_{t1} = 6\text{MN-m/rad}$

Stiffness $K_{t2} = 3\text{MN-m/rad}$

Compressor moment of Inertia, $I_c = 18\text{kg-m}^2$

Turbine moment of Inertia, $I_t = 14\text{kg-m}^2$

Generator moment of Inertia, $I_g = 9\text{kg-m}^2$



(OR)

- (b) In a Two Degree of Freedom system, mass $M_1 = 100\text{kg}$, mass $M_2 = 150\text{kg}$, $K_1 = 20\text{N/mm}$, $K_2 = 40\text{N/mm}$, $K_3 = 60\text{N/mm}$. Mass M_2 is subjected to 500N (downwards) force. Find the natural frequency, amplitude ratio for both the natural frequencies of the system.
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) Define aero elasticity. With the help of Collar's triangle, give an account of the different aero elastic phenomena.

(OR)

- (b) (i) What is control reversal? (4)
- (ii) Consider a 2-D wing with aileron attached. Derive and obtain an expression for the aileron control reversal speed. (10)
