Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 1, 2018					

ENG432 – Dynamics of Engineering Systems	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES

1. Read all questions carefully.
2. Answer all questions.
3. Exam is worth 50% of total marks for this unit.
4. Total marks available on this test are 90.
5. Questions are not of equal value.
6. Lecture Textbook permitted: "Mechanical Vibration" by William J. Palm III.

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a RESTRICTED OPEN BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
Lecture Textbook/s (Unannotated)	1 x 20 Page Book

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Question 1

A machine of mass m=1000 kg is mounted on a simply supported steel beam of length l=2 m having rectangular cross section (h = 0.1 m, w = 1.2 m) and Young's modulus E=2.06×10^{11} N/m^2. To reduce vertical deflection of the beam, a spring of stiffness k is attached at mid-span (Figure 1). Determine the value of the k to reduce deflection of the beam by

(a) 25 % of its original value.

(b) 50 % of its original value.

(c) 75 % of its original value.

(Marks: 10)

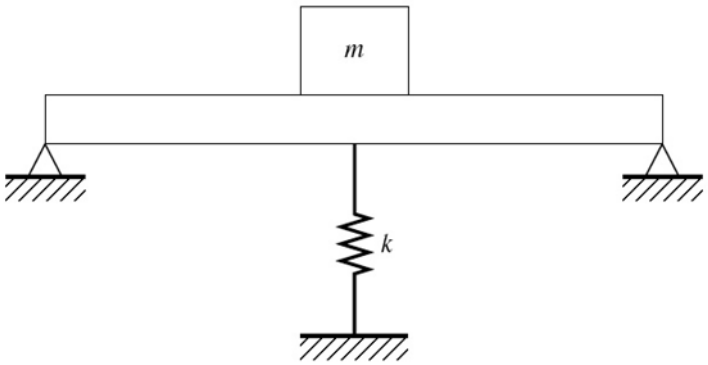

Figure 1*

**W.J.Palm: Mechanical vibration, Wiley, 2007, S.S. Rao: Mechanical vibrations, Pearson Education, 2011*

Question 2

(a) A spring-mass system has a natural period of 0.21 s. What will be the new period if the spring constant is (i) increased by 50 % and (ii) decreased by 50 %.

(Marks: 6)

(b) A certain mass-spring system undergoes viscous damping. The mass is 11 kg and the spring constant is 15 000 N/m. The amplitudes in meters of the first through to the fourth cycles of free vibration are 0.098, 0.073, 0.055 and 0.041. Compute the constant c of the system.

(Marks: 9)

Question 3

Find the response of an overdamped single-degree of freedom system subjected to a step force with the equation of motion:

$$2\ddot{x} + 8\dot{x} + 6x = 5u_s(t)$$

Assume the initial conditions as x_0=1 and $\dot{x}_0$=2.

(Marks: 20)

Question 4

A mass *m* is suspended from a spring of stiffness 4000 N/m and is subjected to a harmonic force having amplitude of 100 N and a frequency of 5 Hz. The amplitude of the forced motion of the mass is observed to be 20 mm. Find the value of *m* (assume undamped case).

(Marks: 15)

Question 5

(a) Find the fundamental frequency for torsional vibration of a shaft of length 2 m and diameter 50 mm when both ends are fixed. The density of the material is 7800 kg/m^3 and the modulus of rigidity is 0.8×10^{11} N/m^2.

(Marks: 5)

(b) A stretched cable of length 2 m has a fundamental frequency of 3000 Hz. Find the frequency of the third mode.

(Marks: 5)

Question 6

Find the free-vibration response of the system shown in Figure 2 for the following set of data: m_1=2, m_2=4, k_1=8, k_2=4, k_3=0, c_1=0, c_2=0, c_3=0. Assume the initial conditions as $x_1(0)$=0, x_2 (0)=1, and $\dot{x}_1(0)$=0, $\dot{x}_2(0)$=0.

(Marks: 20)

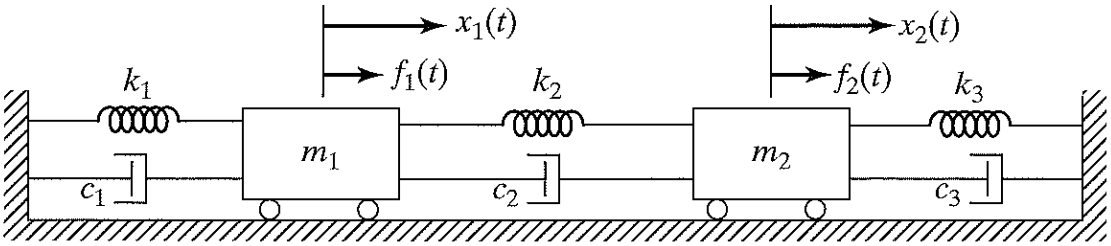

Figure 2*

* *S.S. Rao: Mechanical vibrations, Pearson Education, 2011*