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]

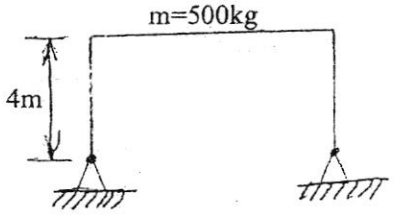
   b) A SDOF system consists of the following parameters: mass, m = 5 kg, k=100 N/m and damping e=3 N-sec/m. Determine:

   (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
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 **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

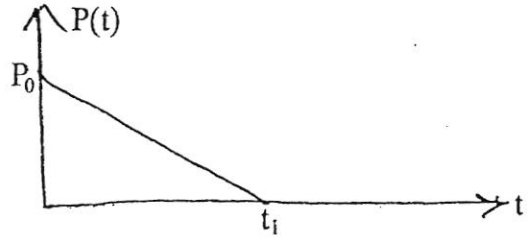
1. a) A machine weighting 100KN is mounted through springs having a total stiffness 20KN/m to a simple supported beam in the mid-span. Assuming 10% of critical damping and neglecting the weight of beam, determine: [10]

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

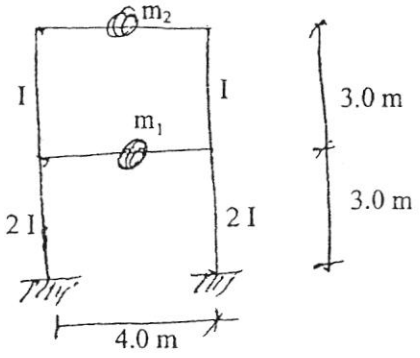
   b) A sensitive instrument with weight 450N is to be installed at a location where the vertical acceleration is 0.1g at a frequency of 10 Hz. This instrument is mounted on a rubber pad of stiffness 15 KN/m and damping such that the damping ratio of the system is 10%. What is the acceleration transmitted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

a) Transverse Vibration of a string [2×10]
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]

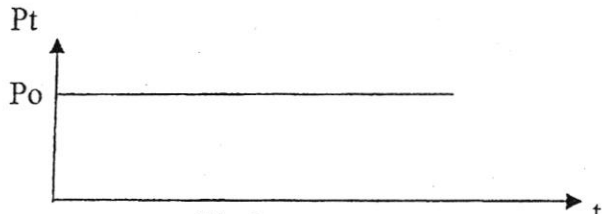

Fig.1

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.
   i) Determine the natural frequencies, mode shapes and sketch. [20]
   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 $<0.2 \quad 0.4>^T$

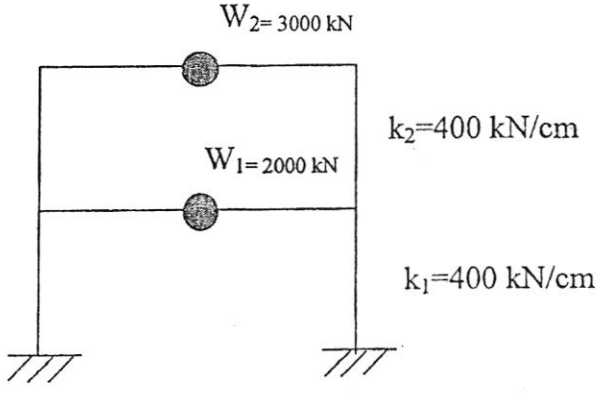

Fig.2

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

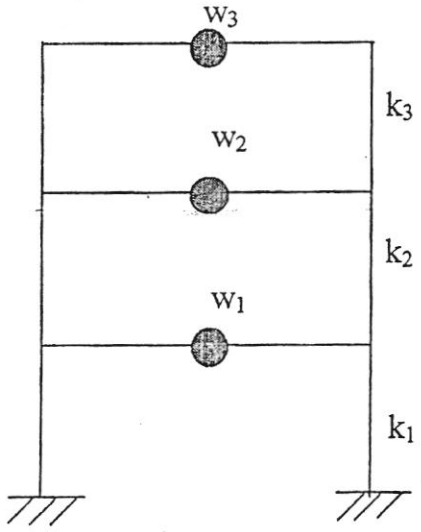

Fig.3

$W_1 = W_2 = 400$ 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

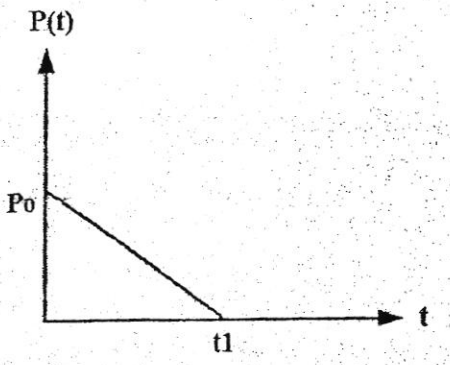
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

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.

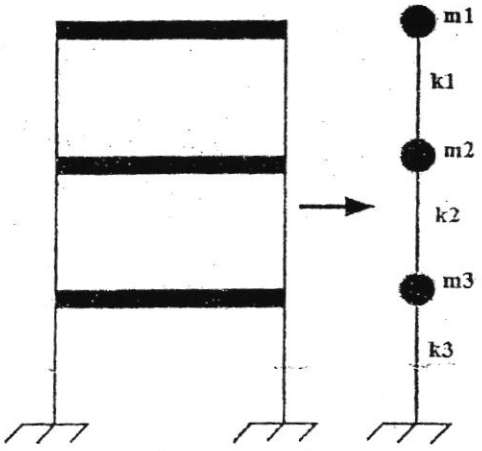
   b) For a SDOF system is subjected to a triangular pulse load of amplitude Po and during 'tl' as shown in the figure below. Determine the response of the undamped system during forced vibration and free vibration phase. [10]



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

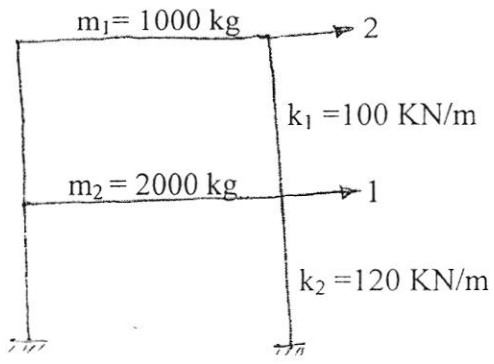
   b) A vibrating system consisting of a mass of 2.15 kg and a spring stiffness 17N/cm is viscously damped such that the ratio of any two consecutive amplitude is 1.00 and 0.97. Determine (i) the natural frequency of the damped system (ii) the logarithmic decrement (iii) the damping factor (iv) the damping 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 $\xi = 0.1$ 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]

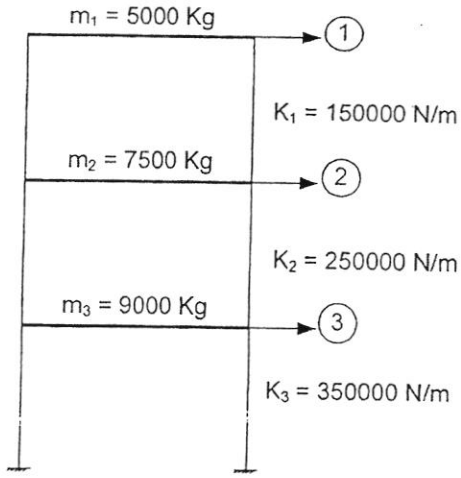
3. The below figure represents a two storey frame idealised as a shear building. The mass and the stiffness parameters are indicated in the same figure. For the given system,

   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]

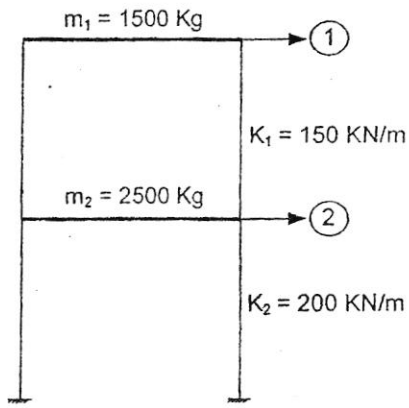
   b) A single bay concrete frame having with fixed support at its base has height 4m, column size 240 mm × 240 mm, E = 25000 N/mm^2 and structure weight 100 KN lumped at its floor level. If the frame is subjected to a sinusoidal ground motion $v_g(t)$ = 4sin5t mm, determine i) transmissibility of motion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

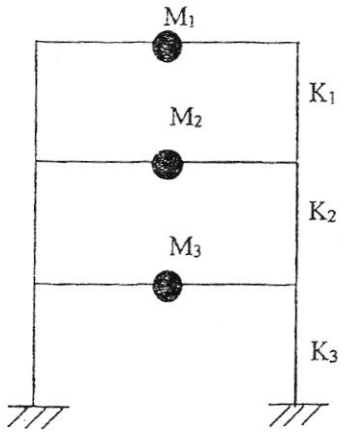
   b) An electric motor of mass 150 kg is mounted on an isolator block of mass 1200 kg and the natural frequency of the total assembly is 150 cpm with damping factor ζ = 0.15.

   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 0.01]^T m and [0.3 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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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)*

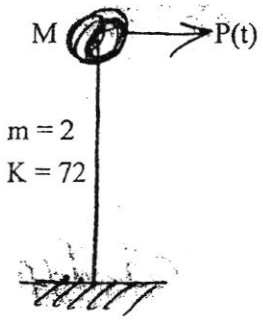
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

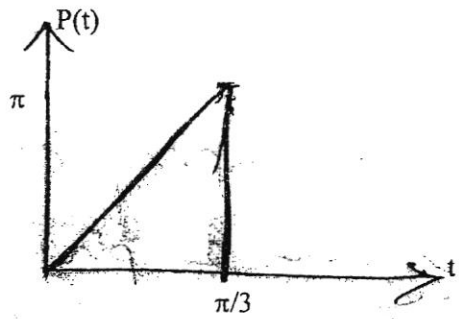
1. a) Define and explain with a simple example structural damping. [4]

   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]

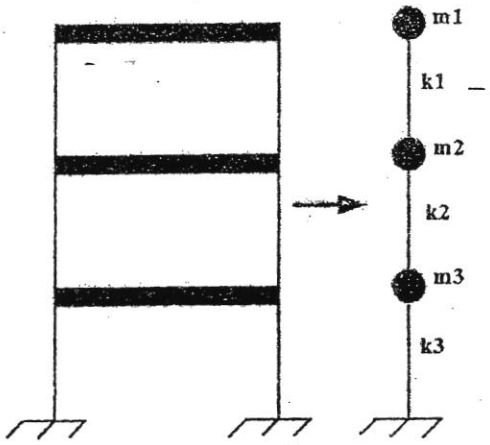
2. a) Determine the response of the following system by the applied force prescribed below. The system initially at rest condition. [8]





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

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

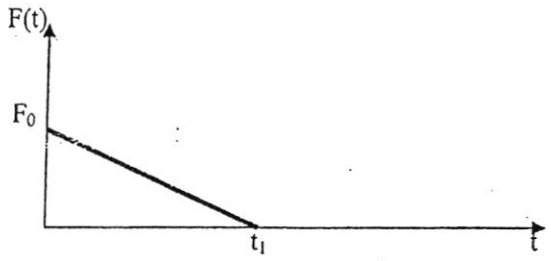
Subject: - Structural Dynamics *(CE72501) (Elective I)*

- ✓ 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 system vibrating with a natural frequency of 8 cycles per second starts with an initial amplitude (v_0) of 3 cms and initial velocity of 40 cm/sec. Find out the following:
(i) Natural period, T and angular frequency, ω.
(ii) Amplitude of the motion, ρ.
(iii) Maximum velocity.
(iv) Maximum acceleration.
(v) Phase angle, φ.
(vi) Static deflection, v_{st}. (8)

(b) A vibrating system consists of a mass of 4 kg and a spring of stiffness of 150 N/m and a damper of coefficient of 5 N-s/m. Determine:
(i) Damping factor
(ii) Natural frequency of damped vibration
(iii) Logarithmic decrement
(iv) Ratio of two successive amplitude
(v) Number of cycles after which the initial amplitude is reduced to 25%. (6)

(c) Determine the response for a spring-mass system during forced vibration and free vibration phase, when it is subjected to a triangular force as shown in the figure given below. (6)



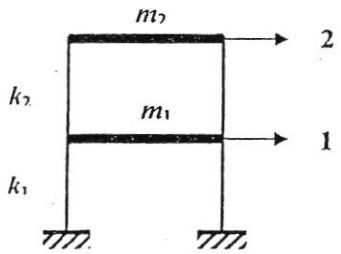
2 (a) Define dynamic magnification factor, and response ratio. Describe in brief with a neat sketch the influence of frequency ratio and damping ratio on dynamic magnification factor. (5)

(b) A damped SDOF system has a mass of 50 kg, a damping ratio of 0.1, a natural frequency of 10 rad/sec, and is subjected to a harmonic excitation of amplitude 2500 N and frequency of 150 rad/sec. Determine the steady-state amplitude and phase angle of the response. (7)

(c) A machine of 200 kg mass is supported on four parallel springs of total stiffness 750 N/m has an unbalanced rotating component which results in a disturbing force of 350 N at a frequency of 2121 rpm. If the damping ratio is 0.2, determine:
(i) Amplitude of motion due to unbalance
(ii) Transmissibility
(iii) Transmitted force. (8)

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)

$m_1 = 1360$ kg;
$m_2 = 660$ kg;
$k_1 = 11.11 \times 10^{-3}$ N/m;
$k_2 = 19.2 \times 10^{-3}$ N/m;



(b) Write down the uncoupled equations of motion for the structure of No. 3 (a) above, and determine the response of the structure for the force vector:

$$\{P(t)\} = \begin{Bmatrix} 0 \\ 300\sin 20t \end{Bmatrix} N \quad (8)$$

4(a) Illustrate with an example how Stodola method is carried out to determine the first mode frequency of a shear building. Also explain how the first mode frequency can be approximated after the first iteration. (10)

(b) Derive the equation of motion in terms of partial differential equation for transverse vibration of beam, and the boundary conditions. Write down the partial differential equations of motion for: transverse vibration of a string, and axial vibration of a rod, with associated boundary conditions. (10)

5. Write in brief the principles and concepts of (any four only): (4x5)
   (a) Base isolation
   (b) Duhamel Integral
   (c) Response due to periodic loading expressed in Fourier series
   (d) Natural frequencies and mode shapes for transverse vibration of a string
   (e) Response of a SDOF system subjected to support motion
   (f) Mode superposition method.

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