SRINIVASAN ENGINEERING COLLEGE

PERAMBALUR

VIBRATIONS & AEROELASTICITY

TWO MARK QUESTION AND ANSWER

UNIT 1

1. What is simple harmonic motion?

   The motion of a body to and fro about a fixed point is called simple harmonic motion. The motion is periodic and its acceleration is always directed towards the mean position and is proportional to its distance from mean position.

2. Explain the term natural frequency?

When no external force acts on the system after giving it an initial displacement, the body vibrates. These vibrations are called free vibrations and their frequency as natural frequency as natural frequency. it is expressed in rad/sec or Hertz.

3. Define the term resonance?

   When the frequency of external excitation is equal to the natural frequency of a vibrating body, the amplitude of vibration becomes excessively large . this concept is known as resonance.

4. Explain free and forced vibration?

   After disturbing the system the external excitation is removed, then the system vibrates on its own. This type of vibration is known as free vibration. Simple pendulum is one of the examples.

   The vibration which is under the influence of external force is called forced vibration. Machine tools, electric bells are the suitable examples.

5. Define damped and un damped vibration?

   If the vibratory system has a damper, the motion of the system will be opposed by it and the energy of the system will be dissipated in friction this type of vibration is called damped vibration.

   On the contrary, the system having no damper is known as un damped vibration.

6. vibrometer indicates 2 percent error in measuring and its natural frequency is 5 hz. If the lowest frequency that can be measured is 40 hz, find the value of damping factor(€) ?

   R=GϿ/GϿn=(40/5)=8,

   z/b=1.02,

   z/b= r^2/square root of (1-r^2)^2 + (2€r)^2, (1.02)^2= 8^4/(1-64)^2 +(16€)^2, €=0.35.

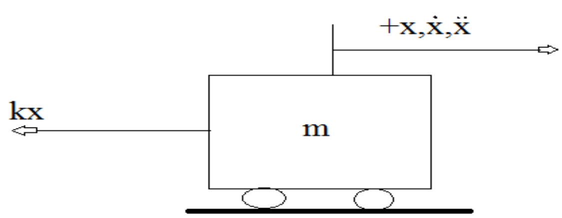
7. Define D'Alembert's principle?

$$F\text{-}ma = 0$$

$$\underset{F(t)}{\longrightarrow} - m\ddot{x} = 0$$

$$\underset{M(t)}{\longrightarrow} - J\ddot{\theta} = 0$$

These equation can be considered equilibrium equation provided that $-m\ddot{x}$ and $-J\ddot{\theta}$ are treated as a force and a moment. This fictitious force(or moment) is knows as the inertia force(or inertia moment) and the artificial state of equilibrium implied by above equation is known as dynamic equilibrium . This principle is called D'Alembert's principle. The application of the principle to the system shown in fig below yields the equation of motion: $-kx - m\ddot{x} = 0$ or $m\ddot{x} + kx = 0$



UNIT 2

1. Define Newton's law of motion?

The equation of motion is just another form of Newton's law of motion, ΣF=ma (total force in the same direction as motion). Equation of motion for many systems are conveniently determined by Newton's law of motion.

2. Define energy method?

For a conservative system, the total energy of the system is unchanged at all time. If the total energy of the system is expressed as potential and kinetic energy , then the followed is true :

K.E. + P.E.= constant or $\frac{d}{dt}$(K.E. + P.E.) = 0

Where the K.E. = kinetic energy, P.E.= potential energy.

The resulting equation is the equation of the motion of the system under the consideration. This is , then , the Energy method.

3. Explain the Seismic instruments.

Seismic instruments are essentially vibratory systems consisting of the support or the base and the mass with spring attached. The support or the base is attached to the body whose motion is to be measured. The relative motion between the mass and the base, recorded by a rotating drum or some other devices inside the instrument, will indicate the motion of the body.

4. Define vibrometer or low frequency transducer?

For measuring the displacement of a machine part, a vibrometer should be used , whose natural frequency is low compared to the frequency of the vibration to be measured.so vibrometer is known as low frequency transducer.

5. Define accelerometer or high frequency transducer?

An accelerometer is used to measured acceleration because hits natural frequency is high compare to that of the vibration to be measured. So accelerometer is known as high frequency transducer.

6. Define two degree of freedom system?

Systems that require two independent coordinates to specify their position are called Two degree of freedom system.

7. Define semi-definite system?

The system having one of their natural frequencies equal to zero are known as semi- definite systems.

UNIT 3

1. Define normal modes of vibration or principle mode of vibration?

   When the masses of the system are oscillating in such a manner that they reach maximum displacements simultaneously and pass their equilibrium points simultaneously, or moving parts of the system are oscillating in phase in one frequency, such a state of the is called normal modes of vibration or principle mode of vibration.

2. Define principle coordinates?

   It is also find the particular set of coordinate such that each equation of the motion contains only one unknown quantity. Then the equation of motion solve independently of each other. Such particular set of coordinate is called principle coordinates.

3. Define coordinate coupling?

   The displacement of one mass will be felt by another mass in the same system since they are coupled together. There are two types of coupling: the static coupling due to static displacements, and dynamic coupling due to inertia force.

4. Define semi-definite system?

   One of the roots of the frequency equation of a vibrating system is equal to zero; this indicates that one of the natural frequency of the system is equal to zero. Such systems are known as semi-definite system.

5. Define influence coefficients?

   An influence coefficient, denoted by α_{12} is defined as the static deflection of the system at position 1 due to unit force applied at position 2 when the force is the only force acting. The influence coefficient is therefore a convenient method to keep account of all the induced deflections due to various applied forces, and set the differential equation of the motion for the system,

   It can be shown that the following expression is true.

$$\alpha_{ij} = \alpha_{ji}$$

6. Define vibration of the continuous media or system?

Mechanical system that have their masses and elastic force distributed, such as cable, rods, beams, plates, etc., rather than "lumped" together in concentrated masses by spring belong to this class of vibration of the continuous media or system.

E.g. cantilever beam

7. Define matrix iteration method?

With the help of this method the natural frequencies and corresponding mode shapes are determined. Use of influence coefficients is made in the analysis.

8. Define vibration absorber?

When a structure externally excited has undesirable vibrations, it becomes necessary to eliminate them by coupling some vibrating system to it. The vibrating system is known as vibration absorber or dynamic vibration absorber.

9. Explain influence coefficients?

The equations of motion of several degrees of freedom system can be expressed in terms of influence coefficients. The influence coefficient Aij is defined as the static deflection at point I because of unit load acting at point j. similarly , Aij is the deflection at point j due to unit load at point i.

10. Explain orthogonality principle?

For a system with three-degree of freedom the orthogonality principle may be written as

m1A1A2 + m2B1B2 +m3C1C2=0

m1A2A3 + m2B2B3 +m3C2C3=0

m1A1A3 + m2B1B3 +m3C1C3=0

Where m1, m2, m3 are masses. A1, A2, A3, B1, B2, B3, C1, C2, C3 are the amplitude of vibration of the system. We will make use of the equation in matrix iteration method to find the natural frequencies and mode shapes of the system.

11. Define matrix iteration method?

With the help of this method the natural frequencies and corresponding mode shapes are determined. Use of influence coefficients is made in the analysis.

UNIT 4

1. Explain holzer's method?

   This is trial and error method used to find the natural frequency and mode shape of multimass lumped parameter system. This can be applied to both free and forced vibrations. this method can be used for the analysis of damped, undamped, semidefinite systems with fixed ends having linear and angular motions.

2. Explain critical speed of a rotating shaft?

   It is well known fact that rotating shafts at certain speeds become dynamically unstable and large vibrations are likely to develop. This phenomenon is due to resonance effects and a simple example will show that the critical speed for a shaft is that speed at which the number of revolations per second of the shaft is equal to the frequency of its natural vibration.

3. Define self-excited vibration?

   We always assumed that force producing vibration is independent of the vibratory motion. In which a steady forced vibration is sustained by forces created by the vibratory motion itself and disappearing when the motion stops .such vibration are called self excited or self induced vibration.

4. Explain Dunkerley's method?

   This method is used to find the natural frequency of transverse viberations. The load of the system is uniformly distributed. Dunkerley's equation can be written as

   $1/\omega^2=1/\omega_1^2+1/\omega_2^2+\ldots\ldots 1/\omega_s^2$

   Where ω=natural frequency of transverse vibration of shaft for many point loads.

   $\omega_1,\omega_2,\omega_3$,=natural frequency of individual point loads.

   ω_s=natural frequency of transverse vibration because of the weight of shaft.

5. Define Rayleigh's Method?

If the given system is a conservative one , the total kinetic energy of the system is zero at the maximum displacement, but is a maximum at the static equilibrium point , for the total potential energy of the system , on the other hand , the reverse is true. Hence,

$$(K.E.)_{MAX}=(P.E.)_{MAX}= \text{Total energy of the system}$$

This is known as Rayleigh's method. The resulting equation will readily yield the natural frequency of the system.

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UNIT 5

1. Define flutter (F)?

   A dynamic instability occurring in an aircraft in flight, at a speed is called the flutter speed. Where the elasticity of the structure plays an essential part in the instability.

2. Define buffeting (B)?

   Transient vibration of the aircraft structural components due to aerodynamic impulses produced by the wake behind the winds, nacceles, fuselage pods, or other component of the aircraft.

3. Define dynamic response, (Z)?

   Transient response of the aircraft structural component produced by rapidly applied load due to gusts, landing , and gun reaction, abrupt control motions, moving shock wake, or other dynamic loads.

4. Define aeroelasticity on stability, S A?

   Influence of the elastic deformation of the structure on dynamic and static airplane stability.

5. Define load distribution?

   Influence of the elastic deformation of the structure on the distribution of the aerodynamic pressures over the structure.

6. Define Divergence, D?

   A static instability of a lifting surface of the aircraft in flight, at a speed called Divergence speed, where the elasticity of the lifting surface plays the essential role in the instability.

7. Define control effectiveness, C?

   Influence of the elastic deformation of the structure on the controllability of the airplane.

8. Define control system reversal, R?

   A condition occurring in flight, at a speed called the control reversal speed, at which the intended effects of displacing a given component of the control system are completely nullified by elastic deformation of the structure.

9. What is the effect of flutter in aircraft design?

- Original mass distribution is affected
- Lifting surface flat form is changed because twisting and bending
- Control surface design is highly affected

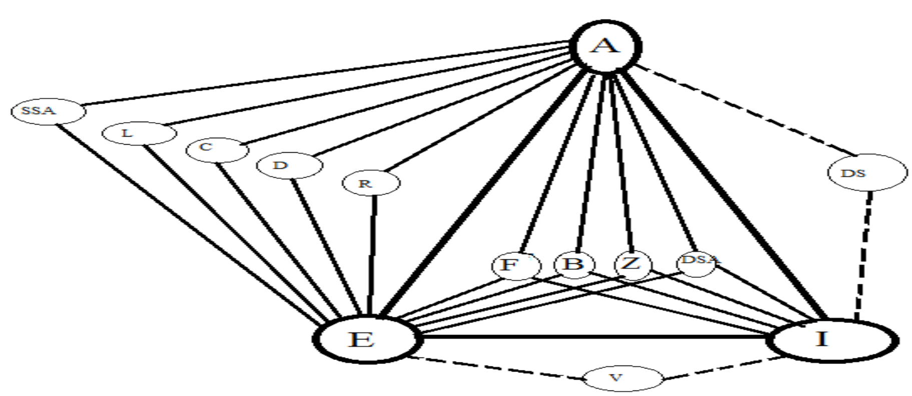
10. What is the type of flutter?

- Classical flutter
- Non-classical flutter

11.Differentiate the classical and Non-classical flutter?

a. Classical flutter	b. Non-classical flutter
c. d. 1.combined bending and torsional mode.(two or more D.O.F) e. 2. It is purely experimental. f. 3. it is approximated result.	g. h. 1.Any one mode either bending or torsion. i. 2.It is purely theoretical j. 3.It give properties of separated flow stalling condition, time lag effect ect.

12. Draw the collar's triangle of force?



A: Aerodynamic force

E: Elastic force

I: Inertia force

V: Mechanical Vibration

DS: Dynamic stability

F: Flutter

B: Buffeting

Z: Dynamic response

L: Load distribution

D: Divergence

C: Control effectiveness

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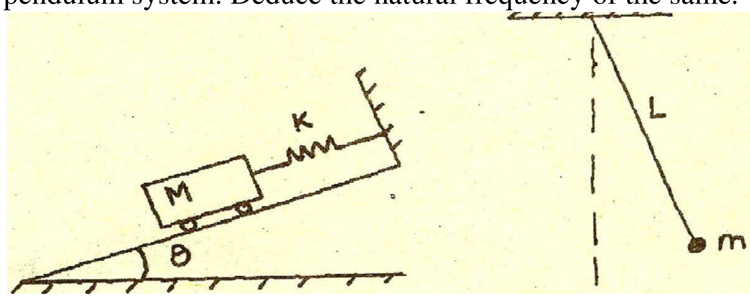
PART B

1. Drive expression and obtain the natural frequency of vibration of a spring mass system in vertical position using 1. Newton's law and 2. Energy method.

2. Drive expression and obtain the natural frequency of vibration of a spring mass system in horizontal position.

3. Obtain the expressions for the equivalent spring constants of spring when they are set in parallel and in series.

4. Using the energy method, obtain the equation governing free vibration for a simple pendulum system. Deduce the natural frequency of the same.



5. Consider a bar undergoing free axial vibrations. Derive and obtain the governing differential equation.

6. Derive the expression for torsional vibration.

7. Derive an expression for the natural frequency of the free longitudinal vibration by (i)Equilibrium method (ii) Energy method (iii)Rayleigh's method

8. Determine equation of motion when a liquid column vibrating in a 'U'tube by (i)Newton's method (ii) Energy method and hence find its natural frequency.

9. Derive and obtain the governing differential equation for a beam undergoing free bending vibration. Solve for natural frequencies and mode shape of a simple supported beam.

10. Consider a single degree of freedom spring mass damper system subject to a single frequency harmonic excitation. Obtain the steady-state system response. Define the magnification factor and phase angle.

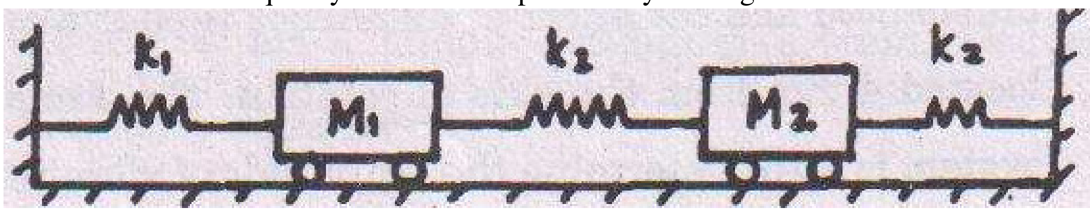
11. Derive and obtain the governing differential equation for the damped free vibrations of a single degree of freedom system. Then solve the same for the following cases :
    (i) Over damping
    (ii) Under damping. When is a system said to be critically damped?

12. Explain the application of Lagrange's equation in vibration.

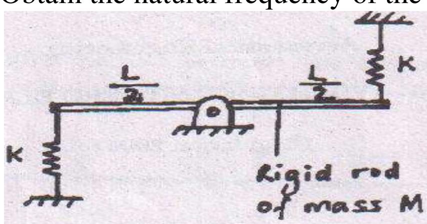
13. State Hamilton principle, obtain the governing equation.

14. Describe an approximate method for determining the frequency and mode shapes of a simply supported beam of arbitrary mass distribution undergoing flexural vibrations.

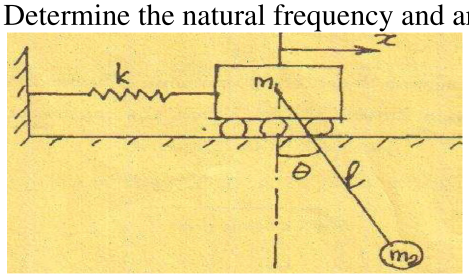
15. Obtain the natural frequency and mode shape of the system fig.



16. Obtain the natural frequency of the system fig.



17. Determine the natural frequency and amplitude ratios of the fig.



18. Deduce the expression for the free longitudinal vibration in terms of spring stiffness, its inertia effect and suspended mass.

19. Explain the different types of vibration measuring instruments?

20. Explain the working principle of frahms reed tachometer.

21. Discuss the design of a dynamic vibration absorber unit.

22. Write short notes on following
    (i) loss of aileron control
    (ii) divergence of a 2d using
    (iii) stall flutter

23. Consider a 2-d wing with aileron attached. Derive and obtain an expression for the aileron control reversal speed.

24. Distinguish resonance and flutter.

25. Explain Collar's triangle and different aeroelastic phenomen

26. Briefly discuss the different methods of flutter prevention,