MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY

UNIVERSITY EXAMINATIONS
2013/2014 ACADEMIC YEAR

FOURTH YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE OF
BARCHELOR OF TECHNOLOGY
IN CIVIL AND STRUCTURAL ENGINEERING

COURSE CODE: **CSE 412**

COURSE TITLE: **STRUCTURAL DYNAMIC**

DATE: **TIME: 3 hours**

INSTRUCTION TO CANDIDATES

- **THIS PAPER CONTAINS 5 QUESTIONS**
- **ANSWER ANY FOUR QUESTIONS**
- **NO UNAUTHORIDED MATERIALS ARE ALLOWED IN THE EXAMINATION ROOM**

Q.1.

(a) Differentiate between Single and Multiple degree of freedom and write their mathematical model. (6 marks)

(b) Determine the equivalent stiffness of a system comprises of two linear spring connecting (1) parallel (2) in series (9 marks)

Q.2. A beam has a modulus of elasticity, $E = 2 \times 10^6$ kg/cm^2, square cross-section of 6 cm by 6 cm and with an attached mass system shown in figure 1 modeled as single degree of freedom with viscous damping. It is found that the logarithmic ratio of two consecutive displaced amplitude is 0.3. Determine the damped natural frequency of the system.
(15 marks)

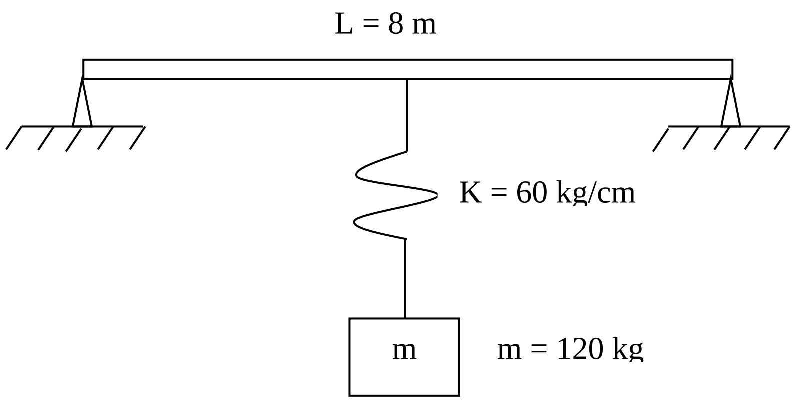


Figure 1

Q. 3. A mass of 100 kg is dropped into the end of a cantilever beam with a velocity of 2 m/s. the mass sticks to the beam and vibrates with the beam. The I-beam is made of steel ($E = 210 \times 10^9$ N/m^2) is 5 m long, has a depth of 15 cm. $I = 4 \times 10^{-5}$ m^4. Find the maximum stress developed in the beam as it vibrates, neglect damping. (15 marks)

Q.4.a. For the undamped structural Frame shown on figure 2, determine the equation of motion for free oscillations in the horizontal direction by D'Alambert principle. Assume that the horizontal member is infinitely rigid with respect to the columns and that the initial condition are non-zero.
Design data:
E = 210 GPa
$I_1 = 3.45 \times 10^7$ mm^4
$I_2 = 7.08 \times 10^7$ mm^4 (12 marks)

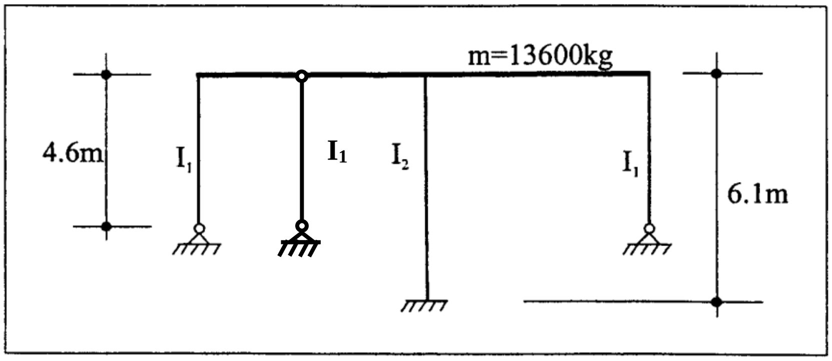


Figure 2

(b) Determine the undamped natural frequency [in Hz] of vibration for the equation of motion developed under (a) (3 marks)

Q.5. A simple supported footbridge of 18 m and constant cross section has a total mass of 12,600 kg and a flexural stiffness of $EI = 3.10^8$ N/m^2 .

a) Following the BS5400 procedure, determine the maximum vertical displacement amplitude and maximum vertical acceleration caused by a pedestrian walking across the bridge in step with the natural frequency of the fundamental vertical mode of the structure. It may be assumed that the pedestrian weighs 700 N, has a stride length of 0.9m and produces an effective harmonic force having amplitude of 180 N. The viscous damping ratio of the fundamental mode of vertical vibration of the bridge may be assumed to be $\zeta = 0.8\%$. (12 marks)

b) Perform an assessment of the footbridge's vibration serviceability in accordance with BS5400 and report your findings. (3 marks)

Table 1: Factor C form BS 5400.

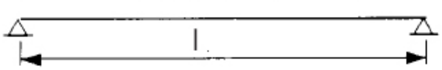
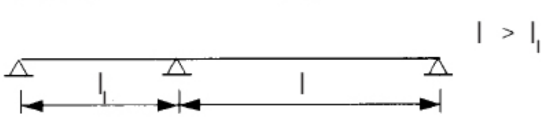
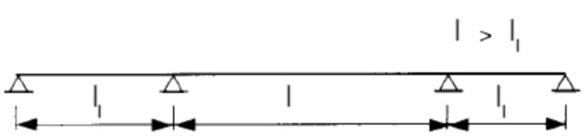
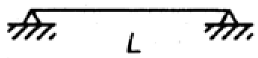
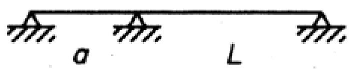
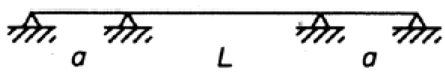
Bridge configuration	Ratio l_1/l	C
	–	π
	0.25 0.50 0.75 1.00	3.70 3.55 3.40 π
	0.25 0.50 0.75 1.00	4.20 3.90 3.60 π

Table 2: Factor K from BS 5400

Configuration	a/L	K
	-	1.0
	1.0	0.7
	0.8	0.9
	<0.6	1.0
	1.0	0.6
	0.8	0.8
	<0.6	0.9

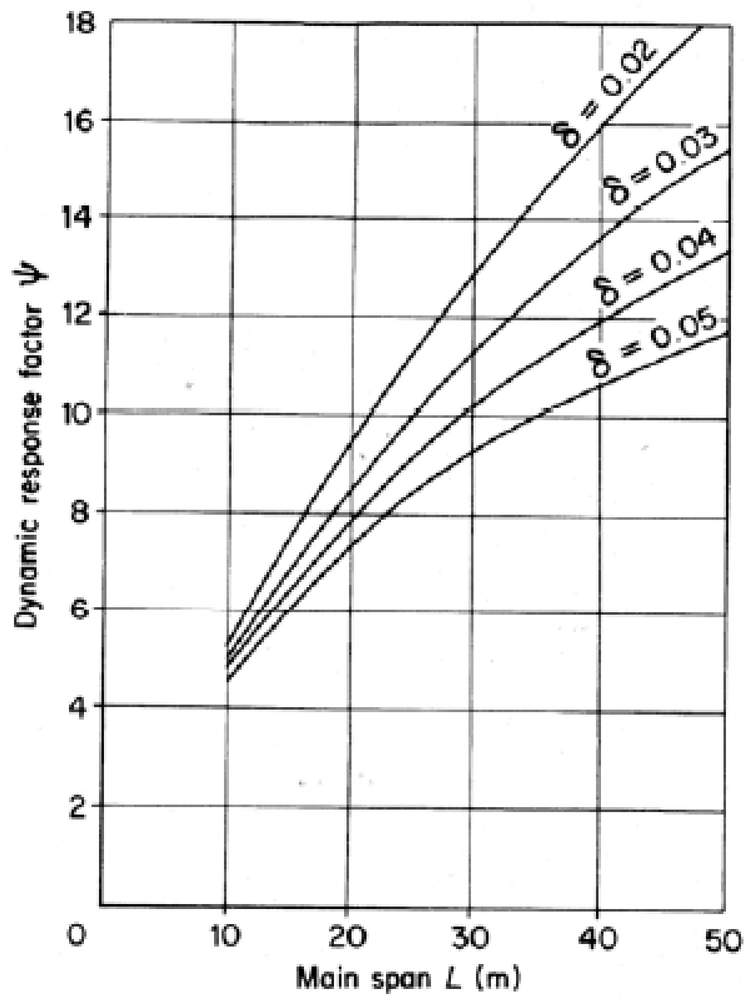


Figure 5: Dynamic response factor for footbridges from BS 5400.