

Prince of Songkla University

Faculty of Engineering

Midterm Examination: Semester II

Academic Year 2005

Thursday, December 15, 2005

Time 9:00-12:00

220-503 Dynamics of Structures

Room A203

Name..... Student No.

Instructions.

1. There are 5 questions which marks shown in the table below.
 2. Attempt all questions using this question-answer book.
 3. Books and notes are allowed.
 4. Pencils are recommended to be used in answering the questions.
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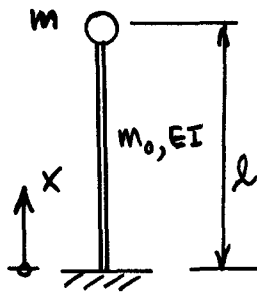
Question	Full Marks	Marks Obtained
1	20	
2	15	
3	15	
4	15	
5	25	
รวม	90	

Instructor : Fukit Nilrat

1. (20 marks) A steel water tank on a steel tower is idealized as shown. To approximate the system to a single degree of freedom, a shape function $\phi(x) = (x/l)^2$ is assumed. The mass of the tank is m and the mass of the tower is assumed to be uniform and is equal to m_0 . The stiffness EI of the tower is also uniform.

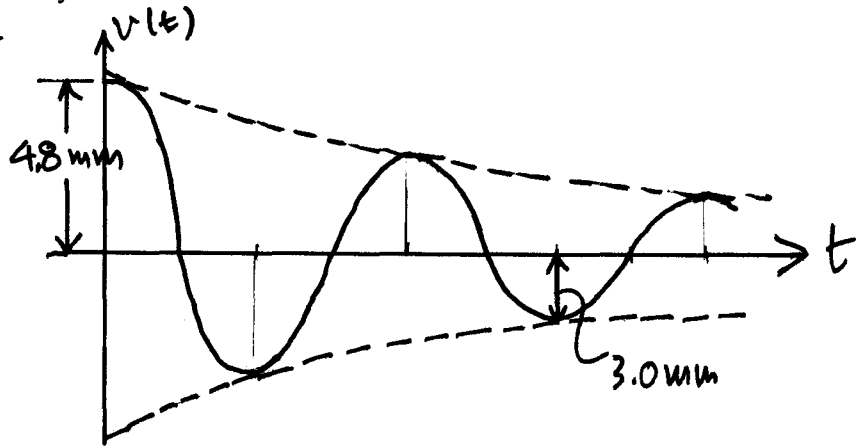
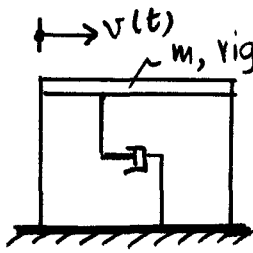
(a) Determine the generalized mass, the generalized stiffness, the generalized geometric stiffness and formulate the equation of motion of the free vibration of the system in terms of given quantities.

(b) For $m = 10000$ kg , $m_0 = 700$ kg/m, $E = 200$ GPa, $I = 1.35 \times 10^6$ cm⁴ , $l = 24$ m, determine the natural period of the system by assuming that the damping ratio is very low.



2. (15 marks) A one-story building is idealized as a rigid girder supported by massless columns as shown. The roof or the rigid girder is displaced laterally for 4.8 mm and then released and it is found that after the 1.5 periods the lateral displacement is 3.0 mm as shown in the graph of the time- displacement of the roof.

Determine the damping ratio of the system.



3. (15 marks) A roof plan of a one-story building similar to the one in Problem 2 is as shown. The sizes of the slabs and beams are as follows:

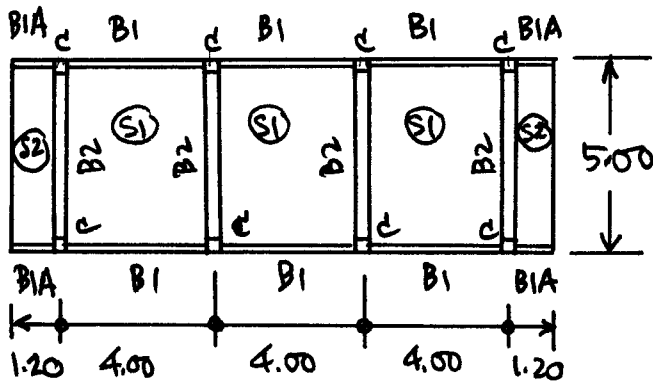
S1, S2 = 0.12 m thick

B1, B1A = 0.15 x 0.50 m

B2 = 0.20 x 0.50 m

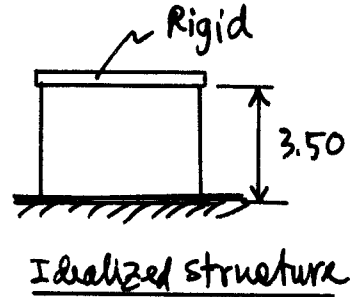
All columns = 0.20 x 0.20 m

Neglecting the reinforcing steels, the mass of the columns, the geometric stiffness and the modulus of elasticity of concrete is given as 20 GPa, determine the natural period of the system.



Roof Plan

Dimensions in m



4. (15 marks) A sieving machine with a mass of 1000 kg is operating at full capacity when it exerts a vertical harmonic force on its supports of 2500 N amplitude at 12 Hz. It is supported by 4 springs, one spring at each corner of the rectangular base. The stiffness of each spring is 125 N/mm. Determine the maximum force transmitted to the supporting base.

5. (25 marks) Express the periodic loading shown as a Fourier series by determining the coefficients of the series. If the loading is applied to an undamped single degree of freedom system, and the ratio of the period of loading to the period of the system is 1.25, determine the steady-state displacement response of the system.

