TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2083 Baishakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Structural Dynamics (*Elective I*) (*CE72501*)

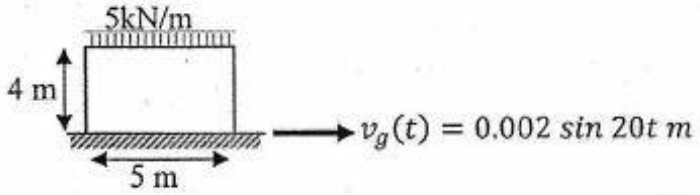
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Drive the relation for damped free vibration response specifying their special cases. [6]

   b) A steel tank supported on columns is tested for lateral vibration. A horizontal force of 20 kN displaces the tank laterally by 8 cm. After the force is removed, free vibrations occur. The amplitude drops from 6 cm to 2.4 cm over 4 cycles, and the time for 4 cycles is 2.8 seconds. [10]
   Find the following:
   a) Logarithmic decrement
   b) Damping ratio
   c) Undamped natural period
   d) Stiffness coefficient
   e) Mass of the tank
   f) Number of cycles for amplitude to reduce to 0.8 cm

2. a) Explain the effectiveness of base isolation under high frequency loading, and describe how damping properties play a role in optimizing performance of isolation system. [6]

   b) A frame shown in figure below is subjected to ground excitation $v_g(t)$ = 0.005 sin 30t m. Determine: [10]
   i) Transmissibility to the motion of girder,
   ii) Maximum shearing force in supporting column,
   iii) Maximum stress in the column,
   for the given properties such as E = 20 $\times 10^6$ kN/m^2, $\xi = 5\%$, column size 240 × 240 mm^2.



3. a) Determine the response of Down-ramp impulse loading induced due to sudden explosion using Duhamel's integral method. For this case, the loading function is given by: [6]

$$p(t) = \begin{cases} p_0\left(1 - \frac{t}{t_d}\right) & for\ t \le t_d \\ 0 & for\ t > t_d \end{cases}$$ where, t_d = time period at the endo of impulse load

and t = time period.

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2082 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Structural Dynamics (*Elective I*) (*CE72501*)

- ✓ *Candidates are required to give their answers in their own words as far as practicable.*
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Define viscous damping and explain its importance in structural dynamic application, highlighting its major features. [4]

   b) A one storey building is idealized as a rigid girder supported by weightless columns. In order to evaluate the dynamic properties of this structure, a free vibration test is made, in which the roof system (rigid girder) is displaced laterally by a hydraulic jack and then suddenly released. During the jacking operation, it is observed that a force of 9072 kg is required to displace the girder 0.51 cm. After the instantaneous release of this initial displacement, the maximum displacement of the first return swing is only 0.41 cm, and the period of this displacement cycle is 1.4 sec. [8]

2. a) Explain the effectiveness of base isolation under low and high frequency loading, and describe how damping properties play a role in optimizing its performance in both cases. [4]

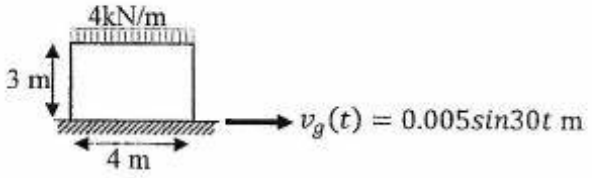
   b) A frame shown in figure below, is subjected to ground excitation $v_g(t) = 0.005sin30t$ m. Determine: [8]

   i) Transmissibility to the motion of girder,

   ii) Maximum shearing force in supporting column,

   iii) Maximum stress in the column,

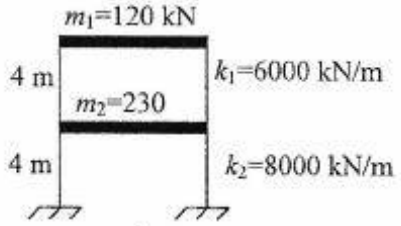
   for the given properties such as $E = 20 \times 10^6$ kN/m^2, $\xi = 5\%$, column size 240×240 mm^2.



3. a) Define unit impulse response function, Duhamel's integral and Convolution integral with their applicability. Also, determine the response of Down-ramp impulse loading induced due to sudden explosion using Duhamel's integral method. For this case, the loading function is given by: [2+6]

$$P(t) = \begin{cases} p_0\left(1 - \frac{t}{t_d}\right) & for\ t \le t_d \\ 0 & for\ t > t_d \end{cases}$$ where, t_d = time period at the end of impulse load and t = time period.

b) Determine the natural frequency and natural vibration mode shapes of the 2-storey building with infinitely rigid floors as shown in figure below. Also, draw each mode shape. [8]



4. a) Calculate the free vibration response of each storey using modal superposition method for the system having following properties: [10]

$$[m] = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1.5 & 0 \\ 0 & 0 & 2 \end{bmatrix} \frac{\text{kips.sec}^2}{in} \qquad [k] = 600 \begin{bmatrix} 1 & 1 & 1 \\ -1 & 3 & -2 \\ 0 & -2 & 5 \end{bmatrix} \frac{kips}{in}$$

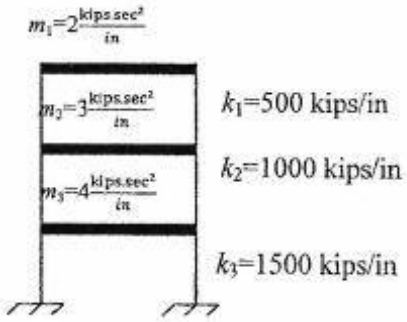
$$\{\omega\} = [14.52 \quad 31.05 \quad 46.10]^T \text{Rad/sec}$$

$$[\varphi] = \begin{bmatrix} 1 & 1 & 1 \\ 0.6486 & -0.6066 & -2.5405 \\ 0.3018 & -2.5405 & -2.4382 \end{bmatrix}$$

Assuming the structure is undamped, and free vibration would result from the following arbitrary initial conditions: $\{v(t=0)\} = [0.6 \quad 0.4 \quad 0.2]^T$ in, and

$$\{\dot{v}(t=0)\} = [0 \quad 6 \quad 0]^T \frac{in}{sec}$$

b) Determine the frequency of the given system shown in figure below using Rayleigh's methods: $R_{00}, R_{01}, and\ R_{11}$. [10]



5. Write short notes on: (Any Four) [4×5]

a) Response of damped free vibration
b) Uncoupled equation of motion and orthogonality condition
c) Element force due to ground motion
d) Frequency domain analysis for support motion
e) Reduction of DOF and static condensation
f) Holzer method to find the fundamental frequency

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2081 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Structural Dynamics (*Elective I*) (*CE 72501*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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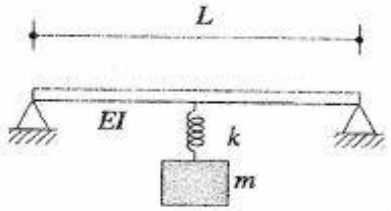
- ✓ *Assume suitable data if necessary.*

1. a) Describe prescribed loading and its types with suitable examples and also list the essential characteristic of the dynamic problem. Also, illustrate the essential characteristics of dynamic problems. [4+2]

   b) Assuming a massless simply supported beam, having length (L) and flexural rigidity (EI), which supports the mass (m) at its midspan from a spring of stiffness (k) at the midpoint of the beam as shown in below. Determine the natural cyclic frequency of the suspended mass. [10]



2. a) A free vibration test is conducted on an empty elevated water tank. A cable attached to the water tank applies a lateral force of 100 kN and pulls the tank horizontally by 5 cm. The cable is suddenly cut, and the resulting free vibration is recorded. At the end of five complete cycles, the time is 2.0 sec, and the amplitude is 2.5 cm. From the given data, compute the following: [8]

   i) Damping ratio
   ii) Natural period of undamped vibration
   iii) Stiffness
   iv) Weight
   v) Damping coefficient and
   vi) Number of cycles required for the displacement amplitude to decrease to 1 cm.

   b) Determine the dynamic response of the tower (figure a) subjected to a blast loading as shown in figure b. Use Duhamel integral and neglect damping effect. Also, calculate the maximum response. [8]

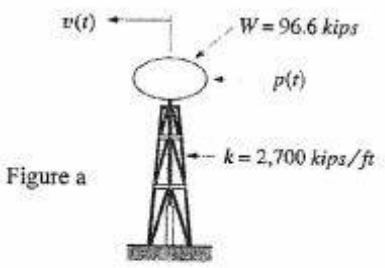


Figure a

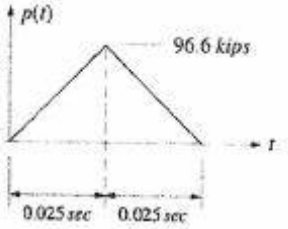
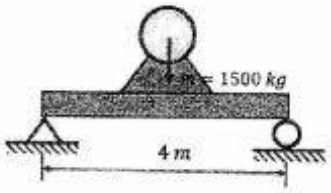
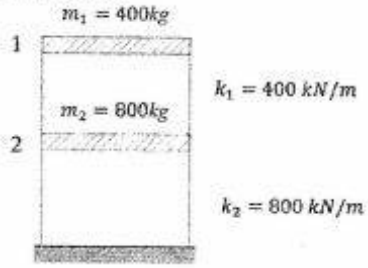


Figure b

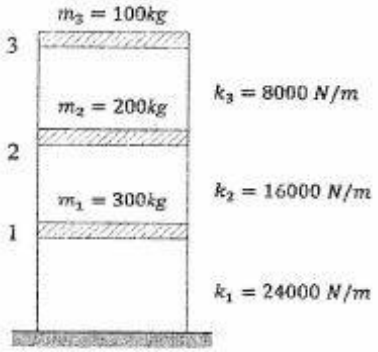
3. a) An electric motor of mass of 2000 kg is mounted on the center of simple RC beam of a size 230×230 mm^2 and span of 4 m as shown in figure below. The motor runs at a speed of 2000 rpm and its rotor is out of balance to the extent of 15 kg at a radius of 310 mm. Find the amplitude of the steady state response, if equivalent viscous damping for the system, is assumed 5% of critical damping. Neglect mass of beam. [8]



b) Find the natural frequencies and natural vibration mode shapes of the 2-storeyed building with infinitely rigid floors as shown in the figure below. Also, draw the mode shapes and write down the modal matrix. [8]



4. a) Evaluate the fundamental natural frequency and time period of vibration of the 3-storeyed building with rigid girders as shown in figure below Holzer's iteration method. Also, demonstrate the obtained fundamental frequency satisfies the support condition at base. [8+2]



b) Derive the equation of motion for the free transverse vibration of a prismatic beam. [6]

5. Write short notes on: (Any Four) [4×4]

a) Method of discretization
b) Vibration isolation and transmissibility
c) Orthogonality condition and Modal coordinate
d) Duhamel integral and Convolution integral
e) Response of a SDOF to a half-sine wave response
f) Frequency domain analysis for support motion

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2081 Baishakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Structural Dynamics (*CE72501*) (*Elective I*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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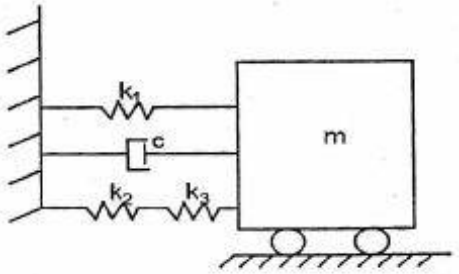
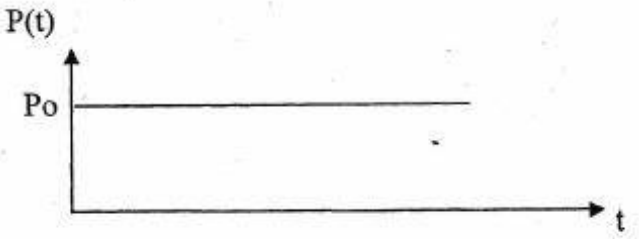
- ✓ *Assume suitable data if necessary.*

1. a) Consider a SDOF System shown in figure below., where m = 30 kg, c = 125 N-s/m. K_1 = 3000 N/m, K_2 = 5000 N/m, K_3 = 1200 N/m. Is the system is overdamped, critically damped or underdamped? [8]



b) Find the steady state response of an undamped system subjected to a constant impulse as shown in figure below. [8]



c) Explain the logarithmic decrement of motion and derive the expression. [2+2]

2. a) Obtain the expression for the dynamic magnification factor of an underdamped SDOF system subjected to a harmonic loading F (t) m= F_0 Sinωt. [4]

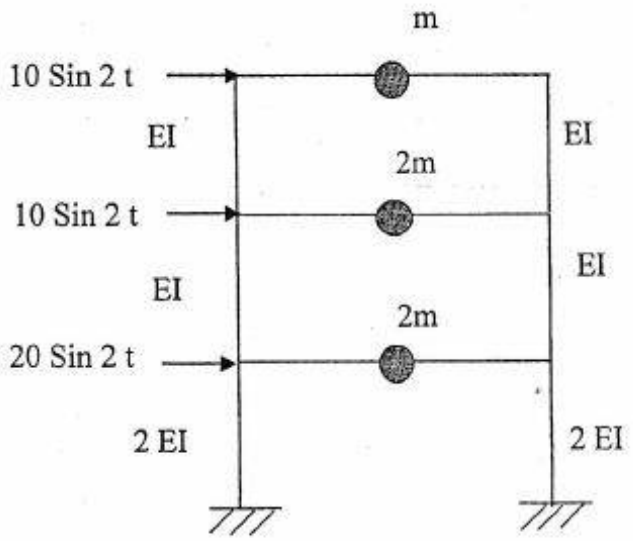
b) A portal frame supports a machine that exerts a sinusoidal force of 10 kN at a frequency of 1.5 Hz. The mass of machine is 3500 kg and is added to that of the frame. The mass of the frame at the floor level is 4000 kg and lateral stiffness is 4×10^6 N/m. [4+4]

i) Determine the steady state amplitude of vibration, if damping ration is 5%.

ii) What would be the steady state amplitude if the forcing frequency was in resonance with the supporting structure?

c) Write down the partial differential equation of motion of a transverse vibration of a string. Explain associated boundary conditions also. [4+4]

3. a) For the shear building shown in figure below, determine the steady state motion for the following load syste, (loads in kN). Take m = 15000 kg, E = 25000 MPa, I = 67,500 cm^4, Height of storey = 3.5 m. [15]



b) Determine the natural frequency of Q 3a using Stodola or Holzer method. [5]

4. Write the notes on: (Any Five) [5×4]

a) Vibration isolation and transmissibility
b) Frequency domain analysis of arbitrary loading
c) Step-by-step integration method of non-linear analysis
d) Uncoupled equation of motion
e) Energy dissipated in viscous damping
f) Orthogonality of modes

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2080 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

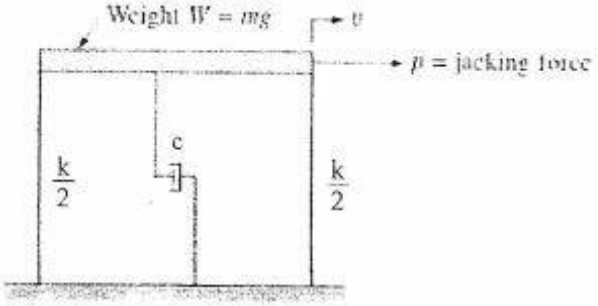
Subject: - Structural Dynamics (*CE72501*) (*Elective I*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks***
- ✓ *Assume suitable data if necessary*

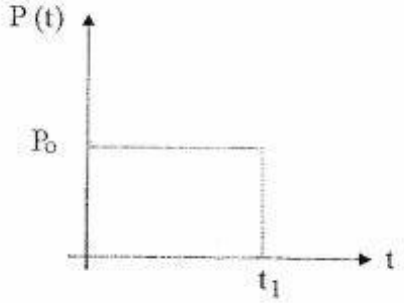
1. a) Explain with example the types of vibrations. [4]

   b) Assume that the mass and stiffness of the structure of fig. are as follows:

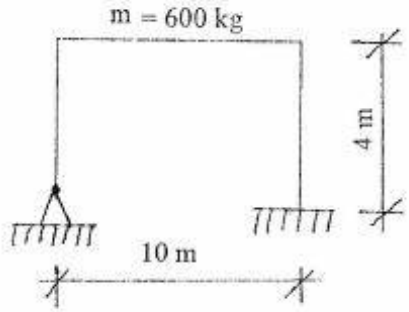
   m = 2 kips.sec^2/in, k = 40 kips/in. If the system is set into free vibration with the initial conditions v(0) = 1.0 in and v (0) = 6.0 in/sec, determine the displacement and velocity at t = 1.2 sec, assuming: (i) c = 0 (undamped system) (ii) c = 2.8 kips.sec/in [12]



2. a) For a SDOF system is subjected to step load of amplitude P_o and duration t_1 sec, as shown below. Determine the response of undammed system during forced and free vibration phases. [8]



   b) A steel frame shown in fig. supports a rotating machine, which exerts a horizontal force at girder level of 30,000 Sin (1ot) N. Take damping as 4% critical damping, moment of inertia of a column 14×10^{-5} m^4, E = 2×10^5 N/mm^2. Determine steady state motion and amplitude of vibration. [8]



3. a) A three storied massless frame is idealized in such a way that the lumped mass in the third, second and first floors are respectively 1, 2 and 3 kps-sec^2/in. Column stiffnesses in the third, second, and first stories are respectively 500, 1000 and 1500 kips/in. The columns are clamped at the bottom. Obtain the

   i) Vibration frequencies.

   ii) Determine and draw vibration mode shapes. [12]

   b) Demonstrate above problem (3a) satisfy I orthogonality condition. [4]

4. a) Write down the steps to carry out Stodola's and Holzer method. [8]

   b) Derive the equation of motion for transverse vibration of a string. [8]

5. Write short notes on: (Any Four) [4×4]

   a) Response to triangular impulsive loading
   b) Mode superposition method
   c) Frequency domain analysis of support motion
   d) Simple Harmonic motion
   e) Working principles of vibration measuring equipments.

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Exam.	Back		
Level	BE	Full Marks	80
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Year / Part	IV / I	Time	3 hrs.

Subject: - Structural Dynamic (*CE72501*) (*Elective I*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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1. a) Describe the terms damping, degree of freedom, simple harmonic motion, and natural frequency. [8]

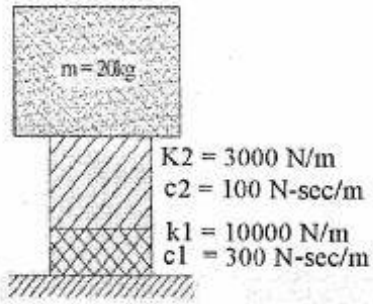
   b) A vibrating system consisting of a mass of 2.15 kg and spring stiffness of 18 N/cm is viscously damped such that the ratio of any amplitudes is 1.00 and 0.97. [8]

   Determine:

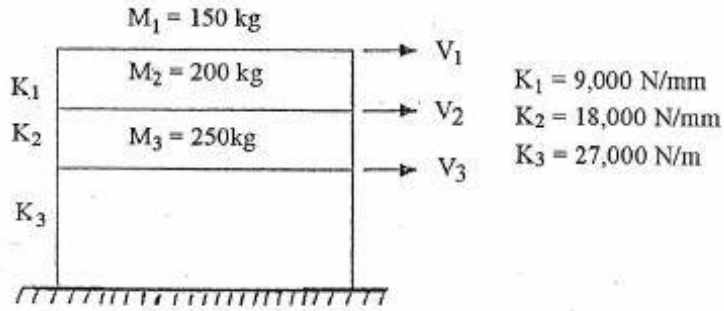
   i) The natural frequency of the damped system
   ii) The logarithmic decrement
   iii) The damping factor, and
   iv) The damping coefficient

2. a) Find natural frequency, damping ratio, logarithmic decrement and ratio of two successive amplitudes of SDOF system having weight 45.0 N, stiffness 54 N/cm and damping coefficient 0.215 N-sec/cm. Take g = 9.81 m/sec^2. What is difference in approximate and exact logarithmic decrement? [8]

   b) A mass of 20 kg supported on two isolators as shown in fig below. Determine the undamped and damped natural frequencies, neglecting the mass of the isolators. [8]



3. a) Determine the natural frequencies and mode shape for the given three storey shear building as shown. Draw the mode shapes and write down the complete model matrix. [12]



   b) Write down the orthogonality properties of mode shapes w.r. to mass and stiffness. [4]

4. a) Illustrate with the example how Stodola's method is carried out. [8]

   b) Write down the partial differential equation of motion of transverse vibration of beam. Explain associated boundary condition. [8]

5. Write short notes on: (Any Four) [4×4]

a) Time domain analysis and Frequency domain analysis
b) Stodola Method
c) Mode superposition method
d) Duhamel Integral
e) Rayleigh's improved method for vibration frequency

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2079 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
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Year / Part	IV / I	Time	3 hrs.

Subject: - Structural Dynamics (*Elective I*)(*CE72501*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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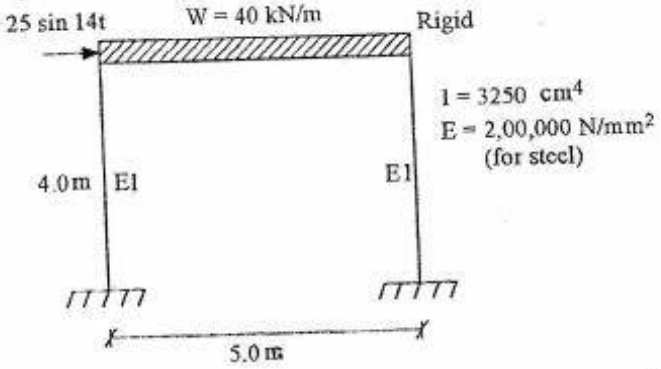
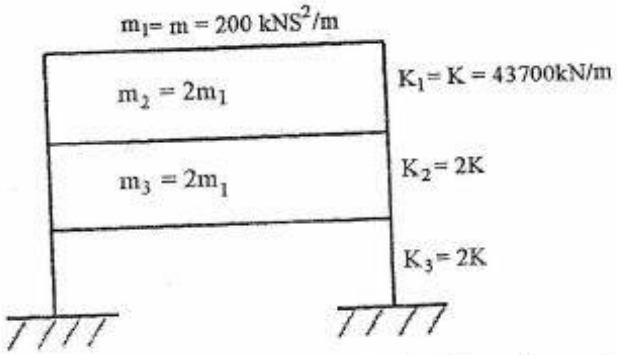
1. a) What is D' Alembert's principle and principle of conservation of energy? Explain. [3]
   b) Differentiate harmonic load from periodic load with examples. [4]
   c) Derive equation for response of SDOF system for un-damped free vibration and explain natural frequency, time period and amplitude of vibration. [9]
2. a) The SDOF system having viscous damping has a spring stiffness 500 N/m, when the weight is displaced and released, the period of vibration is 2.0 sec and ratio of successive amplitude is 4 to 1. Determine the amplitude of the motion, transmissibility ratio (TR) when a force F (t) = 4 sin 4t is applied to the system. [8]
   b) For the steel frame as shown below which is subjected to a horizontal force applied at the girder level BC. The force decreases linearly from 25 kN at time t = 0 to zero at t = 0.6 sec. Determine (i) The horizontal deflection at t = 0.5 secs (ii) The maximum horizontal deflection. Assume the columns to be massless and the girder is rigid. Neglect damping. [8]

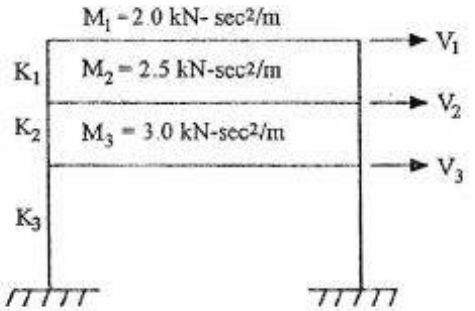


3. a) Determine the natural frequencies and modes shapes for the shear frame building as shown in the figure below. [12]



   b) Demonstrate numerically that the computed mode shape from above satisfies the orthogonality condition. [4]

4. a) Using matrix holzer method, find the fundamental period of vibration and fundamental mode shape of the three storey shear building as given. [10]



Where

K_1 = 700 kN/m
K_2 = 1100 kN/m
K_3 = 1700 kN/m

b) Derive the expression for equation of motion for transverse vibration of a beam. [6]

5. Write short notes on: (Any Four) [4×4]

a) Time domain analysis for general dynamic loading
b) Rectangular impulse
c) Axial vibration of the bar
d) Uncouple equation of motion
e) Periodic loading

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Level	BE	Full Marks	80
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Year / Part	IV / I	Time	3 hrs.

Subject: - Structural Dynamics *(Elective I) (CE7250I)*

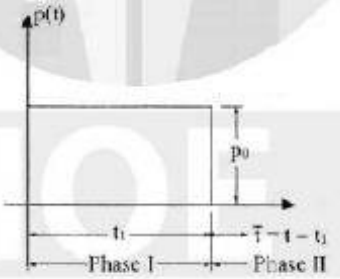
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What do you mean by critically damped system, under-critically damped system and over damped system? Explain with response diagrams. [9]

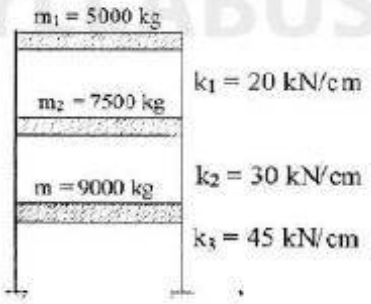
   b) Demonstrate that the equation of motion expressed with reference to static equilibrium position of the dynamic system is not affected by gravitational force. [7]

2. a) A centrifugal fan weighs 50 kg and has a rotating unbalance of 25 kg.cm. When dampers having damping factor $\xi = 0.2$ are used, specify the springs for mounting such that only 10% of the unbalanced force is transmitted to the floor. Also determine the magnitude of the transmitted force. The fan is running at a constant speed of 1000 rpm. [6]

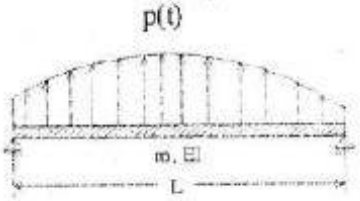
   b) Determine the response of SDOF system subjected to the rectangular impulse as shown in figure below. [10]



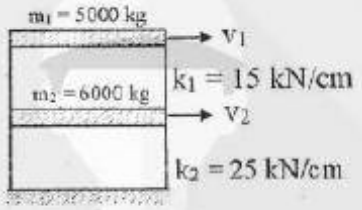
3. Find the frequency vector and mode shape matrix of the system as shown in figure below. [16]



4. a) Using partial differential equations of motion for a continuous system (beam) evaluate frequencies and draw mode shapes of the beam shown in figure. [8]



b) The mass and stiffness properties of a two storey shear building are shown in figure below. The structure is set into free vibration by displacing the floor by $v_1 = 1$ mm, $v_2 = 3$ mm and releasing them suddenly at time $t = 0$ sec. Find the deformed shape at time $t = 2$ sec. Assume undamped vibration. [8]



5. Write short notes on: [4×4]

a) Logarithmic Decrement
b) Duhamel integral
c) Mode superposition method
d) Rayleigh's Improved method for vibration frequency

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Structural Dynamics *(Elective I) (CE 72501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ *Assume suitable data if necessary.*

1. a) Derive the expression of damped free vibration response for SDOF system. [6]

   b) A free vibration test is conducted on an empty elevated water tank. A cable attached to the tank applied a horizontal force of 20kN and pulled the tank horizontally by 7cm. The cable is suddenly cut and the resulting free vibration is recorded. The time taken for 10 complete cycle is 4sec and the amplitude recorded at the end of 10 complete cycle is 2cm. From the data, compute the following: [10]
   (i) Damping ratio
   (ii) Natural period of undamped vibration
   (iii)Stiffness coefficient
   (iv)Effective weight
   (v) Damping coefficient
   (vi)No. of cycle required for the displacement amplitude to decrease to 0.2m.

2. a) Derive the expression for the response of the structure to the harmonic loading of the undamped system. [10]

   b) For a SDOF system is subjected to a rectangular pulse load of amplitude 120kN and duration 0.4 second. Determine the response of the tower having mass 500kg and stiffness 200kN/cm during forced vibration and free vibration phase. Assume undamped system. [6]

3. a) The mass and stiffness properties of a three-story shear building are shown in figure 1. The structure is set into free vibration by displacing the floors as follows: $v_1 = 0.3$ in, $v_2 = 0.8$ in and $v_3 = 0.3$ in and then releasing them suddenly at time $t = 0$. Determine the displaced shape at time $t = 2$ sec assuming undamped vibration. [16]

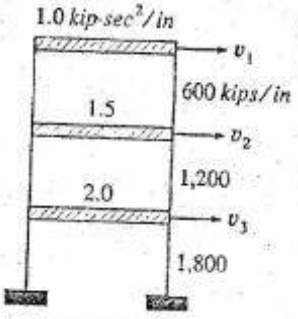

Figure 1

   b) Verify the orthogonality properties of the structure shown in above figure 1. [4]

4. Find the fundamental vibration mode shape and frequency for the structure as shown in figure 2 using Stadola or Holzer method. [12]

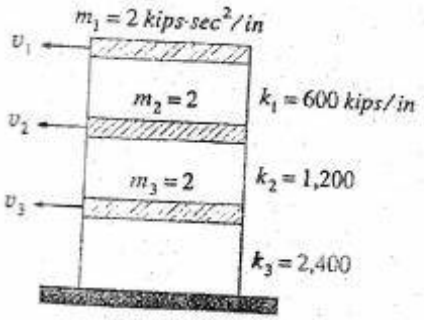

Figure 2

5. Write short notes on:
   a) Frequency domain analysis for supprot motion
   b) Stodala Method
   c) Seismic instrument
   d) Axial vibration of rod

[4×4]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Structural Dynamics *(Elective I) (CE 72501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) How to differentiate between static and dynamic loading? Describe types of dynamic loading. Explain D'Alembert's Principle. [8]

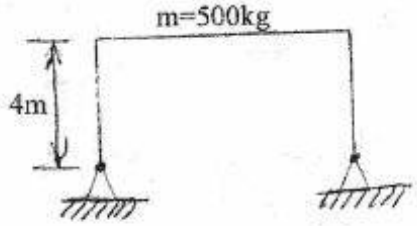
   b) A SDOF system consists of the following parameters: mass, m = 5 kg, k=100 N/m and damping e=3 N-sec/m. Determine:

   (i) the damping factor
   (ii) the natural frequency of the damped vibration
   (iii) logarithmic decrement
   (iv) No. of cycles after which the original amplitude is reduced to 20%? [8]

2. a) Determine the response of the following system under the given initial conditions. Stiffness 320 kN/cm, weight = 58.86 kN, damping constant = 4, initial displacement= 2cm and initial velocity = 7.6 m/sec. Also plot the response. [8]

   b) For a SDOF system is subjected to a rectangular pulse load of amplitude 100KN and duration 0.4 second. Determine the response of the tower having mass 500kg and stiffness 200 kN/cm during forced vibration and free vibration phase. Assume undamped system. [8]

3. a) A steel rigid frame, as shown in figure below, supports a rotating machine, which exerts a horizontal force at the girder level of 50,000 sin11tN. Assuming 4 percent critical damping, what is the steady state amplitude of vibration? $I_{column} = 1500\times10^{-7}$ m^4, $E=21\times10^{10}$ N/m^2. [6]



   b) Explain with an example how Holzer's method is carried out to determine the first mode of frequency of shear building. [10]

4. Find out the frequencies and mode shapes of a building system having multi degree of freedom as shown in figure below by matrix partition method. [16]

5. Write short notes on: (Any Four) [4×4]

   a) Vibration isolation and its effectiveness
   b) Time domain analysis for general dynamic loading
   c) Mode superposition method
   d) Transverse vibration of beam
   e) Axial vibration of a bar

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Structural Dynamics *(Elective I) (CE72501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ *Assume suitable data if necessary.*

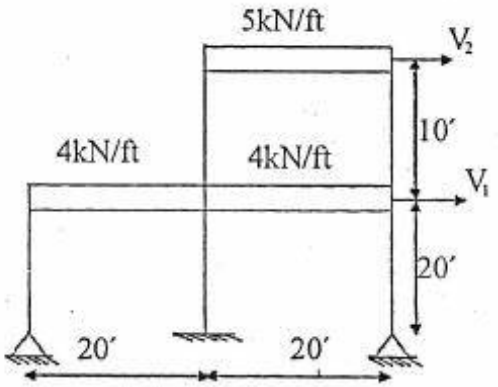
1. a) A block of mass 0.10 kg is suspended from a spring having a stiffness of 25 N/m. The block is displaced downwards from the equilibrium position through a distance of 2 cm and released with an upward velocity of 3 cm/sec. Determine
   (i) Natural Frequency (ii) Period of Oscillation
   (iii)Maximum Velocity (iv) Maximum Acceleration [10]

   b) A SDOF system having viscous damping has a spring of stiffness 550 N/m. When the weight is displaced and released, the period of vibration is 2.0 secs and ratio of successive amplitude is 4 to 1. Determine the amplitude of the motion and the phase angle when a force $F(t) = 5\sin 4t$ is applied to the system. [10]

2. a) The energy dissipated by damping in the structural system is represented by enclosed ellipse area. Prove the statement. [10]

   b) An electric motor of mass 160 kg is mounted on an isolator block of mass 1,000kg and the natural frequency of the total assembly is 140 cpm with damping ratio (ξ) = 0.12. If there is an unbalanced force of $F = 60\sin 30t$, determine amplitude of the vibrating of block and force transmitted to the floor. [10]

3. a) Determine the natural frequency and mode shape for the shear building as shown in figure below. Draw the mode shapes and also show that mode shapes meet the orthogonally condition. Take EI = 120 (kN/in^2) for all column. [10]



   b) Determine the steady state displacement at t = 0.5 sec for the above shear frame when it is subjected to a force p(t) = {4 sin5t, 8 sin5t} at each floor level respectively. [10]

4. a) Write down the partial differential equation of motion of transverse vibration of a string a beam. Also explain about associated boundary condition. [10]

   b) Define Dynamic magnification factor and response ratio. [5]

   c) Explain the logarithmic decrement method to evaluate the damping ration (ξ). [5]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Chaitra

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Structural Dynamics *(Elective I) (CE72501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ *Assume suitable data if necessary.*

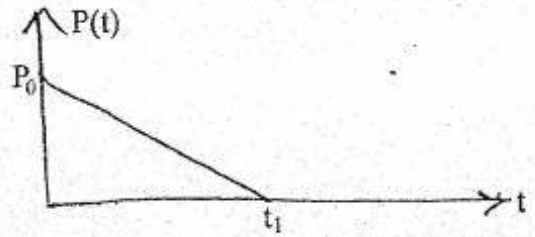
1. a) A machine weighting 100KN is mounted through springs having a total stiffness 20KN/m to a simple supported beam in the mid-span. Assuming 10% of critical damping and neglecting the weight of beam, determine: [10]

   (i) Equivalent mass
   (ii) Equivalent stiffness
   (iii)Natural frequency
   (iv)Equivalent damping coefficient

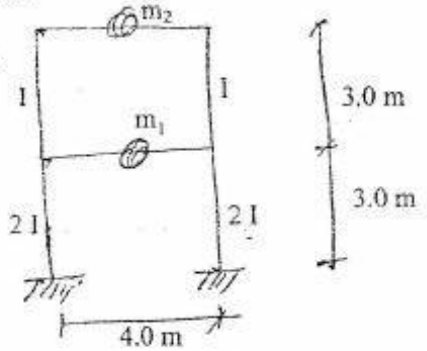
   b) A sensitive instrument with weight 450N is to be installed at a location where the vertical acceleration is 0.1g at a frequency of 10 Hz. This instrument is mounted on a rubber pad of stiffness 15 KN/m and damping such that the damping ratio of the system is 10%. What is the acceleration transmitted to the instrument? [10]

2. a) A delicate instrument weighting 100kg is to be mounted on a rubber pad to the floor of a test laboratory where the vertical acceleration is 0.2g at frequency of f=12 cps. It has been determined experimentally that ratio of the stiffness k, to the damping coefficient c, is equal to 100(1/sec) for the type of rubber pad material used in the isolation. What is the stiffness of the isolation required to reduce to 0.02g the acceleration transmitted to the instrument? [10]

   b) For a SDOF system is subjected to a triangular pulse load of amplitude P_0 and during 't_1' as shown below. Determine the response of the undamped system during forced vibration and free vibration phase. [10]



3. a) Determine the natural frequencies and mode shapes of the two storied shear building as shown. Also sketches the mode shapes and illustrate that modes shape satisfy the orthogonally conditions.



Where $m_1 = 2400kg$; $m_2 = 1700kg$
$EI = 8{,}000$ KN-m^2. If required to solved the problem. [10]

b) Illustrate with example how the Stodola method is used to find the first mode of shear building. [10]

4. Write short notes with appropriate expressions and description of notation (any two): [2×10]

a) Transverse Vibration of a string
b) Frequency domain analysis for support motion
c) Uncoupled equation of motion for the structure

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06A TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Structural Dynamics *(Elective I) (CE72501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any* ***Four*** *questions.*
- ✓ *The figures in the margin indicate* ***Full Marks.***
- ✓ *Assume suitable data if necessary.*

1. a) A structure is modeled as a damped oscillator with spring constant 100 kN/cm and an undamped natural frequency ω = 20 rad/sec. It was found that a force of 80 kN produced a relative velocity of 2.0 cm/sec in the damping element. Find (a) the damping ratio ξ, (b) the damped period T_D, (c) the logarithmic decrement δ, and (d) ratio between two consecutive amplitudes. [10]

   b) Determine the response of SDF system to the constant force shown in fig1: [10]

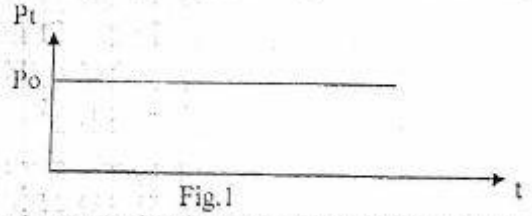
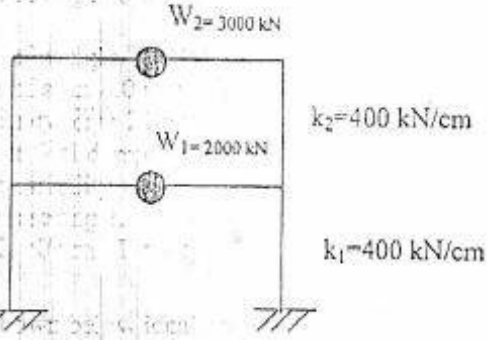


Fig.1

2. (a) Derive the expression for the response of the structure to the free vibration of underdamped system. [10]

   (b) A machine of weight of 120 kN is mounted centrally on a simply supported beam of span 4.0 m producing harmonic force of magnitude F= 150 kN at frequency $\bar{\omega}$ = 70 rad/sec. Neglect the weight of the beam and assume 15% of critical damping, determine the amplitude of motion of the machine, transmissibility ratio, force transmitted to the support and corresponding phase angle. [10]
   Take E = 2.1×10^5 N/mm^2, I = 45×10^6 mm^4 .

3. (a) The figure shown below idealized as two storey shear frame building. [20]
   i) Determine the natural frequencies, mode shapes and sketch.
   ii) Verify the orthogonality properties.
   iii) Normalize each mode so that roof displacement is unity.
   iv) Normalize each mode so that the modal mass M_n has unit value .
   v) Determine the free vibration response of the structure of at t= 0.2 sec, if initial displacement is $<0.04 \quad 0.08>^T$ and initial velocity is $<0.2 \quad 0.4>^T$



4. a. Find the fundamental vibration mode shape and frequency for the structure shown in fig 3 using Stodola or Holzer method. [10]

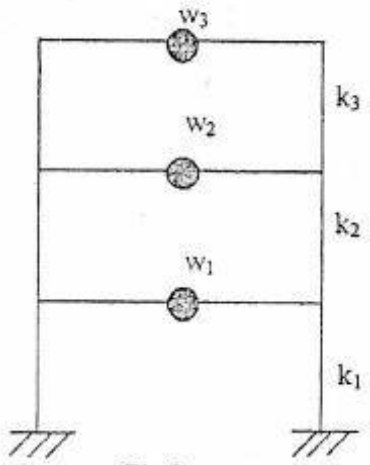


Fig.3

$W_1 = W_2 = 400$ kN; $W_3 = 350$ kN;
$K_1 = 400$ kN/cm; $K_2 = 350$ kN/cm and $K_3 = 300$ kN/cm

b. Derive the expression for the equation of motion for transverse vibration of a beam. [10]

5. Write the notes on (any four): [5x4]
   a. Uncoupled equation of motion
   b. Duhamel integral
   c. Mode superposition method
   d. Time domain analysis for general dynamic loading
   e. Lagrange's equation of motion

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06A TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Chaitra

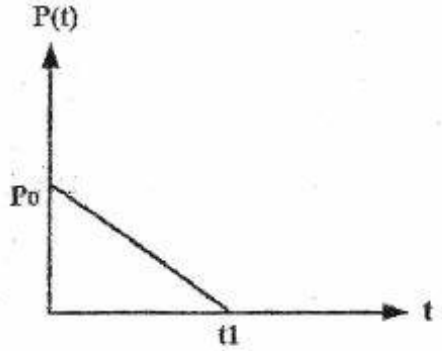
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Structural Dynamics *(Elective I) (CE72501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Four** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) A free vibration test is conducted on an empty elevated water tank. A cable attached to the tank applied a horizontal force of 20KN and pull the tank horizontally by 7 cm. The cable is suddenly cut and the resulting free vibration is recorded at the end of 10 complete cycle the time is 4 sec and the amplitude is 2 cm, from the data compute the following. [10]
   a) Damping ratio
   b) Natural period of undamped vibration
   c) Stiffness coefficient
   d) effective weight
   e) Damping coefficient
   f) No. of cycle required for the displacement amplitude to decrease to 0.2 cm.

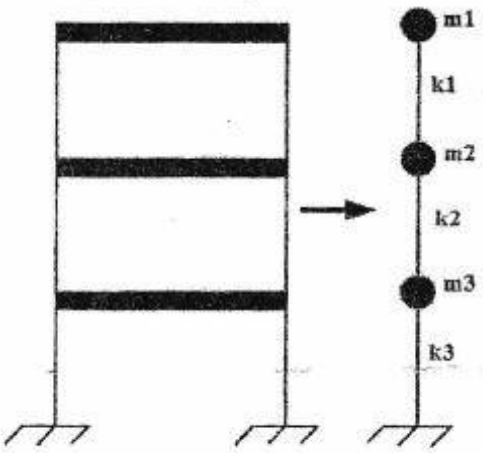
   b) For a SDOF system is subjected to a triangular pulse load of amplitude Po and during 't1' as shown in the figure below. Determine the response of the undamped system during forced vibration and free vibration phase. [10]



2. a) A machine of mass 100 kg is supported on steel springs that deflect 1.2 mm under the weight of the machine. At the operating speed of the motor of 3000 rpm, imbalance causes a maximum disturbing force of 360 KN. What is the maximum force transmitted to the foundation if damping in the steel springs is negligible? If the steel springs were replaced by neoprene pads having the same stiffness but a damping ratio 0.2, what would be the maximum transmitted force? [10]

   b) What is dynamic magnification factor? What are the factors influencing dynamic magnification factor? Explain with suitable curve plot. [10]

3. a) Determine the Eigen values and Eigen vector for the shear building as shown in figure. Draw the Mode Shapes and write down the modal matrix. [15]



Top story: $m_1 = m = 150$ kN.sec^2/m , $k_1 = k = 43750$ kN/m
Middle story: $m_2 = 2m$, $k_2 = 2k$
Ground story: $m_3 = 2m$, $k_3 = 2k$

b) Demonstrate numerically that the computed mode shapes satisfy the orthogonality conditions with respect to stiffness only. [5]

4. a) Illustrate with an example how Holzer method is carried out to determine the first mode frequency of a shear building. [10]

b) Write down the partial differential equation of motion of transverse vibration of a string and beam. Explain about associated boundary condition. [10]

5. Write in brief with necessary relationships: (any four) [4X5]
   a. Duhamel's integral and its solution.
   b. Logarithmic decrement
   c. Dirac-Delta Function and Unit Impulse Response Frequency
   d. Mode Superposition Method.
   e. Vibration isolation and Transmissibility

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6 A TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Structural Dynamics *(Elective I) (CE72501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) An SDOF system (m = 20kg, k = 20N/m) is given an initial displacement of 10mm and initial velocity of 150 mm/sec. Find: [8]

   (i) The natural frequency
   (ii) The period of vibration
   (iii) The amplitude of vibration
   (iv) The time at which the fifth maximum peak occurs

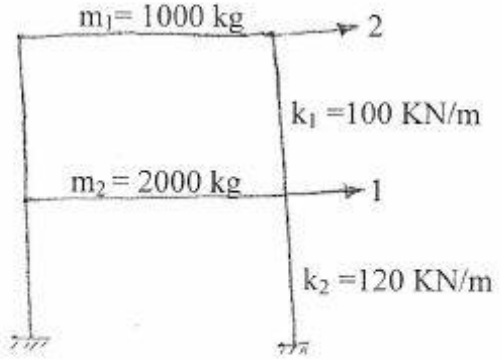
   b) A vibrating system consisting of a mass of 2.15 kg and a spring stiffness 17N/cm is viscously damped such that the ratio of any two consecutive amplitude is 1.00 and 0.97. Determine (i) the natural frequency of the damped system (ii) the logarithmic decrement (iii) the damping factor (iv) the damping coefficient [8]

2. a) A centrifugal fan running at a constant speed of 1000 rpm weighs 100 kg and has a rotating unbalance of 30 kg-cm. When dampers having damping factior ξ = 0.1 are used, specify the spring stiffness for mounting such that only 10% of the unbalance force is transmitted to the floor. Also determine the magnitude of transmitted force. [8]

   b) The equation of motion of a SDOF system is given by $1000\ddot{\upsilon}(t)+1600\upsilon(t)=P(t)$ with initial displacement and velocity equal to zero. The system is subjected to a rectangular impulse of 20 KN for 0.2 seconds. Determine the response of the system at t = 0.3 Sec. Units of mass and stiffness are Kg and KN/m respectively. [8]

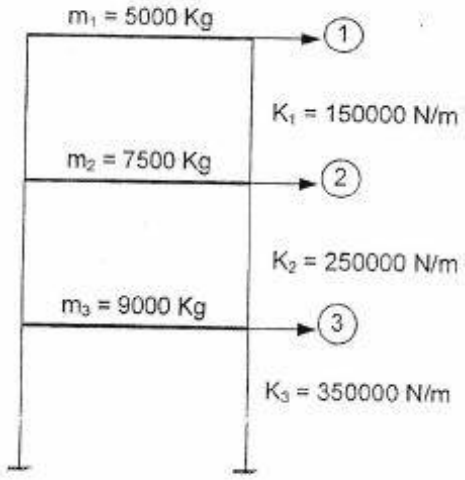
3. The below figure represents a two storey frame idealised as a shear building. The mass and the stiffness parameters are indicated in the same figure. For the given system,

   a) Formulate the equation of motions
   b) Determine the modal frequencies
   c) Draw the made shapes of the frame
   d) Determine the free vibration response at t = 0.4sec if initial displacement = $[0.01 \quad 0.08]^T$m and initial velocity = $[0.2 \quad 0.1]^T$ m/sec. [16]



4. a) Write down the steps to determine frequencies and mode shapes of a system having multi degree of freedom by matrix iteration (Stodola) method. [6]

   b) Using Improved Rayleigh (R00, R01 and R11) method, determine fundamental frequency of vibration of three storey building frame shown in below figure. [10]



5. Write short notes on: (Any Four) [4×4]

   a) Orthogonality conditions for mode shapes
   b) Vibration isolation and its effectiveness
   c) Traserverse vibration of beam
   d) Axial vibration of rod
   e) Response to rectangular impulse

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6 A TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Structural Dynamics *(Elective I) (CE72501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Assume that mass and stiffness of a system are 200 Kg and 5000 N/m respectively and it is undamped. If initial displacement is 40 mm and the displacement at t = 1.2 second is also 40 mm, determine displacement at t = 2.4 second. Also determine the amplitude of free vibration. [8]

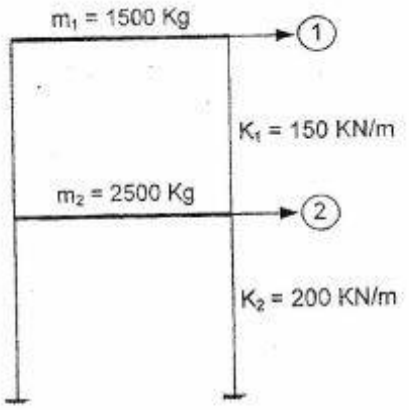
   b) A single bay concrete frame having with fixed support at its base has height 4m, column size 240 mm × 240 mm, E = 25000 N/mm^2 and structure weight 100 KN lumped at its floor level. If the frame is subjected to a sinusoidal ground motion $v_g(t)$ = 4sin5t mm, determine i) transmissibility of motion to girder, ii) maximum shear force and bending moment in support columns and iii) maximum stress in the columns. [4+2+2]

2. a) Derive the expression for the response of the structure to the harmonic loading of the undamped system. [8]

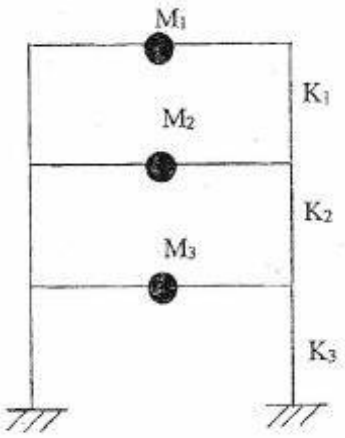
   b) An electric motor of mass 150 kg is mounted on an isolator block of mass 1200 kg and the natural frequency of the total assembly is 150 cpm with damping factor ζ = 0.15.

   If there is an unbalance force of F = 80 Sin 31.4t, determine amplitude of the vibration of the block and transmitted to the floor. [8]

3. The figure shown below represents a two-storey frame idealized as a shear building. The mass and the flexural rigidity parameters are indicated in the same figure. For the given system determine free vibration response at t = 0.5 sec if initial displacement and velocity are $[0.02 \quad 0.01]^T$ m and $[0.3 \quad 0.2]^T$ m/s respectively. [16]



4. a) Find the fundamental vibration mode shape and frequency for the structure shown in figure below using Stodola or Holzer method. [10]



$M_1 = 40$ kg; $M_2 = M_3 = 60$ kg;
$K_1 = 600$ N/m; $K_2 = 800$ N/m and $K_3 = 1000$ N/m

b) Derive the expression for the equation of motion for an axial vibration of a bar. [6]

5. Write short notes with appropriate expressions and description of notations. (Any four) [4×4]

a) Over damped system
b) Unit impulse response function
c) Mode superposition method
d) Uncoupled equations of motion
e) Complex frequency response function

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05A TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Shrawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Structure Dynamics *(Elective I) (CE72501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) How dynamic problems differ from static problem? Explain. [4]

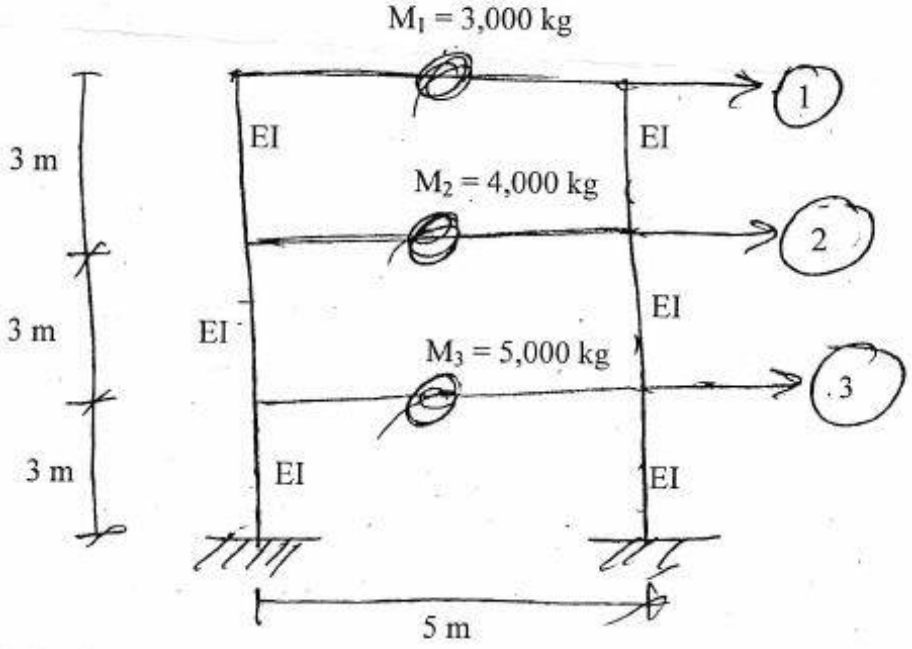
   b) The stiffness and damping characteristics of a dynamic system are to be determined by a free vibration test. In this test a mass of 18 kg is set into free vibration by displacing to 25 mm through a hydraulic jack and then suddenly released. At the end of 20 complete cycles, the elapsed time is 3 secs and the amplitude is 5 mm. Determine the damping and stiffness of the system. [8]

   c) A SDOF system having v is cons damping has a spring of stiffness 500N/m. When the weight is displaced and released the period of vibration is 2.0 secs and ratio of two successive amplitudes is 4 to 1. Determine the amplitude of the motion and the phase angle when a force $F(t) = 4 \sin 4t$ is applied to the system. [8]

2. a) A machine of mass 100 kg is supported on steel spring that deflect 1.2 mm under the weight of the machine. At the operating speed of the motor of 3000 rpm, imbalance causes a maximum disturbing force of 360 KN. What is the maximum force transmitted to the foundation if damping in the steel springs is negligible? If the steel springs were replaced by neoprene pads having the same stiffness but a damping ratio 0.2, what would be the maximum transmitted force? [10]

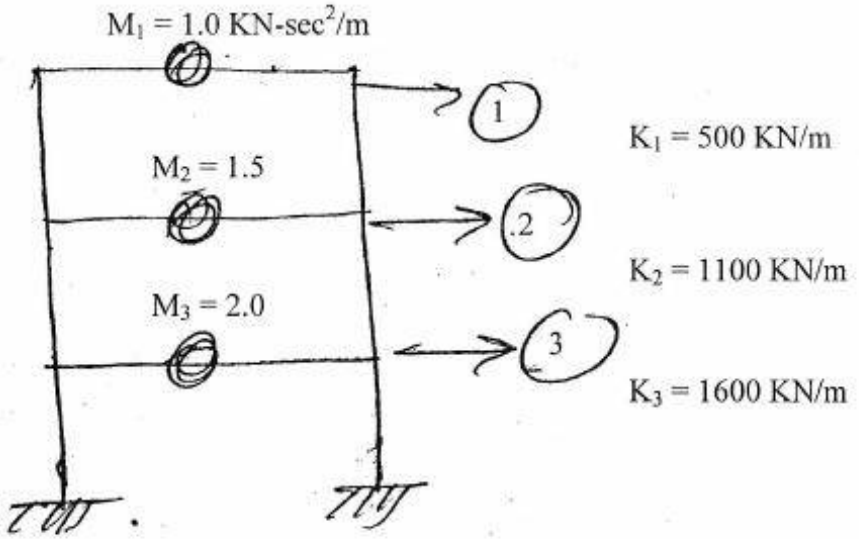
   b) What is dynamic magnification factor? What are the factors influencing dynamic magnification factor? Explain with suitable curve plot. [10]

3. a) Determine the natural frequency and mode shapes (with sketches) of the given MDOF system. Also illustrate that the mode shapes satisfy the orthogonality conditions. [15]



   b) Describe the mode superposition method with mathematical expressions as required. [5]

4. a) Using Matrix iteration method (Stodola or Holzer method), find fundamental period of vibration of three story shear building as given below. [14]



b) Write down the partial differential equation for transverse vibration of a string, transverse vibration of a beam and axial vibration of a rod with associated boundary condition. (Detailed derivation not required). [6]

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04A TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Kartik

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Structural Dynamics *(Elective I) (CE72501)*

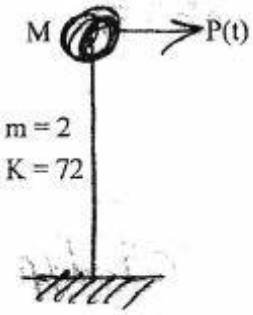
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

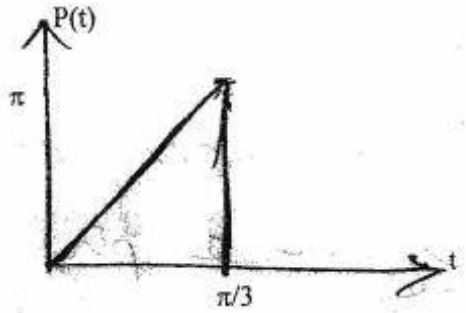
1. a) Define and explain with a simple example structural damping. [4]

   b) A SDOF system consists of the following parameters: mass, m = 5 Kg, K = 100 N/m and damping C = 3 N Sec/m. Determine (i) the damping factor, (ii) the natural frequency of damped vibration (iii) logarithmic decrement (iv) the ratio of two consecutive amplitudes and (v) the number of cycles after which the original amplitude is reduced to 20 %. [8]

   c) A single bay concrete frame having fixed support at its base has height 3 m, column size 240 mm×240 mm, E = 25000 N/mm² and structure weight 20 KN lumped at its floor level. A rotating machine exerts a horizontal force P(t) = 10 sin20t KN at the girder level. Assuming 5 % of critical damping, determine (a) Steady state amplitude of vibration and (b) Maximum dynamic stress in the columns. Assume that the girder is rigid. [8]

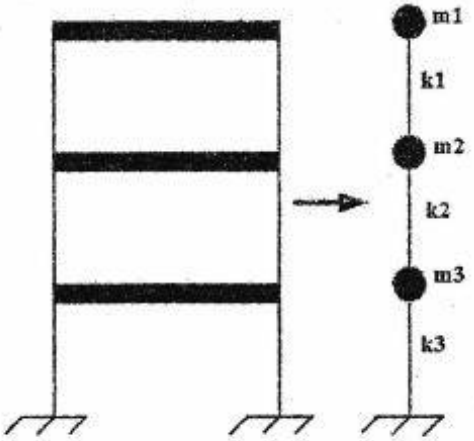
2. a) Determine the response of the following system by the applied force prescribed below. The system initially at rest condition. [8]





   b) Explain with an example how Hozler method is carried out to determine the first mode of frequency of a shear building. [12]

3. a) Determine the natural frequencies and mode shape for the shear building as shown in figure below. Draw the Mode Shapes and write down the modal matrix. [15]



Top story: $m_1 = m = 150$ kN.sec^2/m , $k_1 = k = 43750$ kN/m
Middle story: $m_2 = 2m$, $k_2 = 2k$
Ground story: $m_3 = 2m$, $k_3 = 2k$
Height of building (h) = 3m

b) Demonstrate numerically that the computed mode shapes satisfy the orthogonality conditions with respect to mass only. [5]

4. a) Write down the partial differential equation of motion for transverse vibration of a string and beam. Explain the associated boundary conditions. [12]

b) What is dynamic magnification factor? What are the factors influencing dynamic magnification factor? Explain with suitable curve plot. [8]

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12A TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

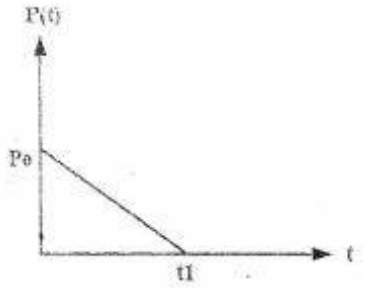
Subject: - Structural Dynamics *(Elective I) (CE72501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) A free vibration test is conducted on an empty elevated water tank. A cable attached to the tank applied a horizontal force of 20 KN and pull the tank horizontally by 7 cm. The cable is suddenly cut and the resulting free vibration is recorded at the end of 10 complete cycle the time is 4 sec and the amplitude is 2 cm, from the data compute the following: [10

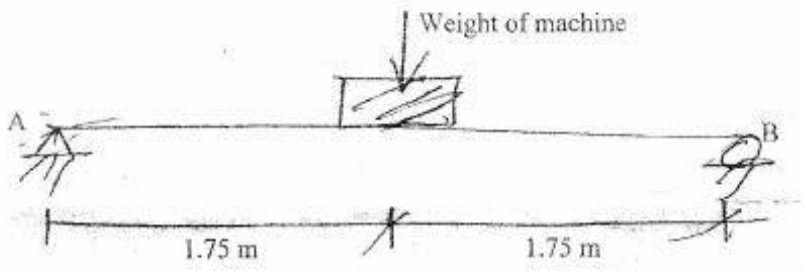
   i) Damping ratio
   ii) Natural period of undamped vibration
   iii) Stiffness coefficient
   iv)Effective weight
   v) Damping coefficient
   vi)No. of cycle required for the displacement amplitude to decrease to 0.2 cm

   b) For a SDOF system is subjected to a triangular pulse load of amplitude Po and during 'tl' as shown in figure below. Determine the response of the undamped system during forced vibration and free vibration phase. [10



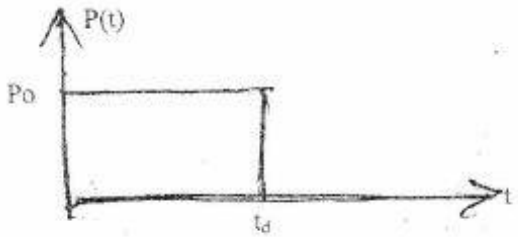
2. a) A machine of weight 80 KN is mounted centrally on a simply supported beam of span 3.50m produces a harmonic force of magnitude F = 140 KN at frequency $\dot{\omega}$ = 60 rad/sec. Neglect the weight of the beam and assume 15% of critical damping, determine: [9

   i) The amplitude of motion machine
   ii) Transmissibility ratio (TR)
   iii) Force Transmitted to the support
   Given $E = 2\times10^5 N/mm^2$
   $I = 30\times10^6\ mm^4$



b) Define Dynamic magnification factor and response ratio. Describe in brief with a neat sketch the influence of frequency and damping ratio on dynamic magnification factor. [6]

c) Determine the response for a spring mass system when it is subjected to a rectangular impluse as shown in figure below. Solve this problem using Duhamel's integral. [5]



3. a) Determine the natural frequencies and mode shapes of the two storied shear frame shown in figure below. Sketch the mode shapes and also illustrate that modes shapes satisfy the orthogonally conditions. [10]

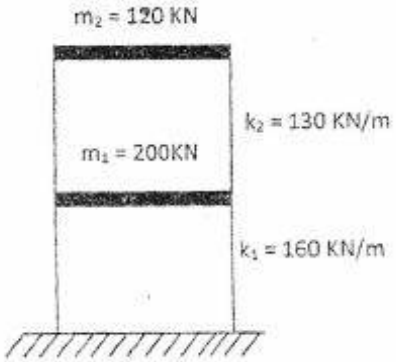


Fig 3(a)

b) If the frame shown in figure 3(a) is subjected to a force P(t) = 3sin2t at first floor and P(t) = 6 sin4t in the second floor, determine the steady state displacement at t = 0.1 sec. Assume structure be rest initially. [10]

4. a) Illustrate with an example, how Holzer method is carried out to determine the first mode frequency of a shear building. [10]

b) Write down the partial differential equation of motion of transverse vibration of a string and beam. Explain about associated boundary condition. [10]

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06A TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Structural Dynamics *(Elective I) (CE72501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Define and explain with a simple example simple harmonic motion. [4]

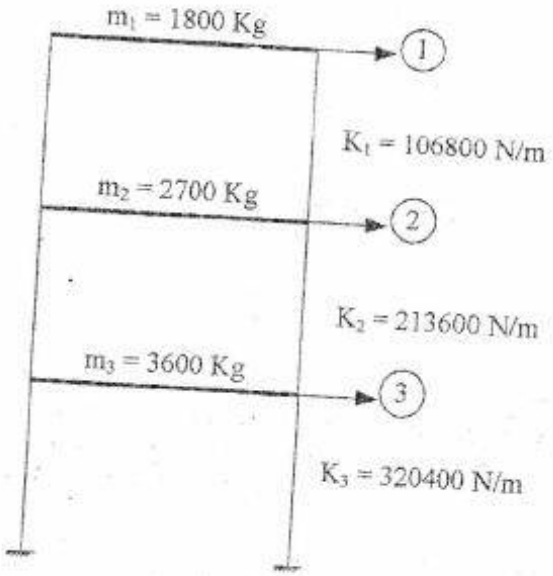
   b) It is required to determine the dynamic properties of a frame system, for which it is decided to do a free vibration test of the frame system. Supplied with a hydraulic jack, it is possible to supply a jacking force to displace the frame. With a jacking force of 90 kN it is noted that the frame has displaced 5 mm. After jacking the frame, the frame is released from the jack and the motion is recorded. On the first return swing after release, the frame does not come back to the release point but rather only 4 mm towards it. The time between the time of release is recorded, and the first return of 4 mm – this time is 1.4 seconds.
   Determine the following: [12]

   a. **Natural frequency (ω)**
   b. **Mass of the girder (m)**
   c. Logarithmic decrement (δ)
   d. Damping ratio (ξ)
   e. Damping coefficient (c)
   f. Damping frequency (ω_D)
   g. Amplitude of the frame after 6 cycles, v_6
   h. Plot the time history response of the system, $v(t)$

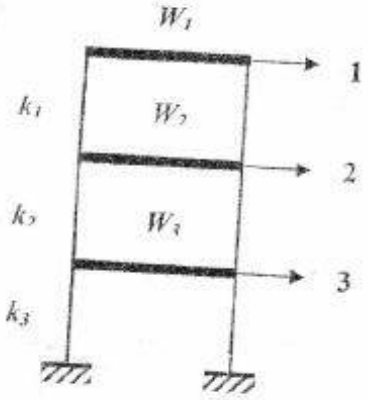
   c) An SDOF system is excited by a sinusoidal force. At resonance the amplitude of displacement was measured to be 5 mm. At an exciting frequency of one-tenth the natural frequency of the system, the displacement amplitude was measured to be 0.5 mm. Estimate the damping ratio of the system. [4]

2. a) A machine of mass 100 kg is supported on steel spring that deflects 1.2 mm under the weight of the machine. At the operating speed of the motor of 3000 rpm, imbalance causes a maximum disturbing force of 360 KN. What is the maximum force transmitted to the foundation if damping in the steel springs is negligible? If the steel springs were replaced by neoprene pads having the same stiffness but a damping ratio 0.2, what would be the maximum transmitted force? [8]

b) Using matrix iteration (Stodola or Holzer) method, find fundamental period of vibration of three storey building frame shown in figure below: [12]



3. a) Determine the natural frequencies and natural vibration mode shapes for the three-storied shear frame shown in the figure given below. Sketch the mode shapes, and also illustrate that the modes shapes satisfy the orthogonality conditions. The weight of each storey of the structure from top to bottom is $W_1 = W_2 = W_3 = W = 9800$ kN, each storey stiffness is $k_1 = 3k$, $k_2 = 5k$ and $k_3 = 6k$, where $k = 200$ kN/cm. [12]



b) Write down the uncoupled equations of motion for the above structure. Describe systematically the procedure how the response of the structure is determined, if it was initially at rest, and subjected to a force vector: (exact calculation is not necessary) [8]

$$\{P(t)\} = \begin{Bmatrix} 0 \\ 0 \\ 200\sin 2t \end{Bmatrix}$$

4. a) Write down the partial differential equation of motion for transverse vibration of the string and beam. Explain the associated boundary conditions. [12]

   b) What is dynamic magnification factor? What are the factors influencing dynamic magnification factor? Explain with suitable curve plot. [8]

5. Write in brief the principles and concepts of (any four only): [4x5]
   (a) Principles of Seismic Instruments
   (b) Duhamel Integral for Damped System
   (c) Response due to periodic loading expressed in Fourier series
   (d) Response of a SDOF system subjected to support motion
   (e) Mode shape vectors and Modal Matrix
   (d) Partial differential equations for ttransverse vibration of a string, transverse vibration of a beam, and axial vibration of a rod with associated boundary conditions.

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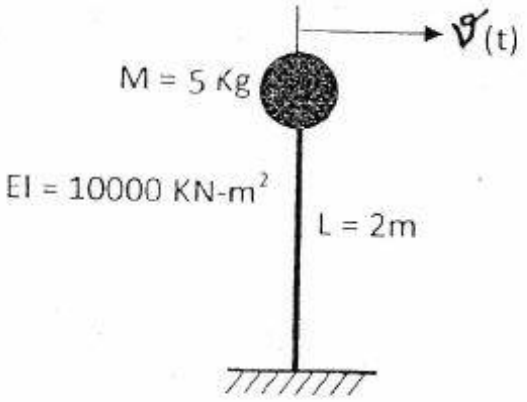
01A TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Ashad

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

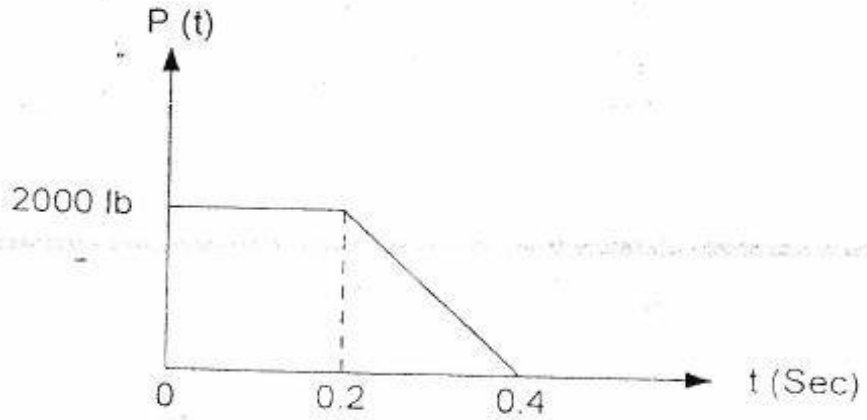
Subject: - Structural Dynamics *(Elective I) (CE501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Four** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*
- ✓ *Use proper and consistent unit system.*

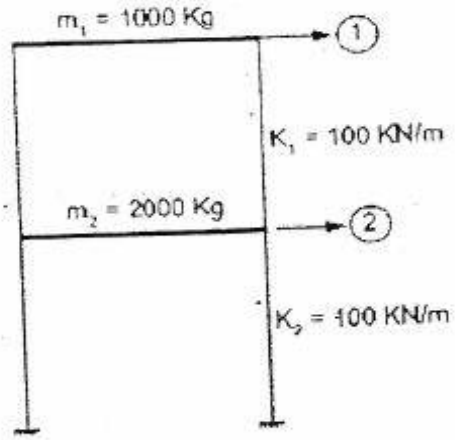
1. A SDOF system consists of the following parameters: length L = 2 m, mass m = 5 kg, EI = 10000 KN/m^2 and damping C = 3 N-sec/m. Determine (i) Natural frequency (ii) The damping factor, (iii) The frequency of damped vibration (iv) Logarithm decrement (v) The ratio of two consecutive amplitudes and (vi) The number of cycles after which the original amplitude is reduced to 20%. Assume that the mass is supported by mass less column. [20]



2. A signal degree of freedom system (SDOF) is subjected to the force idealized as shown in the figure below. Determine the displacement as a function of time. Also determine displacement at t = 0.5 sec. What is the maximum displacement? Take weight w = 100 lb and stuffiness k = 1000 lb/in. [20]

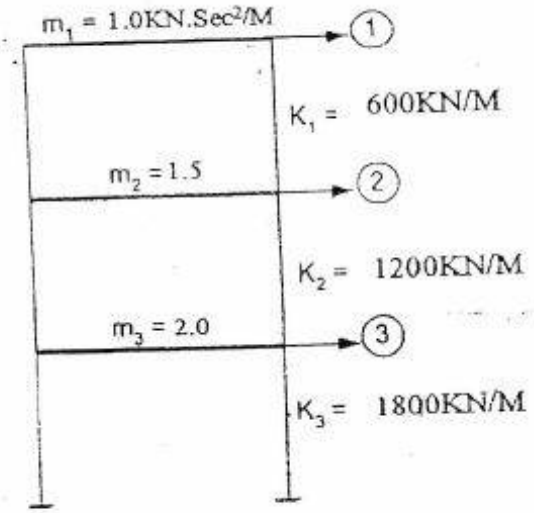


3. The figure below represents a two-storey frame idealized as a shear building. The mass and the flexural rigidity parameters are indicated in the same figure for the given system: [20]



a) Determine the natural frequencies.
b) Determine the mode shapes and sketch the mode shapes.
c) Determine free vibration response at t=0.4 sec,
if initial displacement = $[0.01 \quad 0.008]^T$ m
and initial velocity = $[0.2 \quad 0.1]^T$ m/s.

4. a) Using matrix Holzer method, find the fundamental period of vibration of three storey building frame shown in the following figure: [15]



b) Drive the expression for the equation of motion for transverse vibration of a beam. [5]

5. Write short notes with appropriate expressions and description of notations on: (any two) [2×10]

a) Vibration isolation transmissibility ratio.
b) Mode superposition method.
c) Frequency domain analysis for support motion

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INSTITUTE OF ENGINEERING

Examination Control Division

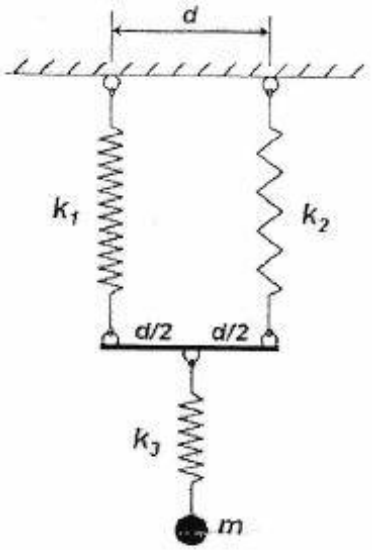
2070 Chaitra

Level	BE	**Full Marks**	80
Programme	BCE	**Pass Marks**	32
Year / Part	IV / I	**Time**	3 hrs.

Subject: - Structural Dynamics *(Elective I) (CE725)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Four** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1 (a) Two mass-less linear springs with spring constants k_1 and k_2 are used to hang a mass-less rigid bar of length d from a slab. A third mass-less linear spring with spring constant k_3 is connected to the rigid bar in the middle and is used to support mass m, as shown below. Note that the springs are connected to the bar and the slab with frictionless hooks. Therefore, the mass-less rigid bar is free to rotate. Considering only the vertical motion of the mass, find the expression for the natural frequency of the system for small motion (i.e. springs remain vertical). (10)



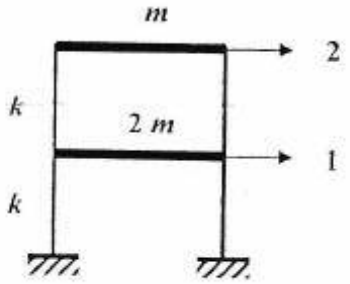
(b) A single-degree-of-freedom structure with mass **m**, stiffness **k**, and damping coefficient **c** undergoes free vibrations. It is observed that the peak displacement decreases by 50% over five cycles of motion. If the mass of the structure is quadrupled, i.e. its mass is increased to **4m**, but its stiffness and damping coefficient are kept same as before, what will be the reduction (in %) of the peak displacement of the new structure over ten cycles of free vibration? (10)

2 (a) What are the methods of evaluation of damping in the system? Explain any one method. (6)

(b) The vibration of an elastic system consisting of a weight W = 200 N and a spring with stiffness, k = 15 N/mm is damped viscously so that the two successive amplitudes are 1.0 mm and 0.7 mm. Determine:

(i) Logarithmic decrement
(ii) Damping ratio
(iii) Natural frequency
(iv) The amplitude after 10^{th} oscillation if the first amplitude is 5 mm (14)

3 (a) Determine the natural frequencies and mode shapes of the two-storied shear frame shown in the figure given below. Sketch the mode shapes, and also illustrate that the modes shapes satisfy the orthogonality conditions. (12)



(b) Write down the uncoupled equations of motion for the structure of 3 (a). Determine the response of the structure for the force vector: (8)

$$\{P(t)\} = \begin{Bmatrix} 0 \\ P_0 \sin \varpi t \end{Bmatrix}$$

4 (a) Illustrate with an example how Improved Rayleigh's method is carried out to determine the first mode frequency of a shear building. (10)

(b) Write down the partial differential equation of motion for transverse vibration of a string and a beam. Explain about the associated boundary conditions. (10)

5 Write in brief the principles and concepts of (any four only): (4x5)

(a) Transmissibility Ratio
(b) Response of a SDOF to a periodic loading expressed in exponential form
(c) Normal Coordinates and modal analysis
(d) Duhamel integral and its limitations
(e) Dirac-Delta Function and Unit Impulse Response Function
(f) Stodola's method of iteration for vibration frequency.

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