Prince of Songkla University

Faculty of Engineering

Final Examination: Semester I — Academic Year 2006

Monday, October 9, 2006 — Time 9:00-12:00

220-503 Dynamics of Structures — Room: Robot Conference

Instructions

1. There are 4 questions. The total full marks are 100.
2. Attempt all questions.
3. Books and notes are allowed.
4. Pencils are recommended to be used in answering the questions.

Instructor : Fukit Nilrat

---

1. (30 marks) A uniform simple beam with mass per unit length ***m*** and flexural stiffness ***EI*** is shown in Fig.1.
   (a) **Derive an expression for the vertical deflection** of the beam subjected to uniformly distributed load by using the method of double integration.
   (b) By modifying the deflection obtained in (a), **find the Rayleigh's shape function $\phi(x)$** so that the maximum deflection or $\phi_{max} = 1$.
   (c) Using the shape function in (b), **evaluate the fundamental frequency** of the beam.

2. (20 marks) A two-story frame with the mass per unit length in terms of $\overline{m}$ and the flexural stiffness in terms of ***EI*** of columns and girders is shown in Fig.2. The degrees of freedom of the frame is assumed to 6.
   (a) Evaluate the following stiffness matrix coefficients k_{11}, k_{21}, k_{31}, k_{51}, k_{22}, k_{32}, k_{52}, k_{33}, k_{43}, k_{53} and k_{55}.
   (b) Evaluate the lumped mass matrix.

3. (30 marks) A three-story frame with rigid girders is shown in Fig.3. The mass of the frame is lumped to the girders. The total mass of each girder is 12 tons (12000 kg) and the total lateral stiffness of **each floor (story)** is 40 kN/mm.
   (a) Evaluate the stiffness matrix and the mass matrix of the frame.
   (b) Formulate the frequency equation of the frame.
   (c) It is given that the three frequency of the system are 25.69, 71.99, and 104.03 rad/s, determine the three mode shapes of the frame.

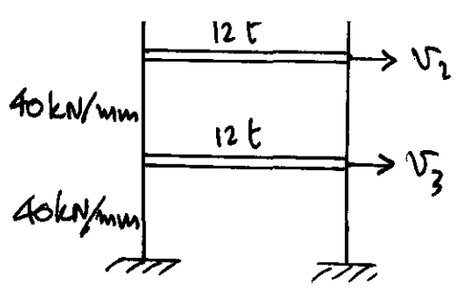

Fig. 3

4. (20 marks) The initial displacement vector of the frame in Problem 3 is given as $\begin{Bmatrix} 10 \\ 0 \\ 0 \end{Bmatrix}$ mm and the initial velocity vector is **a zero vector.**

(a) Evaluate the normal-coordinate generalized mass matrix of the frame.

(b) Evaluate the modal displacements $Y_1(t)$, $Y_2(t)$ and $Y_3(t)$ of the undamped free vibration of the frame.

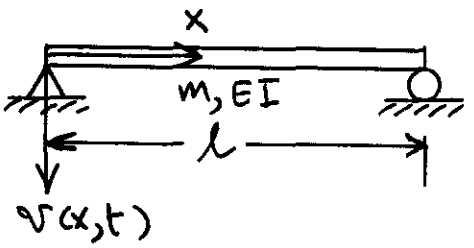

Fig. 1

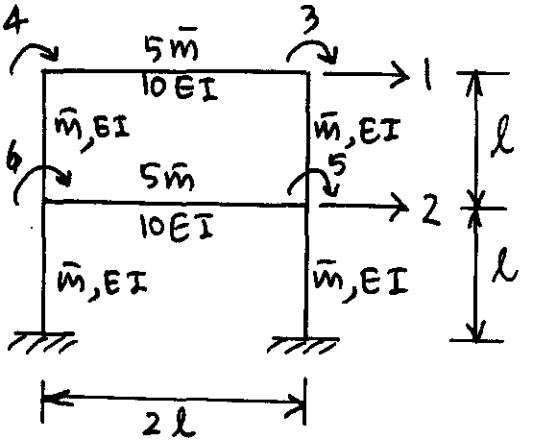

Fig. 2

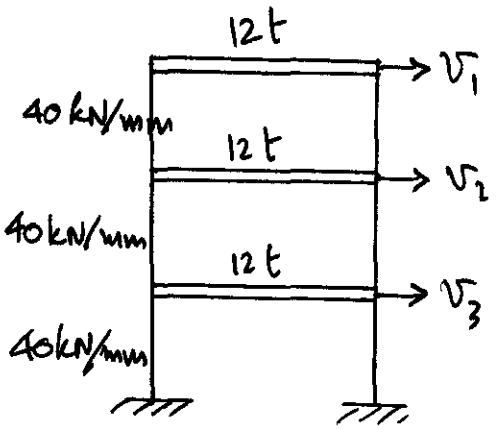

Fig. 3