بسم الله الرحمن الرحيم

King Abdulaziz University
Engineering College
Department of Production and Mechanical System Design

MENG 470 Mechanical Vibrations

Second Exam
Closed-book Exam
Monday: 28/3/1425 H
Time Allowed: 90 mins

Name:	Sec. No.:	ID No.:

Question 1		7
Question 2		8
TOTAL		15

Instructions

1. There are totally 2 problems in this exam.
2. This is a closed book and closed notes Opportunity to Shine
3. Show all work for partial credit.
4. Assemble your work for each problem in logical order.
5. Justify your conclusion. I cannot read minds.

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Mechanical Vibrations | Closed Book Exam
MENG 470 | Time: 1 ½ Hour
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Q1. For the multi-degree-of-freedom system shown in the Figure 1:

a) What is the degree-of-freedom for this system?
b) Determine the deferential equations governing the motion using *Lagrange's* equations.
c) Determine the deferential equations governing the motion using *Newtonian* approach.
d) Is your system of equations dynamically coupled, statically coupled, or both?

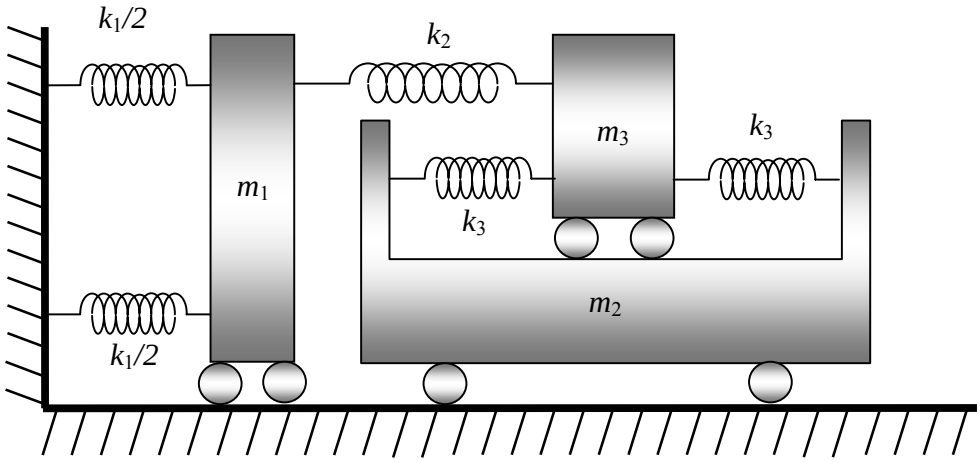

Figure 1

Q2. Two identical cylinders, each of radius *r* and mass *m*, are connected by a spring with constant *k* and roll without slipping relative to ground as shown in Figure 2. If the mass moment of inertia about the mass center of each cylinder is $J = \frac{1}{2}mr^2$.

a) Derive the equations of motion of the system

b) Determine the natural frequencies of vibration.

c) Determine the system mode shapes

d) Calculate the *modal* matrix of the system.

e) Express the equations of motion in *modal* domain as a set of uncoupled differential equations of second order.

f) Using the modal analysis, find the free vibration response of the system (i.e. $x_1(t)$ and $x_2(t)$). Assume the following data: m=10 kg, k=300 N/m, r = 10 cm

$$\begin{Bmatrix} x_1(0) \\ x_2(0) \end{Bmatrix} = \begin{Bmatrix} 1 \\ 0 \end{Bmatrix}, \quad \begin{Bmatrix} \dot{x}_1(0) \\ \dot{x}_2(0) \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix}$$

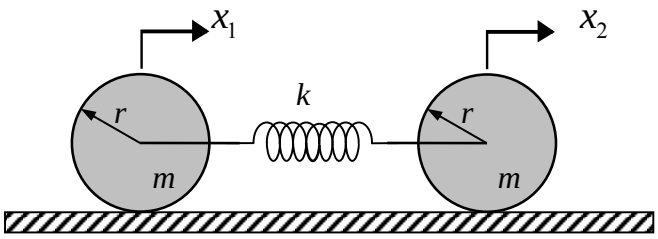

Figure 2

أتمنى لك من أعماق القلب
أداء رائعا فأنت أهل لذلك

د. سعيد بن أحمد عسيري