# SRM VALLIAMMAI ENGINEERING COLLEGE

SRM Nagar, Kattankulathur – 603 203

## DEPARTMENT OF CIVIL ENGINEERING

## M.E STRUCTURAL ENGINEERING

## QUESTION BANK

## I SEMESTER

## 1917102 –DYNAMICS OF STRUCTURES

## Academic Year 2021 – 2022

*Prepared by*


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# SRM VALLIAMMAI ENGINEERING COLLEGE

DEPARTMENT OF CIVIL ENGINEERING

## Question Bank

**SUBJECT: 1917102 –DYNAMICS OF STRUCTURES**

**SEM/YEAR: 01/I**

| **UNIT I** | | | |
|---|---|---|---|
| PRINCIPLES OF DYNAMICS<br>Vibration and its importance to structural engineering problems – Elements of vibratory systems and simple harmonic motion – Generalized mass - D'Alembert's principle – Mathematical modelling of dynamic systems - Degree of freedom – Equation of motion for S.D.O.F - Damped and undamped free vibrations – Undamped forced vibration – Critical damping – Response to harmonic excitation – Damped or undamped – Evaluation of damping – resonance – band width method to evaluate damping – Force transmitted to foundation – Vibration isolation - examples related to structural engineering. | | | |
| **PART-A (2 MARKS)** | | | |
| **Sl.No** | **Questions** | **BT-Level** | **Competence** |
| 1. | Define Vibration | BT-1 | Remember |
| 2. | What are the methods to derive the equation of motion. | BT-2 | Understand |
| 3. | Sketch the mathematical model of a single degree of freedom system. | BT-3 | Application |
| 4. | Differentiate free and forced vibration. | BT-4 | Analyze |
| 5. | Define the term Dynamic Load factor | BT-1 | Remember |
| 6. | List out the types of vibration isolation | BT-6 | Create |
| 7. | What do you understand by damping? | BT-2 | Understand |
| 8. | What are the different types of damping encountered in a vibrating structural system. | BT-6 | Create |
| 9. | Define damping ratio. | BT-1 | Remember |
| 10. | Write short notes on critical damping. | BT-1 | Remember |
| 11. | Explain about over-damped system. | BT-2 | Understand |
| 12. | Identify the types of vibration | BT-3 | Application |
| 13. | State D Alembert's principle | BT-1 | Remember |
| 14. | Define logarithmic decrement. | BT-1 | Remember |

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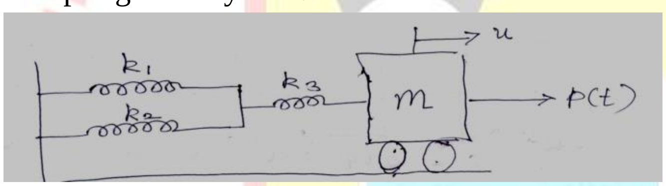
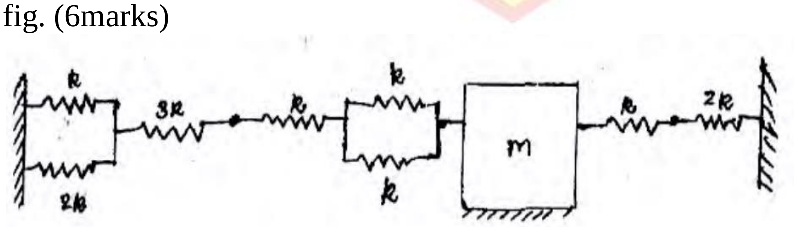
| 15. | What are the classification of prescribed dynamic loading? | BT-2 | Understand |
| 16. | Write down the formula for natural frequency and time period. | BT-3 | Application |
| 17. | Criticize about the transmissibility. | BT-4 | Analyze |
| 18. | Criticize about the frequency ratio. | BT-4 | Analyze |
| 19. | Explain Dynamic Loading | BT-5 | Evaluate |
| 20. | Evaluate Degree of Freedom | BT-5 | Evaluate |
| 21. | Criticize about Half- power Bandwidth method. | BT-5 | Evaluate |
| 22. | Formulate the consequences of vibration. | BT-6 | Create |
| 23. | Summarize the forms of damping encountered in a vibrating structural system? | Bt-2 | Understand |
| 24. | Develop a formula to calculate the equivalent stiffness of spring in series, springs in parallel | BT-3 | Application |
| 25. | Examine resonance and natural frequency | BT-4 | Analyze |

**PART-B (13 MARKS)**

| | | | |
|---|---|---|---|
| 1. | a)Develop the effective stiffness of the combined spring system shown in figure and write the equation of motion for the spring mass system.   b) Derive the solution for undamped single degree of freedom system. (6) | BT-6 | Create |
| 2. | (i) Develop the equation of motion for viscous damping. (7marks)<br>(ii) Determine the natural frequency of the system shown in fig. (6marks)   . | BT-1 | Remember |
| 3. | Calculate the natural frequency for a structure with mass 1000kg. All columns together offer a lateral resistance of 25000N/m. Find the resulting motion and hence find the displacement, velocity and acceleration at time t = 2 secs for | BT-3 | Application |

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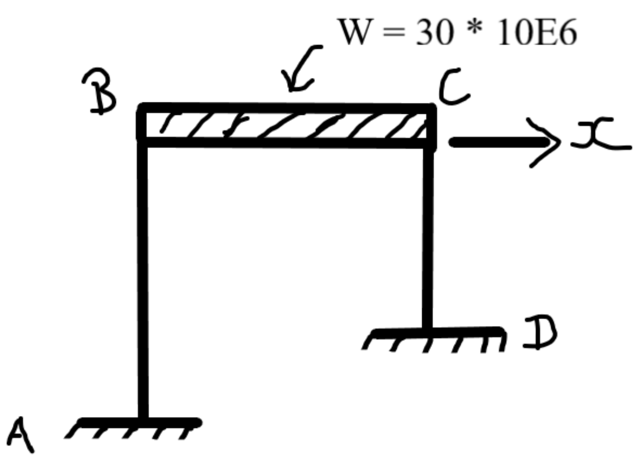
| | the initial displacement of 0.1m and initial velocity of 1m/sec. | | |
| 4. | An SDOF system consists of a mass of 20kg, and a spring of stiffness 2200kN/m and dashpot with a damping coefficient of 60Ns/m and is subjected to a force of F = 200sin5t. Find its steady state response and peak amplitude. Find the maximum bending moment and shear force in the column if the column is infinitely rigid. | BT-1 | Remember |
| 5. | A damped free vibration test is conducted to determine the dynamic properties of a one story building. The mass of the building is 10000 kg initial displacement of the building is 0.702 cm. Maximum displacements on the first cycle is 0.53cm and period of this displacement cycle is 1.7s. Estimate the Undamped frequency, Logarithmic decrement, damping ratio, damping coefficient, Damped frequency and the amplitude after 6 cycles. | BT-1 | Remember |
| 6. | Derive the equation of motion for SDOF system free vibration and find the solution for<br>a) Under damped system<br>b) Over damped system<br>c) Critically damped system. | BT-4 | Analyze |
| 7. | Calculate the natural frequency in side sway for the frame shown in fig. The column length AB = 1m and CD = 0.8m. Also calculate the natural period if there is initial displacement of 25mm and initial velocity of mass obtained at time t = 5 secs. Take EI = $30 * 10^6 Nm^2$<br><br> | BT-2 | Understand |
| 8. | A vibrating system consists of a mass of 5kg, spring of stiffness 120 N/m and a damper with a damping co-efficient of 5 N-s/m. Examine Damping factor, Natural frequency of the system, Logarithmic decrement, The ratio of two successive amplitude, The number of cycles after which the initial amplitude reduces to 25% | BT-4 | Analyze |
| 9. | A single degree of freedom system with mass m = 10kg, stiffness k = 10 N/m and damping coefficient c= 10Ns/m is | BT-3 | Application |

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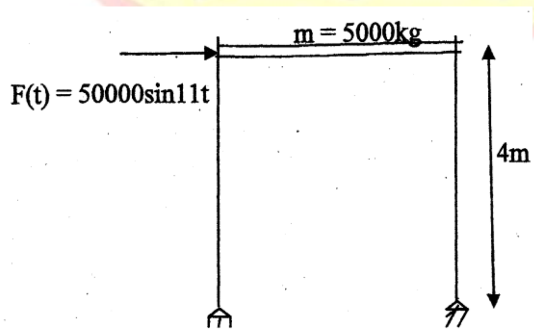
| | subjected to an initial velocity of 1m/s and initial displacement of 0.5m. Determine natural frequency, damped natural frequency, damping ratio and equation of motion. Find the displacement and velocity at time t = 1 second | | |
| 10. | A single degree of freedom system having a mass of 2.5kg is set into motion with a viscous damping and allowed to oscillate freely. The frequency of oscillation is found to be 20 Hz, and measure of the amplitude of vibration shows two successive amplitude to be 6mm and 5.5mm. Estimate the viscous damping co-efficient. | BT-5 | Evaluate |
| 11. | A weight W is suspended from the mid span of a simply supported beam of span L, flexural rigidity EI and mass per unit length m. If the wire by which the weight w is suspended suddenly snaps.<br>(a) Describe the subsequent vibration of the beam. Neglect damping.<br>(b) Find its deflection expression at the centre. | BT-2 | Understand |
| 12. | (i) A vibrating system consisting of a weight of 100 N and spring stiffness of 4000 N/m is viscously damped so that two consecutive amplitudes measured are 150 mm and 8021 mm respectively. Determine the logarithmic decrement and the co-efficient of damping.<br>(ii) Describe Half-power Band width Method | BT-2 | Understand |
| 13. | A steel rigid frame, shown in fig., supporting a rotating machine which exerts a horizontal force at the girder level of 50000sin11t N. Assuming 4% critical damping, what is the steady state amplitude of vibration?<br>I for columns = $15 \times 10^{-6} m^4$, $E = 21 \times 10^7 kN/m^2$<br><br> | BT-2 | Understand |
| 14. | A block of weight 900 N (moving between vertical guides) is supported by a spring of stiffness $10^6$N/m. the block is given an initial displacement of 50 mm with a velocity of 300 mm/sec, determine the period of vibration, natural frequency, amplitude of motion, maximum velocity and maximum acceleration of the block. Assuming a damping of 20% and show the logarithmic decrement and the damping coefficient | BT-2 | Understand |

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| | of the system. | | |

**PART-C (15MARKS)**

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| **1.** | A machine foundation weighs 60 KN. The spring constant is 11000KN/m and dash pot constant (C) = 200 KN-s/m. Evaluate<br>i) Whether the system is over damped, under damped or critically damped.<br>ii) Determine Logarithmic decrement<br>iii) Determine Ratio of two successive amplitudes<br>If the initial displacement is 10mm and initial velocity is zero displacement at t = 0.1s | BT-5 | Evaluate |
| **2.** | List out some example of SDOF system and explain any one of its behavior | BT-6 | Create |
| **3.** | A vibrating system consisting of mass 100kg and spring with stiffness of 75000n/m is viscously damped so that the ratio of 2 consecutive amplitudes is 1.0 to 0.85. Determine natural frequency, damping ratio, logarithmic decrement, damping and critical damping. | BT-4 | Analyze |
| **4.** | Explain the different types of vibration in a structural dynamic problem | BT-2 | Understand |

**UNIT-2**

**TWO DEGREE OF FREEDOM SYSTEMS**

Mathematical models of two degree of freedom systems, free and forced vibrations of two degree of freedom systems, normal modes of vibration, applications.

**PART-A (2 MARKS)**

| Sl.No | Questions | BT-Level | Competence |
|---|---|---|---|
| 1. | What is a shear building? | BT-1 | Remember |
| 2. | List out the assumptions made in shear building. | BT-1 | Remember |
| 3. | What are all the differences between free and forced vibration | BT-2 | Understand |
| 4. | What will be the equation of motion of a damped two DOF system with free vibration | BT-2 | Understand |
| 5. | Normal mode of vibration – explain. | BT-2 | Understand |
| 6. | Define two degree of freedom system | BT-1 | Remember |
| 7. | Write the equation of motion of a forced undamped two DOF system. | BT-3 | Application |

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| 8. | Draw a mathematical model of a free undamped two DOF system. | BT-3 | Application |
| 9. | What is mass matrix? | BT-1 | Remember |
| 10. | What is stiffness matrix? | BT-4 | Analyze |
| 11. | What is Damping matrix. | BT-5 | Evaluate |
| 12. | What is the other name of natural frequency? | BT-1 | Remember |
| 13. | What is the fundamental frequency and fundamental mode of vibration. | BT-1 | Remember |
| 14. | Write the equation of motion of a damped two DOF system with forced vibration | BT-6 | Create |
| 15. | What is a mode shape? | BT-5 | Evaluate |
| 16. | Write the characteristic equation of two DOF system. | BT-3 | Application |
| 17. | What is frequency ratio? | BT-4 | Analyze |
| 18. | Elaborate the term node. | BT-6 | Create |
| 19. | Distinguish two DOF system and MDOF system. | BT-4 | Analyze |
| 20. | What is meant by first and second mode of vibration? | BT-2 | Understand |
| 21. | Evaluate principal mode of vibration. | BT-5 | Evaluating |
| 22. | Construct the equation of motion of a free damped two DOF system. | BT-6 | Create |
| 23. | How will you identify principal mode of vibration. | BT-3 | Application |
| 24. | Examine and explain about normal values | BT-4 | Analyze |
| 25. | Summarize about modal vectors. | BT-2 | Understand |

**PART-B (13 MARKS)**

| | | | |
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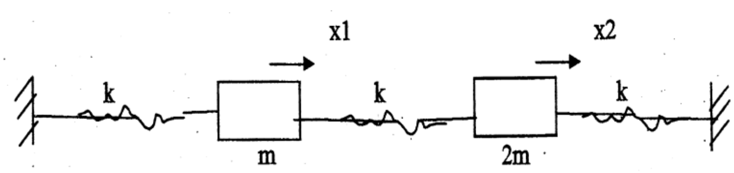
| 1. | A two storey building having a floor weight 1200kN, 600kN, for the first and second floor respectively. The height of each floor is 3m and EI = $30 \times 10^{12}$ $Nmm^2$. Analyze the natural frequencies and mode shapes. | BT-4 | Analyze |
| 2. | Develop a solution for the figure given below calculating the natural frequencies and corresponding mode shapes.   | BT-6 | Create |

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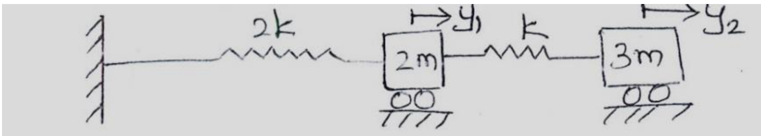
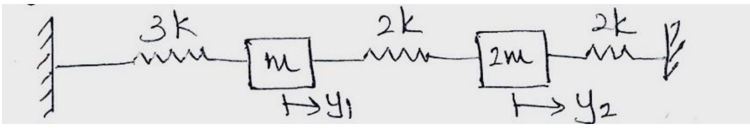
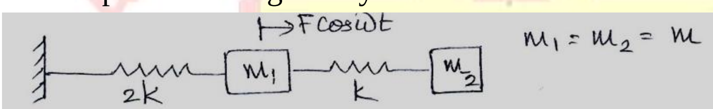
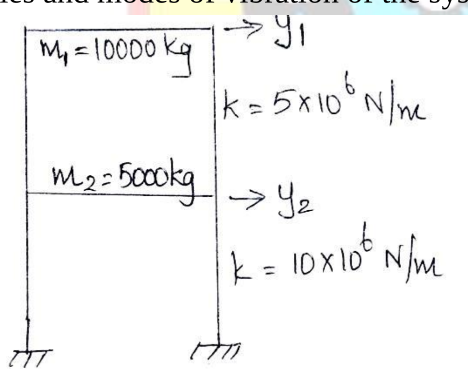
| 3. | Analyze the natural frequency and mode shape of the system shown in fig.<br><br> | BT-4 | Analyze |
| 4. | Evaluate the natural frequency and mode shape of the two degree of freedom system shown in fig.<br><br> | BT-5 | Evaluate |
| 5. | Estimate the expression for free damped vibration of 2 DOF. | BT-2 | Understand |
| 6. | Explain the concept of shear building and derive the expression for steady state response of a forced undamped 2DOF system. | BT-2 | Understand |
| 7. | Calculate the natural frequencies and mode shape and steady state response of the given system.<br><br> | BT-3 | Application |
| 8. | Formulate the free vibration equations for the two element frame given in fig. the frame is massless with lumped masses at the two nodes is constant. Determine the natural frequencies and modes of vibration of the system.<br><br> | BT-1 | Remember |
| 9. | A two storey building has seismic weights of 300 kN and 420 kN at I and II storeys respectively; The corresponding stiffnesses are 25000 kN/m and 30000 kN/m.<br>(i) Determine the model frequencies.<br>(ii) Sketch the mode shapes. | BT-2 | Understand |
| 10. | Determine the natural frequencies and mode shapes of a three storey building having a floor weight 2500kN, 2000kN for the first , second floor respectively. The height of each floor is 3m and EI = $28 \times 10^{12}$ $nmm^2$. | BT-1 | Remember |

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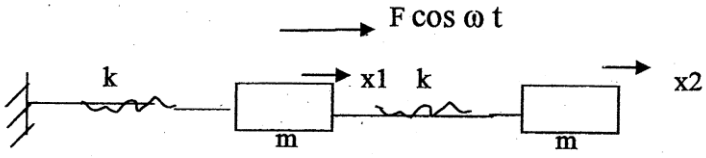
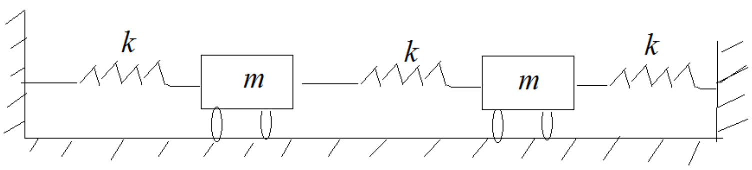
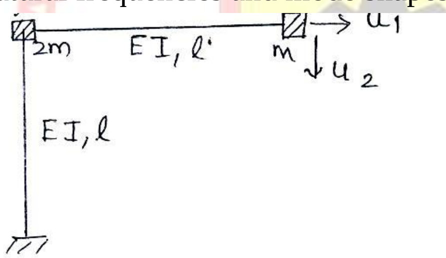
| 11. | Solve the natural frequency and mode shape for a single bay two storey RCC frame. Mass of each rigid frame is 20,000kg and combined stiffness of first storey columns is $2 * 10^6$N/m and combined stiffness for second storey column is $2 * 10^6$ N/m | BT-3 | Application |
| 12. | Determine the natural frequencies and corresponding mode shape for the system shown below.   | BT-2 | Understand |
| 13. | Obtain the natural frequencies and mode shapes of the system.   | BT-1 | Remember |
| 14. | Set up the differential equation of motion and determine the natural frequencies and mode shapes for the given system.   | BT-1 | Remember |

**PART-C (15 MARKS)**

| | | | |
|---|---|---|---|
| 1. | What are the normal modes for the following system and show that the modes are orthogonal $\begin{bmatrix} 2m & 0 \\ 0 & m \end{bmatrix}\begin{bmatrix} \ddot{x}_1 \\ \ddot{x}_2 \end{bmatrix} + \begin{bmatrix} 3k & -k \\ -k & k \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$ | BT-1 | Remember |
| 2. | A cantilever bar is to be modeled by a uniform massless uniform bar to which are attached with two lumped masses representing the mass of original system as K = 2AE/L and m=ρAL. Determine the natural frequencies and the normal | BT-6 | Create |

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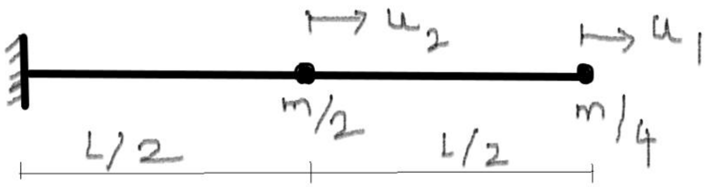
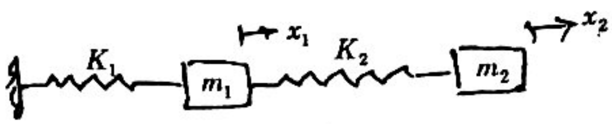
| | modes of this model.<br><br> | | |
| 3. | Explain in detail about the free and forced vibration of two degree of freedom systems. | BT-2 | Understand |
| 4. | For the two degree of freedom system shown in fig. , the system parameters are given by m1=m, m2=2m, k1=k, k2=2k. Solve for the frequencies and corresponding mode shapes.<br><br> | BT-4 | Analyze |

## UNIT-3

### DYNAMIC RESPONSE OF MULTI-DEGREE OF FREEDOM SYSTEMS

Mathematical models of Multi-degree of freedom systems, orthogonality of normal modes, free and forced vibrations of multi degree of freedom systems Mode superposition technique, response spectrum method, Applications.

### PART-A (2 MARKS)

| Sl.No | Questions | BT-Level | Competence |
|---|---|---|---|
| 1. | Define MDOF system. | BT-1 | Remember |
| 2. | Draw the mathematical model of a 3DOF system. | BT-3 | Application |
| 3. | What is the definition for spectral matrix? | BT-2 | Understand |
| 4. | What is modal analysis | BT-1 | Remember |
| 5. | Write the uncoupled stiffness matrix. | BT-6 | Create |
| 6. | What is eigen values and eigen vectors? | BT-1 | Remember |
| 7. | Write the equation of motion of an undamped MDOF system with Free Vibration. | BT-6 | Create |
| 8. | Define modal matrix | BT-1 | Remember |
| 9. | What is a lumped mass? | BT-2 | Understand |

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| 10. | Which property of eigen vectors facilitate the modal analysis | BT-3 | Application |
| 11. | State the modal orthogonal conditions with reference to mass and stiffness | BT-1 | Remember |
| 12. | What are the different methods to analyze forced vibration of MDOF system? | BT-4 | Analyze |
| 13. | Write the formula of modal matrix. | BT-3 | Application |
| 14. | Write the equation of motion of a damped MDOF system with Forced Vibration. Justify | BT-5 | Evaluate |
| 15. | Criticize the formula of uncoupled mass matrix. | BT-4 | Analyze |
| 16. | What is fundamental natural frequency? Justify | BT-5 | Evaluate |
| 17. | What is decoupling of equation in MDOF system? | BT-1 | Remember |
| 18. | What do you mean by dynamic coupling? | BT-2 | Understand |
| 19. | List out the steps to find out the natural frequency of a 3DOF system and compare with the 2DOF system | BT-4 | Analyze |
| 20. | What is mode acceleration method? | BT-2 | Understand |
| 21. | Identify some applications of multi degree of freedom systems in civil engineering | BT-3 | Application |
| 22. | List the approximate methods used to find the mode shapes and frequencies. | BT-4 | Analyze |
| 23. | Explain When do you model a system as a Multiple D.O.F. system | BT-2 | Understand |
| 24. | Recommend any two methods of finding natural frequency of multiple degree of freedom system. | BT-5 | Evaluate |
| 25. | Propose the effective utilization of static condensation method used in dynamic analysis. | BT-6 | Create |

**PART-B (13 MARKS)**

| | | | |
|---|---|---|---|
| 1. | The Stiffness and mass matrices of a vibrating system is given below. Determine its fundamental frequency and Mode shapes. $[M] = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1.5 & 0 \\ 0 & 0 & 2 \end{bmatrix}$ $[K] = \begin{bmatrix} 600 & -600 & 0 \\ -600 & 1800 & -1200 \\ 0 & -1200 & 3000 \end{bmatrix}$ | BT-5 | Evaluate |

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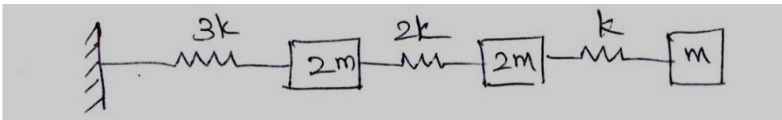
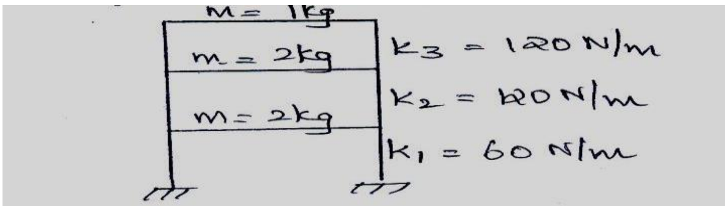
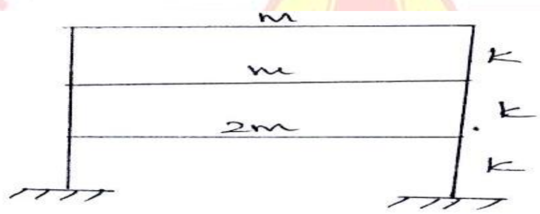
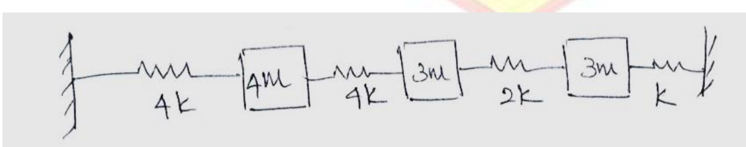
| 2. | Develop the natural frequencies and mode shapes of a system described by the equation of motion given below.<br><br> | BT-6 | Create |
| 3. | Analyze the Natural Frequencies and mode shape of the shear building shown in fig.<br><br> | BT-4 | Analyze |
| 4. | a. Prove the orthogonality property of mode shapes ( 5m)<br>b. Calculate the natural frequency for the given frame.<br><br> | BT-3 | Application |
| 5. | Write the spectral and Modal matrix for the given shear frame.<br>$[M] = \begin{bmatrix} 8 & 0 & 0 \\ 0 & 8 & 0 \\ 0 & 0 & 4 \end{bmatrix}$ $[k] = \begin{bmatrix} 9 & -4 & 0 \\ -4 & 7 & -3 \\ 0 & -3 & 3 \end{bmatrix}$ | BT-3 | Application |
| 6. | Analyze the Natural frequencies and mode shape for the given system and Check the orthogonality conditions.<br><br> | BT-4 | Analyze |
| 7. | For a MDOF system with<br>mass matrix [m] =<br>$\begin{bmatrix} \mathbf{1} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{1} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{1} \end{bmatrix}$ | BT-1 | Remember |

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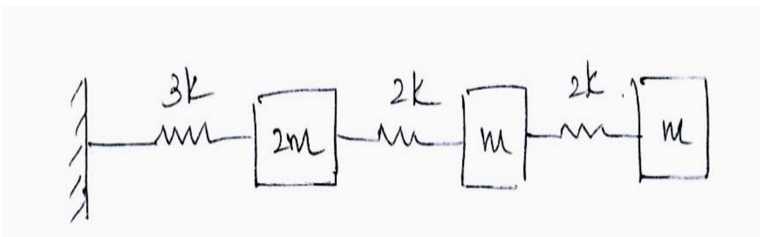
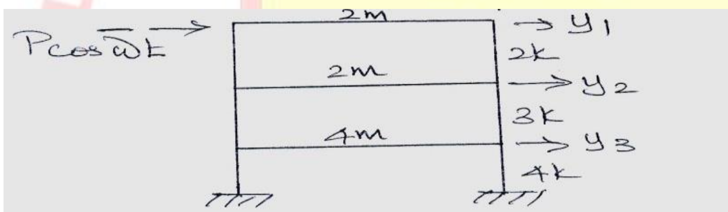
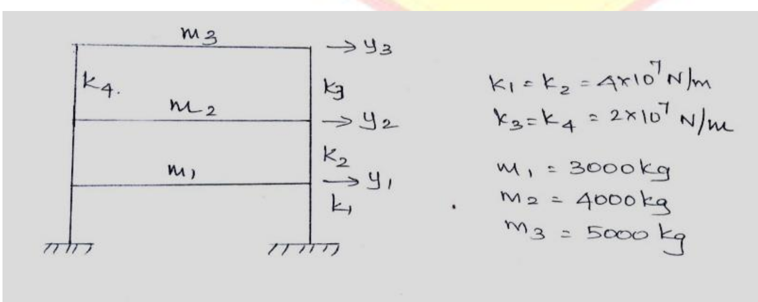
| | Stiffness matrix [k] = <br> $$\begin{bmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 2 \end{bmatrix}$$ <br> Determine the frequency and mode shapes | | |
| 8. | Estimate the uncoupled stiffness and mass matrix for the following system. <br>   | BT-2 | Understand |
| 9. | A 3 Storey Frame is given in the figure. Determine the response and the top level on the basis of consideration of all the modes for $\omega = 1.5\omega_1$ <br>   | BT-2 | Understand |
| 10. | Find the natural frequency and mode shapes for the given structure. <br>   | BT-2 | Understand |
| 11. | (i) Explain how mathematical modeling can be done for a multi-degree freedom system. <br> (ii) Briefly explain about orthogonality of normal modes. | BT-1 | Remember |
| 12. | Determine the natural frequencies and mode shape for the shear | BT-2 | Understand |

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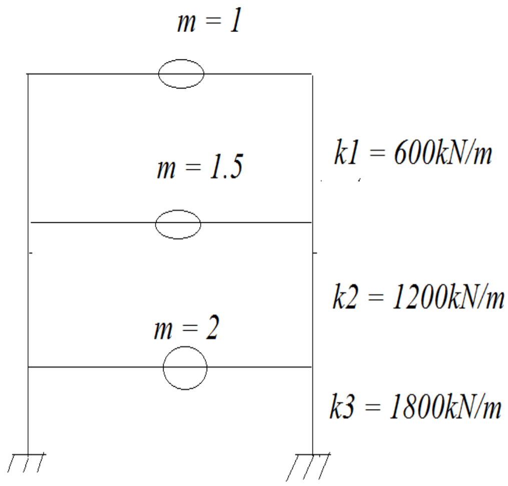
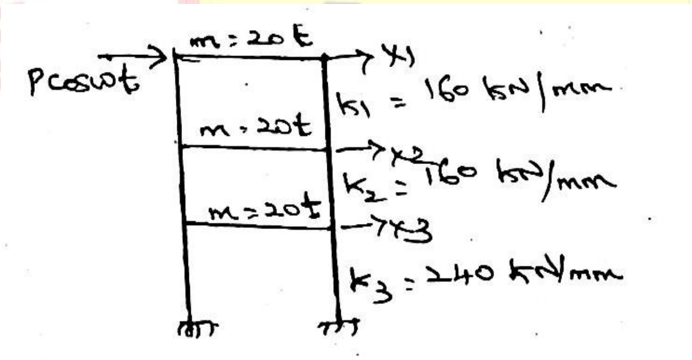
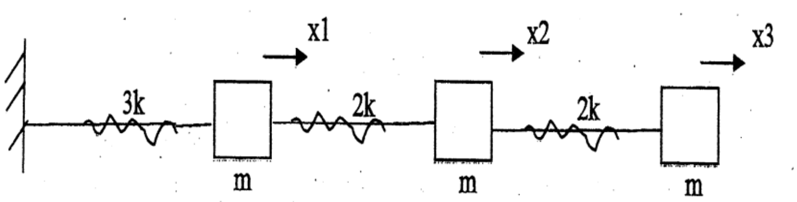
| | building as shown in figure.<br> | | |
| 13. | A three storey frame shown in fig. is subjected to an excitation force of P cosωt at the top level due to steady state vibration. Determine the response at the top level on the basis of consideration of first mode only and first two modes only for ω = 0 and ω = 0.5 p1.<br> | BT-1 | Remember |
| 14. | Determine the natural frequencies and corresponding mode shapes for the MDOF shown in fig.<br> | BT-1 | Remember |







**PART-C (15 MARKS)**

| | | | |
|---|---|---|---|
| 1. | Determine the mode shapes and nodal frequencies of a three | BT-1 | Remember |

| | | | |
|---|---|---|---|
| | storey building by modal super position method. The storey masses are M1=360 kg, M2=250kg, M3= 150kg and storey stiffness are $K_1$= 3000kN/m, $K_2$= 2000kN/m and $K_3$=1000kN/m. | | |
| 2. | The following matrices were obtained for a vibrating system using matrix iteration technique. Evaluate and obtain the natural frequencies and the corresponding modal amplitudes. $$[\delta]=\begin{bmatrix}9 & 11 & 7\\ 11 & 16 & 11\\ 7 & 11 & 9\end{bmatrix} \quad [m]=\begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 1\end{bmatrix}$$ | BT-5 | Evaluate |
| 3. | List down the steps in use of response spectra for designing MDF system. | BT-2 | Understand |
| 4. | Construct the step by step procedure involved in the mode superposition technique for a 3 DOF system. | BT-6 | Create |

**UNIT-4**

**DYNAMIC RESPONSE OF CONTINUOUS SYSTEMS**

Free and forced vibration of continuous systems,Rayleigh – Ritz method – Formulation using Conservation of Energy – Formulation using VirtualWork, Applications

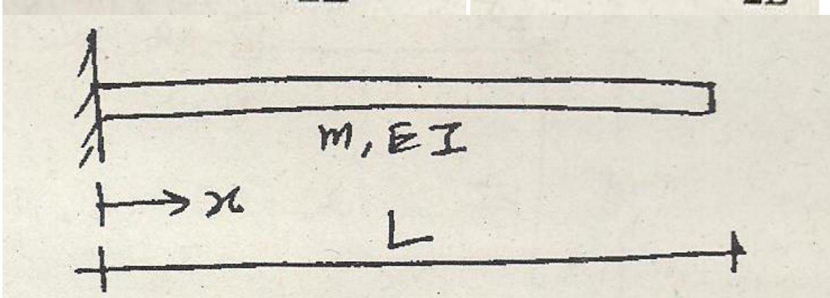
**PART-A (2 MARKS)**

| **Sl.No** | **Questions** | **BT-Level** | **Competence** |
|---|---|---|---|
| 1. | What is the definition of Timoshenko’s Inertia? | BT-1 | Remember |
| 2. | Write the natural frequency and mode shapes for simply supported at one end. | BT-6 | Create |
| 3. | Differentiate between flexural and axial vibration of bars. | BT-4 | Analyze |
| 4. | Can you have a beam with both ends free in flexural vibration mode? Justify. | BT-5 | Evaluate |
| 5. | List out the forces acting on beam element. | BT-1 | Remember |
| 6. | Write short notes on Hamilton’s principle application in | BT-1 | Remember |

| | | | |
|---|---|---|---|
| | equation of motion. | | |
| 7. | Write the general solution for flexural beam. | BT-6 | Create |
| 8. | Evaluate the natural frequency and mode shapes for simply supported at both ends. | BT-5 | Evaluate |
| 9. | Give the explanation on virtual work. | BT-2 | Understand |
| 10. | Draw a neat sketch used to derive equation of flexural vibration of uniform beams. | BT-3 | Application |
| 11. | Write down the governing differential equation for flexural vibration of continuous system. | BT-3 | Application |
| 12. | Discuss about the natural frequency and mode shapes for both ends free. | BT-2 | Understand |
| 13. | List the natural frequency and mode shapes for both ends fixed. | BT-1 | Remember |
| 14. | Analyse the natural frequency and mode shapes for one end fixed and other end free. | BT-4 | Analyze |
| 15. | Determine the natural frequency and mode shapes for one end fixed and other end hinged. | BT-4 | Analyze |
| 16. | Explain the concept of conservation of energy. | BT-2 | Understand |
| 17. | Discuss about the assumptions in Euler- Bernoulli's theory. | BT-2 | Understand |
| 18. | Use Rayleigh's method find an expression for fundamental frequency of a continuous beam by taking the shape function $\Psi(x) = (x/L)^2$ | BT-3 | Application |
| 19. | Give the formula derived from Betti's law. | BT-1 | Remember |
| 20. | List out Rayleigh's quotient. | BT-1 | Remember |
| 21 | Identify the equation for transverse vibration of beams | BT-3 | Application |
| 22 | Recommend how Rayleigh's method be adopted to find the fundamental frequency of a cantilever beam. | BT-5 | Evaluate |
| 23 | Examine how to approximate the two lowest frequencies of the continuous system using Rayleigh Ritz method? | BT-4 | Analyze |
| 24 | Construct the mode shapes in axial vibration of Clamped – Free bar. | BT-6 | Create |
| 25 | Classify the general differential equation of a beam subjected to | BT-2 | Understand |

| | | | |
|---|---|---|---|
| | external vibration? | | |

**PART-B (13 MARKS)**

| | | | |
|---|---|---|---|
| 1. | Derive the equation of motion for flexural beam subjected to forced vibration. | BT-6 | Create |
| 2. | Determine the first two frequencies of a Cantilever beam by Rayleigh-Ritz method by assuming $\phi = \begin{bmatrix} 1.0 & 1.0 \\ 0.45 & -0.55 \\ 0.25 & -0.10 \end{bmatrix}$. | BT-5 | Evaluate |
| 3. | Find out the solution for equation of motion and find out the natural frequency and mode shapes with one end fixed and other end simply supported. | BT-2 | Understand |
| 4. | Derive an expression for the transverse vibration of a uniform beam. Hence find the natural frequencies and mode shapes of a simply supported beam | BT-3 | Application |
| 5. | Determine from first principles, the first three natural frequencies and mode shapes of a simply supported beam subjected to free flexural vibrations | BT-3 | Application |
| 6. | Derive the equation of motion by Rayleigh – Ritz Method. | BT-4 | Analyze |
| 7. | Derive an expression for the transverse vibration of a uniform beam. Hence find the natural frequency and mode shapes of a fixed beam. | BT-1 | Remember |
| 8. | Express in detail the equation of motion by Virtual work method. | BT-4 | Analyze |
| 9. | Find approx.. solution for the first two natural frequencies and modes of latera; vibration of the uniform cantilever beam shown in fig. by Rayleigh- Ritz method using the shape function $\psi_1(x) = 1 - \cos\frac{\pi x}{2L}$ and $\psi_2(x) = 1 - \cos\frac{3\pi x}{2L}$.   | BT-1 | Remember |
| 10. | Formulate the equation of motion by conservation of energy method. | BT-2 | Understand |
| 11. | (i) Explain about the free and forced vibration of continuous systems. | BT-2 | Understand |

| | | | |
|---|---|---|---|
| | (ii) List out the applications of virtual work method? | | |
| 12. | Determine the fundamental frequency of the cantilever beam by Raleigh's method. | BT-1 | Remember |
| 13. | Determine the first two frequencies of a Cantilever beam by Rayleigh-Ritz method by assuming $(\phi)=\begin{pmatrix}1.0 & 1.0\\ 0.55 & -0.65\\ 0.35 & -1.2\end{pmatrix}.$ | BT-1 | Remember |
| 14. | Determine the first two natural frequencies of uniform cantilever beam by Rayleigh – Ritz method. Assume $\varphi(x) = C_1x^2+C_2x^3$ | BT-2 | Understand |

**PART-C (15 MARKS)**

| | | | |
|---|---|---|---|
| 1. | Derive the expression for fundamental frequency of a cantilever beam by virtual work method. | BT-1 | Remember |
| 2. | Explain how the conservation of energy method is used to analyse beams for dynamics. | BT-3 | Application |
| 3. | Determine the fundamental frequency for a uniform simply supported beam by assuming the static deflection curve as $Y=(\rho Ag/24EI)(L^3x-2Lx^3+x^4).$ Compare the frequency with that of exact solution. | BT-4 | Analyze |
| 4. | Determine the natural frequencies of vibration of a uniform beam fixed at x=0 and simply supported at x=l. | BT-2 | Understand |

**UNIT-5**

**DIRECT INTEGRATION METHODS FOR DYNAMIC RESPONSE**

Damping in MDOF systems, Nonlinear MDOF systems, Step-by-step numerical integration algorithms, substructure technique, Applications.

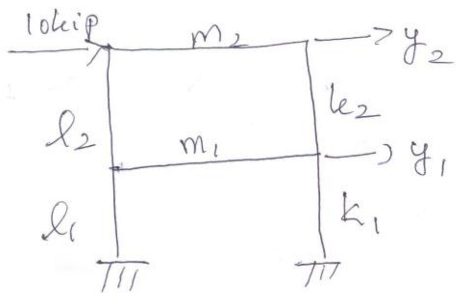
**PART-A (2 MARKS)**

| Sl.No | Questions | BT-Level | Competence |
|---|---|---|---|
| 1. | Define stiffness coefficient | BT-1 | Remember |
| 2. | How is dynamic equilibrium established? | BT-2 | Understand |
| 3. | When Wilson thetamethod become unconditionally stable? Justify | BT-5 | Evaluate |
| 4. | Give the explanation on damping co-efficient. | BT-2 | Understand |
| 5. | Write the incremental velocity equation from Wilson – θ method. | BT-6 | Create |
| 6. | What are the direct integration methods? | BT-1 | Remember |
| 7. | Develop the assumptions made in constant acceleration method. | BT-3 | Application |
| 8. | Write the basic assumptions in Wilson θ method. | BT-6 | Create |

| | | | |
|---|---|---|---|
| 9. | Distinguish between constant acceleration method and linear acceleration method. | BT-4 | Analyze |
| 10. | What is the concept behind linear acceleration method? | BT-2 | Understand |
| 11. | What are the assumptions made in linear acceleration method? | BT-1 | Remember |
| 12. | Explain in detail about the constant acceleration method. | BT-2 | Understand |
| 13. | What is elasto-plastic behavior? | BT-1 | Remember |
| 14. | Discover and explain the principle involved in direct integration methods. | BT-4 | Analyze |
| 15. | Illustrate the effect of damping in MDOF system. | BT-3 | Application |
| 16. | Write shortly about Newmark β method. | BT-3 | Application |
| 17. | What is the concept of Wilson θ method? | BT-1 | Remember |
| 18. | What is the Value of constants in elastoplastic behavior method? | BT-1 | Remember |
| 19. | List the different methods to perform step by step integration. | BT-4 | Analyze |
| 20. | Distinguish between Linear and Nonlinear MDOF systems. | BT-5 | Evaluate |
| 21. | Identify the major parameters that influences in non- linear analysis. | BT-3 | Application |
| 22. | Recommend any two methods of analysis of non - linear MDOF systems. | BT-5 | Evaluate |
| 23. | Explain system damping matrix in case of nonlinear system. | BT-4 | Analyze |
| 24. | Name some of the numerical procedures for finding the transient response of structure. | BT-2 | Understand |
| 25. | Construct the variation of force with time, when the load is applied suddenly. | BT-6 | Create |

**PART-B (13 MARKS)**

| | | | |
|---|---|---|---|
| 1. | Describe about Non-Linear single degree of freedom model. | BT-1 | Remember |
| 2. | Constant acceleration method – Explain in detail. | BT-2 | Understand |
| 3. | Write down the step by step procedure of numerical integration techniques. | BT-3 | Application |
| 4. | Derive the expression for computing the response of a multi degree of freedom system using Wilson's- θ method. | BT-1 | Remember |
| 5. | Explain about New-mark Beta method. | BT-2 | Understand |
| 6. | Write the algorithm for step by step solution of linear system using Wilson – θ method. | BT-6 | Create |
| 7. | Describe the concept of incremental equation of motion for non-linear MDOF system. | BT-1 | Remember |

| | | | |
|---|---|---|---|
| 8. | Calculate the displacement response for two storey shear bulding subjected to suddenly applied force of 10kip at the level of second floor. Neglect damping and assume elastic behavior.<br>$l_2$=120 inch; $l_1$= 180 inch; $m_1$ = 0.136 kipsec$^2$/inch; $m_2$ = 0.066 136 kipsec$^2$/inch.<br> | BT-3 | Application |
| 9. | Write the algorithm for step by step solution of linear system using New-mark Beta method. | BT-3 | Application |
| 10. | List the step by step procedure of direct integration method. | BT-4 | Analyze |
| 11. | Explain the procedure involved in the step by step numerical integration technique for analysis of non-linear MDOF systems. | BT-4 | Analyze |
| 12. | How does a non- linear MDOF system respond to dynamic forces? Explain. | BT-2 | Understand |
| 13. | Evaluate the algorithm for step by step solution for elasto plastic single degree of freedom system. | BT-5 | Evaluate |
| 14. | List the step by step procedure of linear acceleration method | BT-4 | Analyze |

**PART-C (15 MARKS)**

| | | | |
|---|---|---|---|
| 1. | Explain with a 2DOF system the step by step procedure involved in finding displacement of a damped system with forcing function F(t) | BT-2 | Understand |
| 2. | Explain in detail about the direct integration method. | BT-2 | Understand |
| 3. | List some methods for non- linear seismic analysis of regular building. | BT-1 | Remember |
| 4. | Create a Nonlinear MDOF model and evaluate it by Wilson – θ method and New-mark Beta method. | BT-6 | Create |