Code No: R05412101 **R05** **Set No. 2**

IV B.Tech I Semester Examinations, November 2010

THEORY OF VIBRATIONS AND AEROELASTICITY

Aeronautical Engineering

Time: 3 hours Max Marks: 80

Answer any FIVE Questions

All Questions carry equal marks

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1. Figure below shows an equivalent model for a two storey building. The system consists of two rigid masses m_1 and m_2 supported on elastic columns. Columns as massless beams supported at both the ends. Elastic properties of the columns are as shown in the figure 6, Assume that the building only goes under horizontal motion. Let $m_1 = m_2 = m$, $H_1 = H_2 = H$, $I_1 = I_2 = I$.

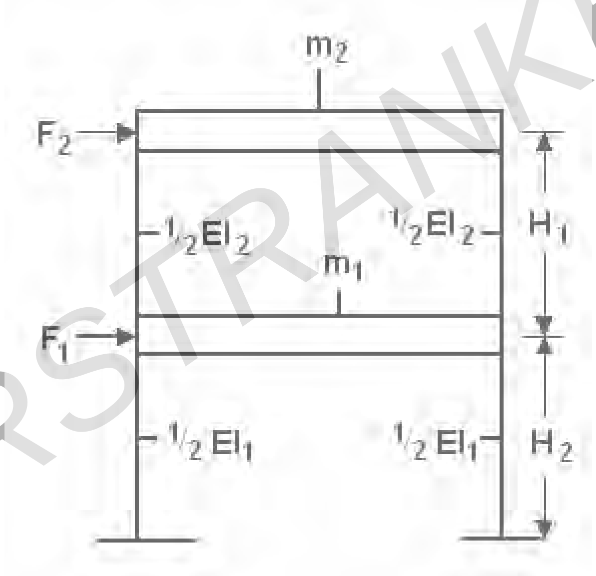

Figure 6

   (a) Derive the differential equations for the horizontal motion of the masses
   (b) Obtain the natural frequencies of the system
   (c) Obtain the natural modes of vibration
   (d) Plot the modes. [16]

2. Describe the following:
   (a) D'Alembert's principle
   (b) Various forms of dampling
   (c) Principle of virtual work
   (d) Amplitude vs Frequency response of a spring-mass-damper system for varying dampling co-efficient. [16]

3. A uniform cantilever beam of length L has a mass per unit length m and flexural rigidity EI.

   (a) The general deflection curve of the beam can be written as
   $(x) = C_1 \sin\beta x + C_2 \cos\beta x + C_3 \sinh\beta x + C_4 \cosh\beta x$ where $\beta^4 = \omega^2 m/EI$. Write down the necessary boundary conditions and obtain the characteristic equation to determine the natural frequencies.

   (b) The cantilever beam can also be represented as an equivalent generalized single degree of freedom system. Write down the expressions for the generalized mass and generalized stiffness in terms of the assumed shape function. Assuming the shape function as $\psi(x) = 3x^2/2L^2 - x^3/2L^3$ obtain the values of the generalized mass and stiffness and determine the fundamental natural frequency of the system. Calculate the percentage error if the exact value is obtained as $\omega = \frac{3.516}{L^2}\sqrt{\frac{EI}{m}}$. [6+10]

4. Draw first and second modes of vibrations of the followings:

   (a) Fixed-fixed beam
   (b) Cantilever beam
   (c) Fixed-fixed string
   (d) String fixed at one end and supported by a spring at the other end
   (e) Pinned - pinned beam. [16]

5. Using a two-degree-of-freedom model of an airfoil section for pitch and plunge motions and assuming steady flow aerodynamics, derive the equations of motion in terms of the lift and moment. Assuming a simple harmonic motion for classical flutter analysis, obtain the flutter determinant condition for a non-trivial solution. [16]

6. A projectile of mass m = 10kg, travelling at velocity v = 100 m/s, hits a board attached to a dashpot of damping co-efficient c = 400 Ns/m, and a spring of stiffness k = 400000 N/m as shown in the Figure 7. The projectile becomes embedded in the board (of negligible mass) after hitting it.

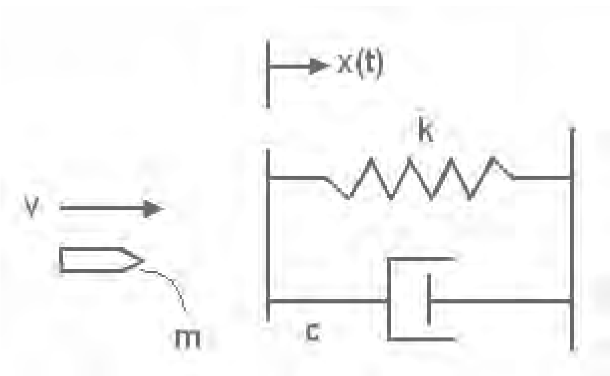

Figure 7

Answer the followings:

(a) Derive the equation of motion of the system after the projectile hits the board

(b) Determine the initial condition as a result of projectile hitting the board, assuming that the board-dashpot-spring system is at rest initially.

(c) Determine the natural frequency of vibration of the motion after the projectile hits the board.

(d) The maximum displacement of the board

(e) The time required for the board to reach the maximum displacement. [16]

7. A uniform massless cantilever beam of total length 1.5m and EI = 0.1×10^6 Nm^2 carries three lumped masses at points along its length as shown in the figure 8b. The smallest mass $m_1 = 100$ kg.

(a) Explain the Myklestad's method for calculating the natural frequencies of this system in pure flexure with the help of the necessary equations.

(b) Obtain the fundamental natural frequency of this system starting with an initial estimate as w = 10 rad/s. [6+10]

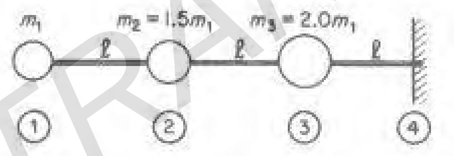

Figure 8b

8. Define whirling of a rotating shaft. Mention a few reasons for the occurrence of whirling.
A shaft carrying a rotor of 45.36kg and eccentricity 0.254 cm rotates at 1200 rpm. Determine:

(a) the steady-state whirl amplitude and

(b) the maximum whirl amplitude during start-up conditions of the system. Assume the stiffness of the shaft as 3.57×10^4 kg/cm and the external damping as 0.1. [16]

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Code No: R05412101 | R05 | Set No. 4

IV B.Tech I Semester Examinations, November 2010

THEORY OF VIBRATIONS AND AEROELASTICITY

Aeronautical Engineering

Time: 3 hours   Max Marks: 80

Answer any FIVE Questions

All Questions carry equal marks

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   (a) Fixed-fixed beam
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   (c) Fixed-fixed string
   (d) String fixed at one end and supported by a spring at the other end
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3. Describe the following:
   (a) D'Alembert's principle
   (b) Various forms of dampling
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4. Figure below shows an equivalent model for a two storey building. The system consists of two rigid masses m_1 and m_2 supported on elastic columns. Columns as massless beams supported at both the ends. Elastic properties of the columns are as shown in the figure 6, Assume that the building only goes under horizontal motion. Let $m_1 = m_2 = m$, $H_1 = H_2 = H$, $I_1 = I_2 = I$.

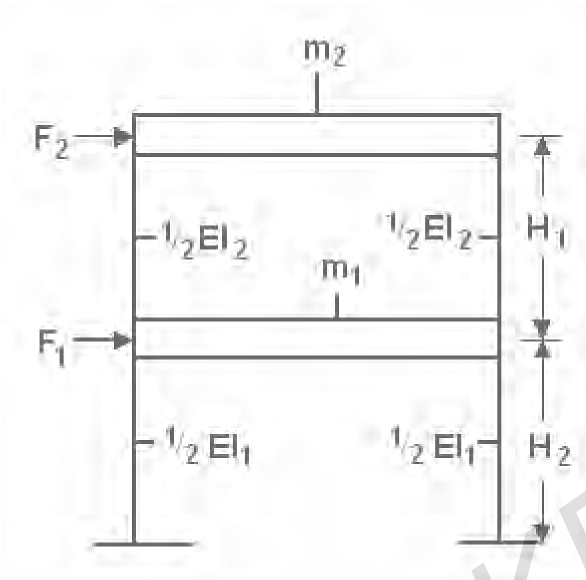

Figure 6

(a) Derive the differential equations for the horizontal motion of the masses

(b) Obtain the natural frequencies of the system

(c) Obtain the natural modes of vibration

(d) Plot the modes. [16]

5. A uniform massless cantilever beam of total length 1.5m and EI = 0.1×10^6 Nm^2 carries three lumped masses at points along its length as shown in the figure 8b. The smallest mass m_1 = 100 kg.

   (a) Explain the Myklestad's method for calculating the natural frequencies of this system in pure flexure with the help of the necessary equations.

   (b) Obtain the fundamental natural frequency of this system starting with an initial estimate as w = 10 rad/s. [6+10]

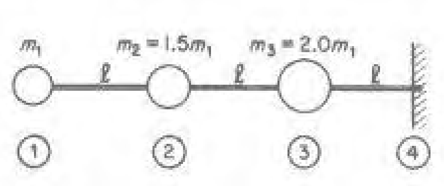

Figure 8b

6. A projectile of mass m = 10kg, travelling at velocity v = 100 m/s, hits a board attached to a dashpot of damping co-efficient c = 400 Ns/m, and a spring of stiffness k = 400000 N/m as shown in the Figure 7. The projectile becomes embedded in the board (of negligible mass) after hitting it.

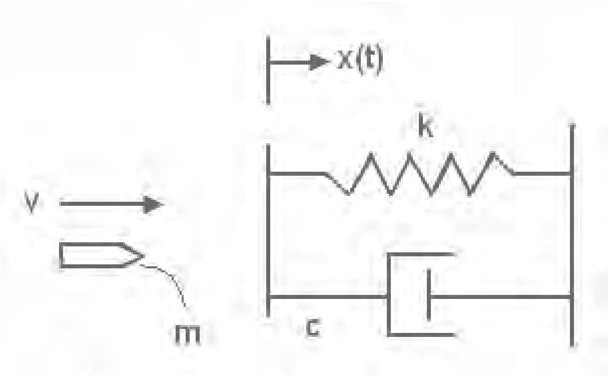

Figure 7

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(a) Derive the equation of motion of the system after the projectile hits the board

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7. A uniform cantilever beam of length L has a mass per unit length m and flexural rigidity EI.

(a) The general deflection curve of the beam can be written as $(x) = C_1 \sin\beta x + C_2 \cos\beta x + C_3 \sinh\beta x + C_4 \cosh\beta x$ where $\beta^4 = \omega^2 m/EI$. Write down the necessary boundary conditions and obtain the characteristic equation to determine the natural frequencies.

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8. Using a two-degree-of-freedom model of an airfoil section for pitch and plunge motions and assuming steady flow aerodynamics, derive the equations of motion in terms of the lift and moment. Assuming a simple harmonic motion for classical flutter analysis, obtain the flutter determinant condition for a non-trivial solution. [16]

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Code No: R05412101 **R05** **Set No. 1**

IV B.Tech I Semester Examinations, November 2010

THEORY OF VIBRATIONS AND AEROELASTICITY

Aeronautical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions

All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. A uniform massless cantilever beam of total length 1.5m and EI = 0.1×10^6 Nm^2 carries three lumped masses at points along its length as shown in the figure 8b. The smallest mass m_1 = 100 kg.
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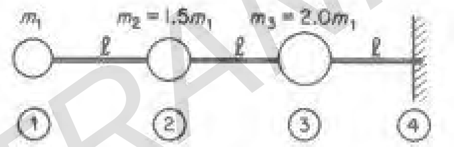

Figure 8b

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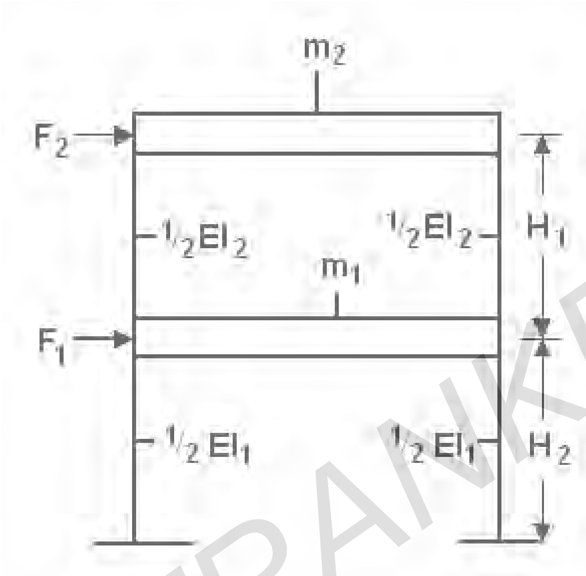

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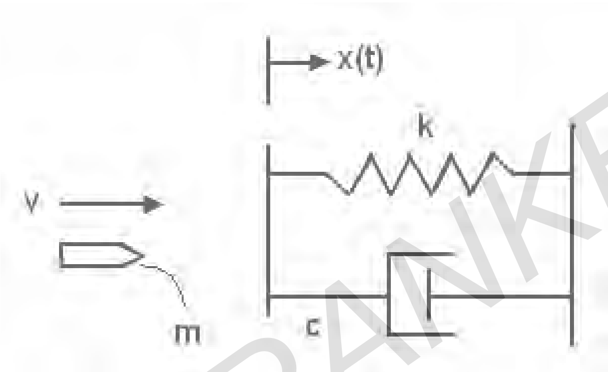

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Code No: R05412101 **R05** **Set No. 3**

IV B.Tech I Semester Examinations, November 2010

THEORY OF VIBRATIONS AND AEROELASTICITY

Aeronautical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions

All Questions carry equal marks

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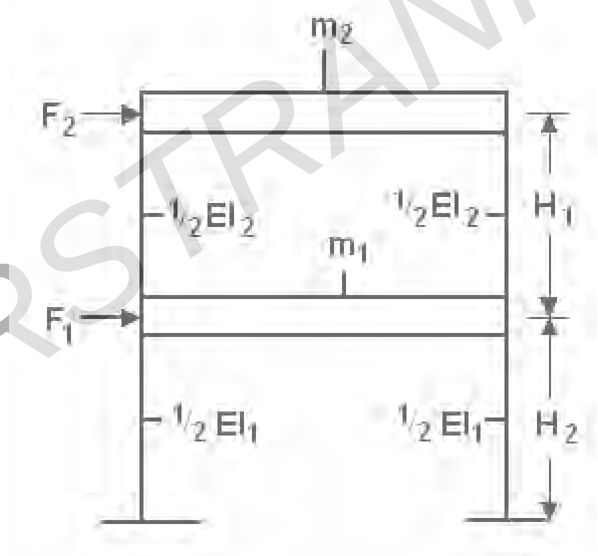

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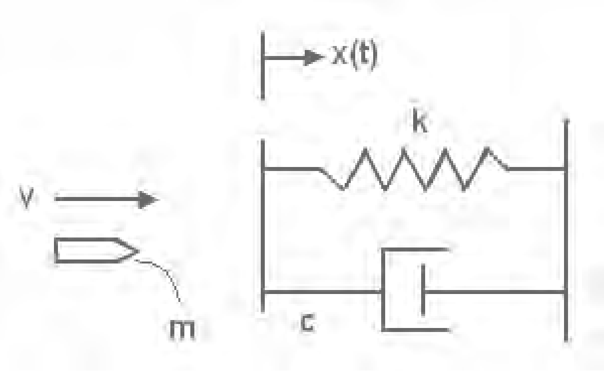

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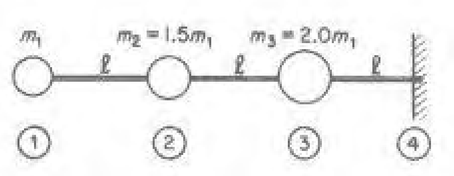

Figure 8b

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