C

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2015

CIVIL ENGINEERING

10CE6105 Structural Dynamics

Max. Marks : 60 Duration: 3 Hours

Part A (Modules I - II)

(Answer any two questions : 2 x 9 = 18 Marks)

I. A spring mass system with Coulomb damping has a mass of 10 kg attached to a spring of stiffness 1200 N/m. If the coefficient of friction is 0.03, calculate

i. The frequency of free vibration.

ii. Number of cycles corresponding to 50% reduction in the amplitude if the initial amplitude is 7 cm.

iii. The time taken to achieve this 50% reduction. (9)

II. a. Differentiate static and dynamic loads. (3)

b. In five cycles, the amplitude of motion is observed to decay from 30 mm to 0.15 mm. Calculate the damping ratio. (6)

III. A tower is idealised as a SDOF system. It is subjected to the loading as shown in Fig. b. Calculate the displacement history for t = 0.2, 0.4, 0.6 and 0.8seconds using numerical evaluation of Duhamel's integrals. Take a time step of 0.1 second. Neglect damping. Given the natural frequency of the system = 7 rad/second. (9)

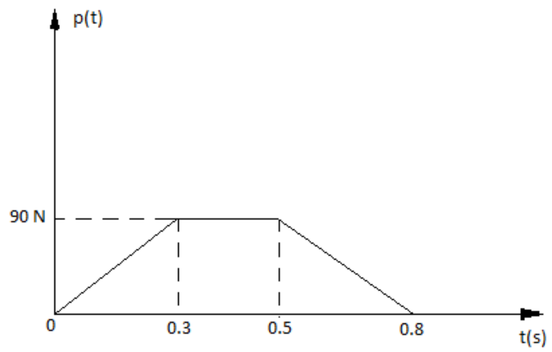


Fig. b

Part B (Modules III - IV)

(Answer any two questions : 2 x 9 = 18 Marks)

IV. Determine the natural frequencies of the structure shown in Fig.a. (9)

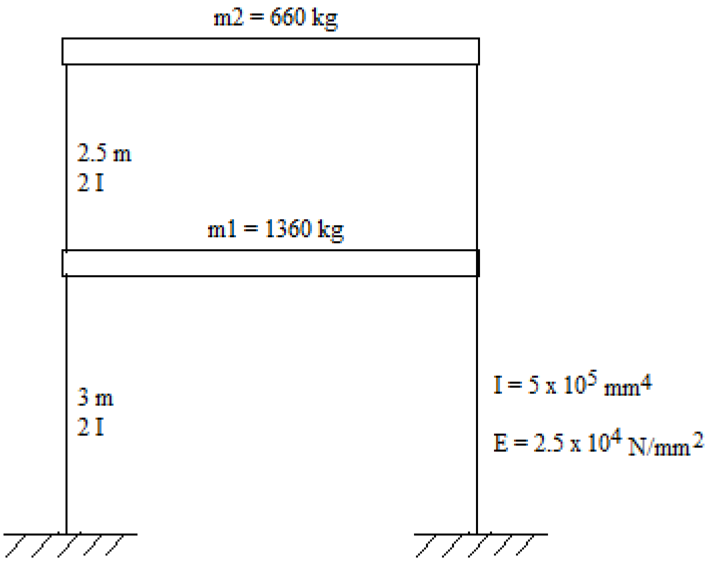


Fig.a

V. Explain Stodola procedure for determination of frequencies and mode shapes. (9)

VI. Determine the natural frequencies and mode shapes of the 2 storey shear type building shown in Fig. c by Rayleigh's method. (9)

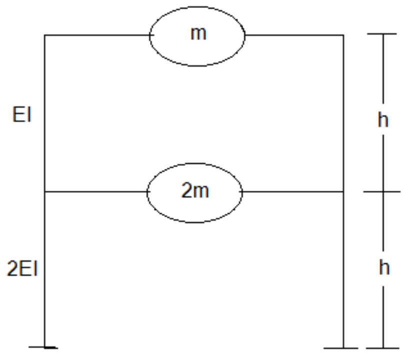


Fig. c

Part C (Modules V & VI)

(Answer any two questions : 2 x 12 = 24 Marks)

VII. Derive the expression for flexural vibration of a single span simply supported beam. (12)

VIII. Derive the expression for flexural vibration of a single span cantilever beam. (12)

IX. Write the Lagrange equation for a uniform cantilever beam (12)

C

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M. TECH DEGREE EXAMINATION, DECEMBER 2016

CIVIL ENGINEERING

10CE6105 Structural Dynamics

Max. Marks : 60 Duration: 3 Hours

Part A

(Answer any two questions : 2 x9 = 18 Marks)

I. A vibrating system consists of a mass 5 kg, spring of stiffness 120 N/m and a damper with a damping coefficient of 5 N-s/m. Determine : (a) Damped natural frequency (b) Logarithmic decrement (c) The number of cycles after which the initial amplitude is reduced to 25%.

II. a) Define damping in a vibrating system. (2)

b) A simply supported rectangular beam has a span of 1 m. It is 100 mm wide and 10 mm deep. A linear spring having stiffness of 98100 N/m is connected at the mid-span of the beam and a mass of 300 kg is attached at the other end of the spring. Determine the natural frequency of the system. Take E = 2.06 x 10^{12} N/m^2 (7)

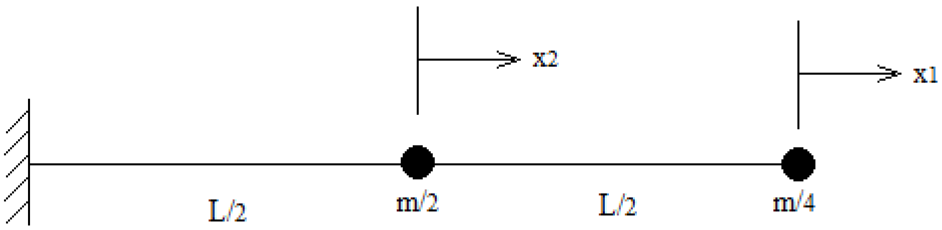
III. A SDOF spring- mass- damper system is subjected to harmonic excitation. The amplitude at resonance is found to be 27 mm and 12 mm at a frequency 0.6 times the resonant frequency. Determine the damping ratio.

Part B

(Answer any two questions : 2 x9 = 18 Marks)

IV. Explain any three methods of vibration control.

V. A cantilever bar is to be modelled by a massless uniform bar to which are attached with 2 lumped masses representing the mass of original system as k = 2AE/L and m=ρAL as shown in Fig.b. Determine the natural frequencies of this model.



VI. The normal modes of a 3 DOF system are given as

$$\phi_1 = \begin{Bmatrix} 0.743 \\ 0.482 \\ 0.224 \end{Bmatrix} \quad \phi_2 = \begin{Bmatrix} 0.636 \\ -0.386 \\ -0.432 \end{Bmatrix} \quad \phi_3 = \begin{Bmatrix} 0.21 \\ -0.535 \\ 0.513 \end{Bmatrix}$$

a) If the system is set to motion by an initial displacement of $u = \begin{Bmatrix} 0.7 \\ 0.124 \\ 0.5 \end{Bmatrix}$ units and released, Determine how much of each mode will be present in the resulting free vibration. (6)

b) Explain the concept of decoupling of equations. (3)

Part C

(Answer any two questions : 2 x 12 = 24 Marks

VII. Derive the general solution for the axial vibration of a uniform rod.

VIII. Solve the equation of motion and draw the modes for the flexural vibration of a uniform simply supported beam.

IX. Derive the differential equation of motion for a beam subjected to flexure including shear distortion and rotary inertia.

C

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M. TECH DEGREE EXAMINATION, DECEMBER 2017

Civil Engineering

(Computer Aided Structural Engineering)

10CE6105 Structural Dynamics

Max. Marks: 60 Duration: 3 Hours

Part A (Modules I - II)

(Answer any two questions: 2 x 9 = 18 Marks)

1. A vibrating system consists of a weight of 150 N and spring stiffness of 4 kN/m is viscously damped so that two consecutive amplitudes measured are 92 mm and 80 mm respectively. Determine the logarithmic decrement and the coefficient of damping.
(9 marks)

2. a) Derive expression for response of a damped SDOF system subjected to free vibration.

b) An SDOF system has m = 10 kg and k = 5 kN/m. The forcing function is shown in Figure 1. Evaluate the response using Duhamel's integral method at t = 0.2 s and 0.4 s.
(4 + 5 = 9 marks)

3. Explain Newmark′ s β method with relevant equations to evaluate the response of a single degree of freedom system. (9 marks)

Part B (Modules III - IV)

(Answer any two questions: 2 x 9 = 18 Marks)

4. Plot the mode shapes of the MDOF system shown in Figure 2. *(9 marks)*

5. (a) Explain the various methods for mathematical modelling of multi degree of freedom systems.
(b) Explain orthogonality of normal modes. *(5 + 4 = 9 marks)*

6. Determine the fundamental frequency of a cantilever beam by Rayleigh's method.
(9 marks)

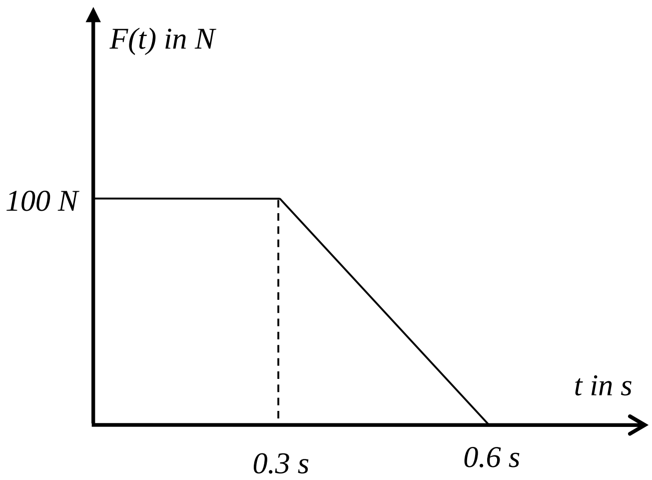


Fig.1

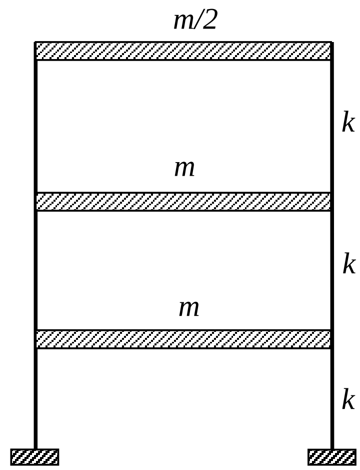


Fig. 2

Part C (Modules V & VI)

(Answer any two questions: 2 x 12 = 24 Marks)

7. Determine the response of a cantilever beam when its base is subjected to a pulsating motion, $\ddot{y}_{s0} \sin \omega t$. *(12 marks)*

8. Considering distributed mass and elasticity from fundamentals derive expressions for first three natural frequencies and draw mode shapes for a simply supported beam. *(12 marks)*

9. Determine the natural frequencies of a simply supported beam, by including the shear deformation and rotary inertia effects. *(12 marks)*

C

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH. DEGREE EXAMINATION, DECEMBER 2017

CIVIL ENGINEERING

10CE6105: STRUCTURAL DYNAMICS

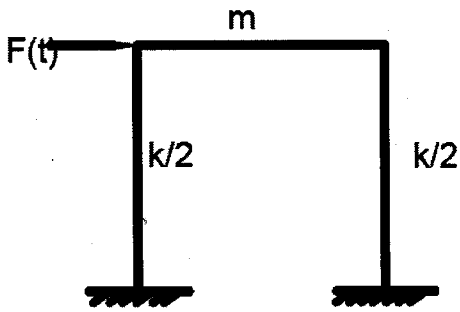
Max. Marks : 60 Duration: 3 Hrs

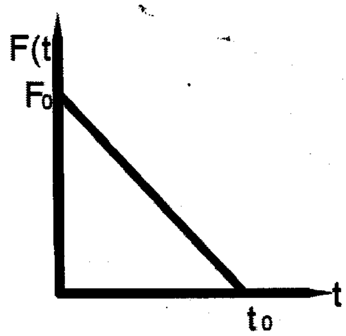
Part A (Modules I - II)

(Answer any two questions : 2 x 9 = 18 Marks)

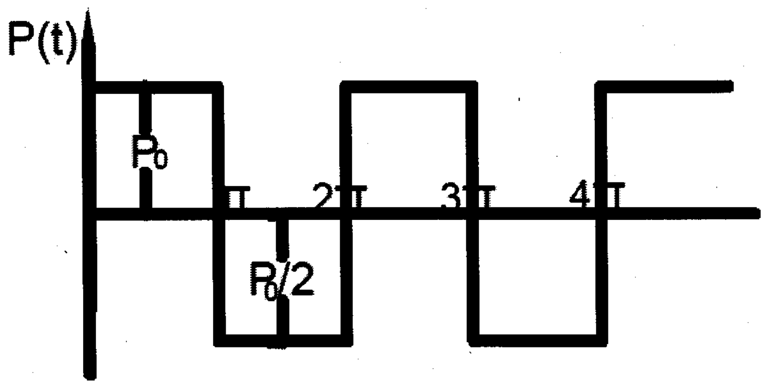
1. Derive equation of motion of Single Degree of freedom system. 9 Marks

2. A building frame shown in figure below is modelled as an undamped single degree of freedom system. Find the response of the frame subjected to a blast force represented by the triangular pulse shown. 9 Marks





3. Find the response of a given SDOF system. 9 Marks

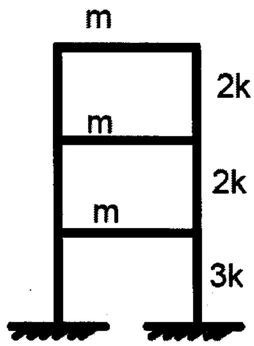


P.T.O

Part B (Modules III - IV)

(Answer any two questions : 2 x 9 = 18 Marks)

1. Discuss types of vibration isolation techniques. 9 Marks
2. Determine natural frequency and mode shapes for the framed structure shown in figure using Stodolas method 9 Marks



3. An aircraft instrument board with instruments having a mass of 25 kg is supported by four rubber mounts rated at 2.5mm/5 kg. What percentage of engine vibrations is transmitted to the instrument board at engine speed of i) 2000 rpm. And ii) 1500 rpm 9 Marks

Part C (Modules V & VI)

(Answer any two questions : 2 x 12 = 24 Marks)

1. Calculate first three natural frequencies and mode shapes of flexural vibrations of Simply Supported beam. 12 Marks
2. Discuss the effect of beam including shear deformation and rotary inertia 12 Marks
3. Calculate first three natural frequencies and mode shapes of flexural vibrations of fixed beam. 12 Marks

C

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2018

Civil Engineering

(Computer Aided Structural Engineering)

10CE6105 Structural Dynamics

Max. Marks : 60 Duration: 3 Hours

Part A (Modules I - II)

(Answer any two questions : 9 x 2 = 18 Marks)

I. A vertical cable 3m long has a cross-sectional area of 4 cm^2 supports a weight of 50 kN. Calculate the natural period and natural frequency of the system. E=2.1 x 10^6 kg/cm^2. Also derive the equation of motion. (9)

II. Derive the Expression for the response of undamped SDOF system subjected to harmonic loading. (9)

III. The damped frequency of a system is obtained as 9.8 Hz from a free vibration test. Maximum amplitude of damped vibration is found to be 9.6 Hz. Find the damping factor for the system and its natural frequency. (9)

Part B (Modules III - IV)

(Answer any two questions : 9 x 2 = 18 Marks)

IV. Explain the working principle of a tuned mass damper. (9)

V. Determine the natural frequencies and mode shapes of the system shown in Fig.a by solving the characteristic equation. (9)

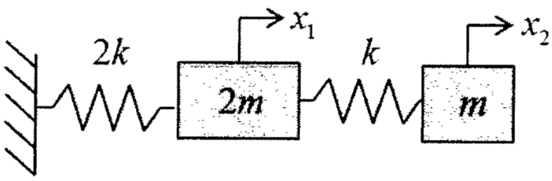


Fig. a

VI. Determine the natural frequencies and mode shape for the structure shown in Fig. b by Stodola's method. Given I = 5 x 10^5 mm^4, E = 2.5 x 10^4 N/mm^2. (9)

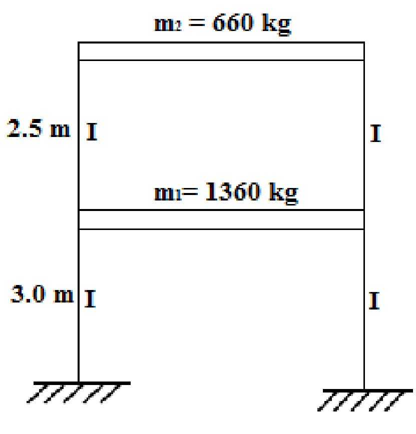


Fig.b

Part C (Modules V & VI)

(Answer any two questions : 12 x 2 = 24 Marks

VII. Derive an expression for the flexural vibration of a simply supported beam and draw the modes. (12)

VIII. Derive the differential equation of motion for the axial vibration of a uniform rod.(12)

IX. Derive the equation of motion for a uniform cantilever beam using Lagrange's equation (12)

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M. TECH DEGREE EXAMINATION, JULY 2019

Civil Engineering

(Computer Aided Structural Engineering)

10CE6105 Structural Dynamics

Max. Marks: 60 Duration: 3 Hours

Part A (Modules I – II)

(Answer any two questions: 2 x 9 = 18 Marks)

1. (a) Why is it important to find the natural frequency of a vibrating system? *(4 marks)*

   (b) An automobile having a mass of 2,000 kg deflects its suspension springs 0.02 m under static conditions. Determine the natural frequency of the automobile in the vertical direction by assuming damping to be negligible. *(5 marks)*

2. a) Derive expression for response of an undamped SDOF system subjected to free vibration with initial displacement as u_0 and initial velocity as $\dot{u}_0$. *(5 marks)*

   b) The natural frequency of a spring-mass system is found to be 2 Hz. When an additional mass of 1 kg is added to the original mass m, the natural frequency is reduced to 1 Hz. Find the spring constant k and the mass m. *(4 marks)*

3. A compacting machine is subjected to a constant force shown in Figure 1. Determine the response of the machine using Duhamel's integral. Consider no damping condition. (9 marks)

Part B (Modules III – IV)

(Answer any two questions: 2 x 9 = 18 Marks)

4. Compute the natural frequencies and plot the mode shapes of the two degree of freedom system shown in Figure 2. *(9 marks)*

5. (i) Explain the concept of vibration isolation with neat sketches *(5 marks)*

   (ii) List the applications of tuned mass damper. *(4 marks)*

6. Estimate the approximate natural frequency of two storey shear frame shown in Figure 3 using Rayleigh's method. *(9 marks)*

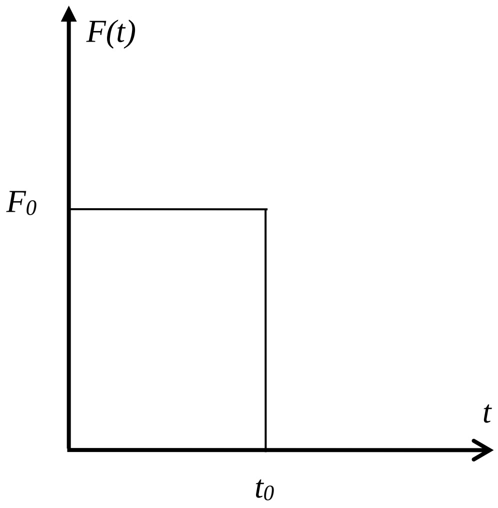


Fig.1

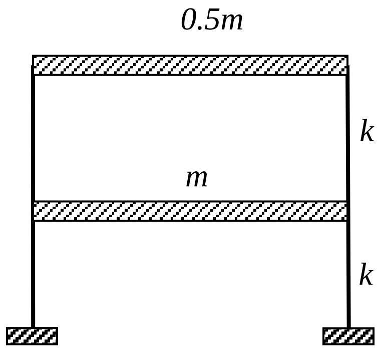


Fig. 2

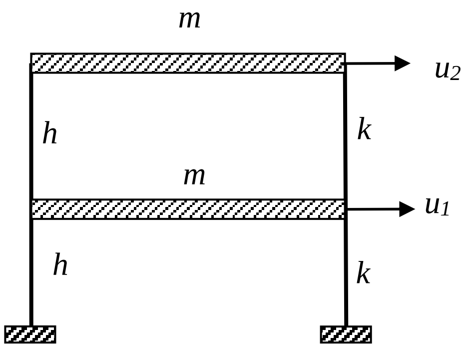


Fig. 3

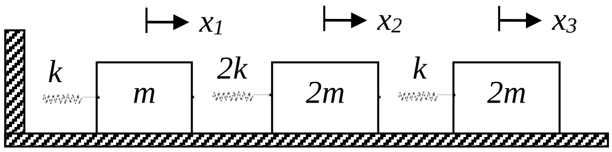


Fig. 4

Part C (Modules V – VI)

(Answer any two questions: 2 x 12 = 24 Marks)

7. Derive the partial differential equation governing free longitudinal vibrations of a uniform bar. *(12 marks)*

8. Develop the characteristic equation for a beam pinned at one end and free at its other end. *(12 marks)*

9. Use Langrange's equations to derive the differential equations governing the motion of the system shown in Figure 4 using x_1, x_2 and x_3 as generalized coordinates. Write the equation in matrix form. *(12 marks)*

C

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2019

Computer Aided Structural Engineering

10CE6105 Structural Dynamics

Max. Marks : 60 Duration: 3 Hours

Part A (Modules I - II)

(Answer any two questions : 9 x 2 = 18 Marks)

1. Determine the natural frequency of the system shown in Fig.1 (9)

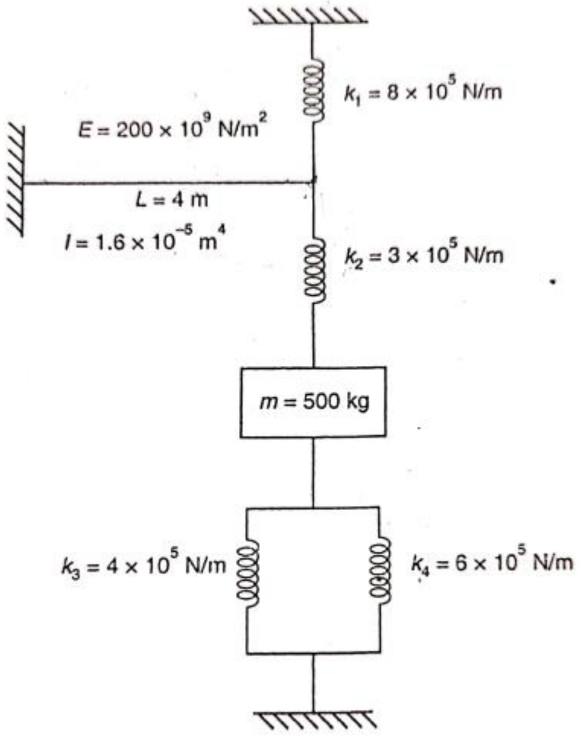


Fig. 1

2. A sinusoidal force of magnitude 30 N is applied to a vibrating system of mass 30 kg. It was found the maximum steadystate amplitude of 1.5 was recorded when the period of response is 0.25 seconds. Determine
   a) The equivalent stiffness of the foundation (4)
   b) The Damping ratio (5)
3. A Damped SDOF system has a mass of 50 kg, stiffness of 50 kN/m and damping coefficient of 100 N-s/m. The system is subjected to a harmonic force having maximum value of 250 N. Determine
   a) The resonant amplitude (5)
   b) Maximum amplitude for the steadystate motion (4)

Part B (Modules III - IV)

(Answer any two questions : 9 x 2 = 18 Marks)

4. Write notes on
   a) Lumped mass and consistent mass (4)
   b) Vibration controlling methods (5)
5. Determine the fundamental natural frequency and fundamental mode shape of the system shown in Fig.2 by Rayleigh's method (9)

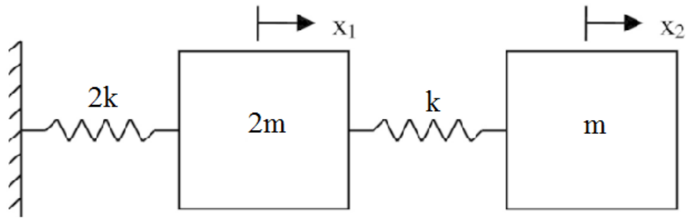


Fig. 2

6. Determine the natural frequencies for the system shown in Fig.3 by solving the characteristic equation. (9)

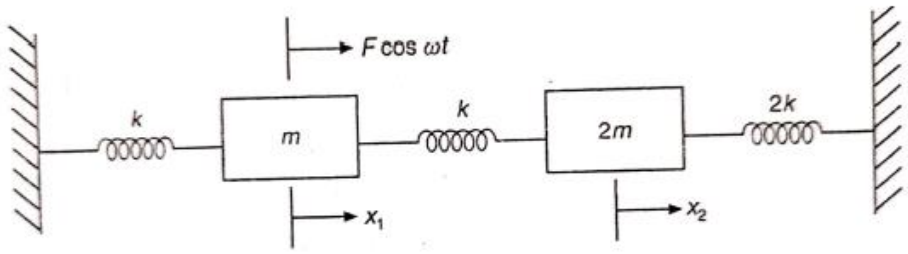


Fig.3

Part C (Modules V & VI)

(Answer any two questions: 12 x 2 = 24 Marks

7. Derive an expression for the flexural vibration of a fixed beam and draw the modes. (12)
8. a) Derive the differential equation of motion for the axial vibration of a uniform rod. (7)

   b) Using Lagrange's equation derive the basic dynamic equilibrium equation of an undamped free SDOF system (5)

9. Derive the differential equation of motion for beam flexure including shear and rotary inertia. (12)

Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

M.Tech S1 (R,S) Exam Dec 2020

Pages : 3 **C**

Reg. No……………… Name:……..…………………

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION

CIVIL ENGINEERING

10CE6105: STRUCTURAL DYNAMICS

Max. Marks : 60 Duration: 3 Hours

PART A (Modules I & II)

Answer any TWO full questions (2 x 9=18 Marks)

1 **(a)** Formulate the differential equation of motion for a simple pendulum. **(4 Marks)**

(b) If a vertical cable 254cm long with cross sectional area 3.23cm^2 supports a weight of 4536kg, find the natural frequency of the system. E=2.1×10^6 kg/cm^2. **(5 Marks)**

2 **(a)** The undamped natural frequency of an SDF system is 15 rad/s. The damping in the system is 8% of critical damping. If the initial velocity is 0.05 m/s and there is no initial displacement, determine the damped natural frequency of the system and the displacement after 1 second. **(5 Marks)**

(b) Derive an expression for logarithmic decrement. **(4 Marks)**

3 **(a)** Find the steady state response of an undamped system against a ramp pulse as shown in Fig. 1, using Duhamel's integral. **(5 Marks)**

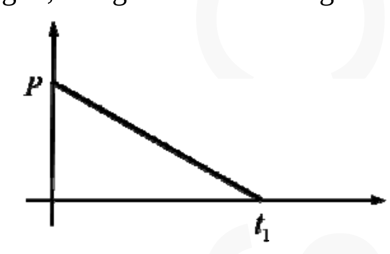


Fig. 1

(b) Name four direct numerical evaluation methods for dynamic analysis and explain any one of them. **(4 Marks)**

PART B (Modules III & IV)

Answer any TWO full questions (2 x 9=18 Marks)

4 **(a)** Derive an expression for response of a vibrating machine against a vertically vibrating foundation. Define transmissibility. **(6 Marks)**

(b) Write a note on methods of active and passive vibration control. **(3 Marks)**

5 **(a)** Determine the natural frequencies of the 2-storey shear frame shown in Fig. 2, by characteristic polynomial method. **(6 Marks)**

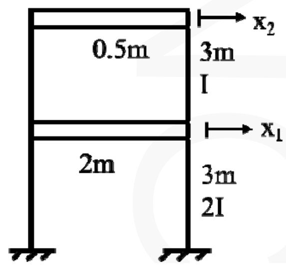


Fig. 2

(b) State and prove the condition of orthogonality of natural modes with respect to stiffness. **(3 Marks)**

6 **(a)** Determine the fundamental natural frequency and mode shape of the 3-storey shear frame shown in Fig. 2, by Rayleigh's method. **(6 Marks)**

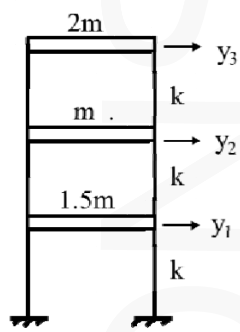


Fig. 3

(b) Write down the procedure of Stodola's method for analysis of MDF systems. **(3 Marks)**

PART C (Modules V & VI)

Answer any TWO full questions (2 x 12=24 Marks)

7 **(a)** Derive solution for undamped displacement response of axial free vibration of a uniform rod. **(6 Marks)**

(b) Find the generalised stiffness, generalised mass and Rayleigh's quotient for flexural vibration of a simple beam of span 3m, with uniform mass 350kg/m across span. $E=2.5\times10^{3}$ N/m^{2}, $I=3.0\times10^{9}$ mm^{4}. Assume harmonic shape function. **(6 Marks)**

8 **(a)** Differentiate between analysis for vibration of discrete systems and **(6 Marks)**

continuous systems.

(b) What are the corrections to be applied for the frequency response of Timoshenko beams? Derive expressions for the same. **(6 Marks)**

9 **(a)** Define Larangian. Give Lagrange equation for non-conservative systems. **(4 Marks)**

(b) Obtain the equation of motion for forced vibration of a damped SDF system from Lagrange equation. **(8 Marks)**

---------*----------

Reg No.:_______________ Name:__________________________

Pages : 3 **APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY** **C**

M.Tech S1 (R,S) Exam Dec 2021

Reg. No.……………… Name:……..…………………

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION

CIVIL ENGINEERING

10CE6105: STRUCTURAL DYNAMICS

Max. Marks : 60 Duration: 3 Hours

PART A (Modules I & II)

Answer any TWO full questions (2 x 9=18 Marks)

1 **(a)** Formulate the differential equation of motion for the system shown in Fig. 1. **(4 Marks)**

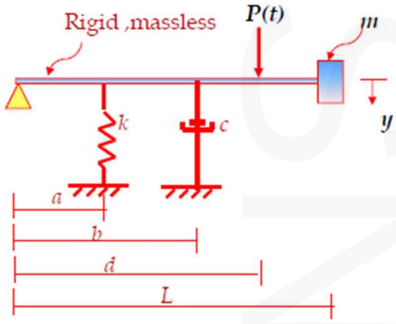


Fig. 1

(b) The system shown in Fig. 2 is a motor with mass 20 kg and suspension, 1000 N/m, that is attached to a flexible support beam with stiffness 200 N/m. Find the natural frequency of the combined system. **(5 Marks)**

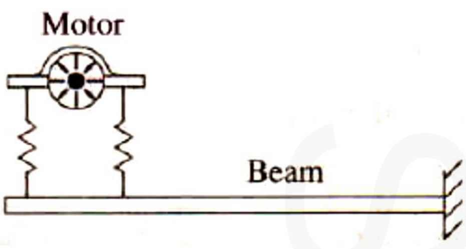


Fig. 2

2 **(a)** A block of weight 100 *kN* is undergoing undamped free vibration while attached to a weightless spring with stiffness 250 *kN/cm*. Given $x(0)=5cm$ and $\dot{x}(\pi)=5\ m/s$. Setup the equation of motion of the system and get an expression for displacement. **(5 Marks)**

(b) Explain resonance and its significance. **(4 Marks)**

3 **(a)** Find the steady state response of an undamped system against a ramp pulse as shown in Fig. 3, using Duhamel's integral. **(6 Marks)**

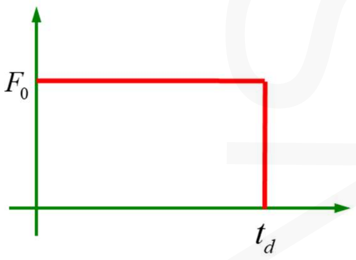


Fig. 3

(b) Explain Newmark's β method for numerical evaluation of dynamic response. **(3 Marks)**

PART B (Modules III & IV)

Answer any TWO full questions (2 x 9=18 Marks)

4 **(a)** A simply supported mild steel beam of span 4m with I = 8×10^7 mm^4 supports a machine of weight 120 kN. The motor runs at 400 rpm and the imbalance in the motor is 180 N at an eccentricity of 200 mm. Calculate the steady state amplitude of the vertical motion of the motor. Damping is 10% of critical damping. **(6 Marks)**

(b) Write a brief note on vibration control methods and devices. **(3 Marks)**

5 Determine the natural frequencies of the 2DOF system shown in Fig. 4, by characteristic polynomial method. m_1 = 2 kg, m_2 = 4kg, k_1 = 40 N/m, k_2 = 100 N/m, k_3 = 200 N/m. **(9 Marks)**

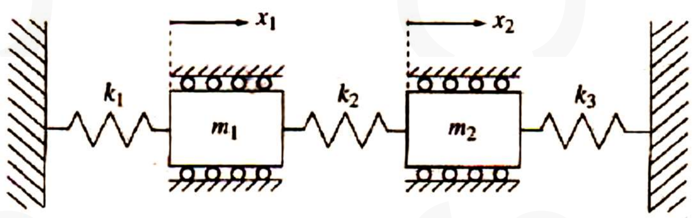


Fig. 4

6 Using Rayleigh's vector iteration method, find the fundamental natural frequency and mode of the 2-storey shear building in Fig. 5. **(9 Marks)**

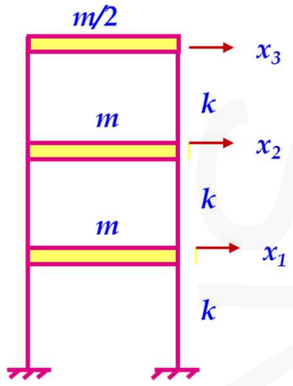


Fig. 5

PART C (Modules V & VI)

Answer any TWO full questions (2 x 12=24 Marks)

7 **(a)** State and prove the condition of orthogonality of natural modes with respect to stiffness, for a system with distributed properties. **(6 Marks)**

(b) Find the generalised stiffness, generalised mass and Rayleigh's quotient for flexural vibration of a simple beam shown in Fig. 6. Assume harmonic shape function. **(6 Marks)**

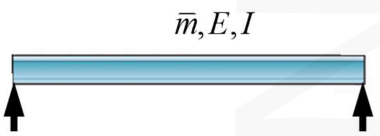


Fig. 6

8 **(a)** What are distributed-parameter (continuous) systems? How is their vibration analysis different from that of discrete systems? **(6 Marks)**

(b) "While corrections due to shear deformation and rotational inertia may be unimportant for the fundamental natural frequency, they could be significant for higher frequencies". Justify this statement. **(6 Marks)**

9 **(a)** Define Lagrangian. Give Lagrange equation for non-conservative systems. **(6 Marks)**

(b) Obtain the equation of motion for free vibration of an undamped SDF system from Lagrange equation. **(6 Marks)**

---------*----------