UNIVERSITY OF TORONTO

FACULTY OF APPLIED SCIENCE AND ENGINEERING

DEPARTMENT OF MECHANICAL & INDUSTRIAL ENGINEERING

*Third Year - MIE302S*

# VIBRATIONS

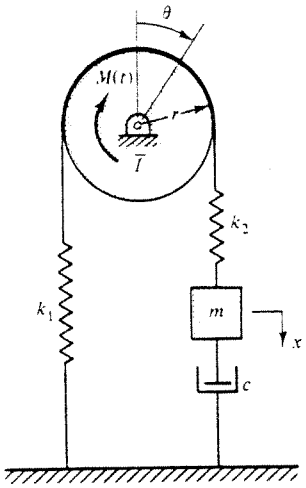
*Final Examination*

**Examiner: J.W. Zu** **Date: April 13, 2000** **Time: 9:30:-12:00**

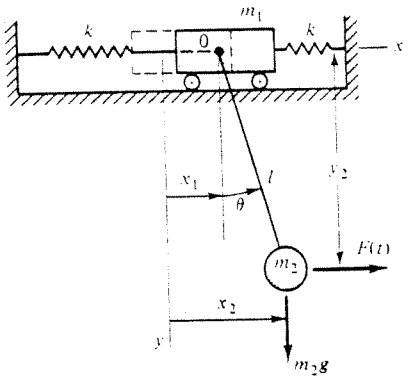
## Instructions:

1. Answer all the questions.
2. Open textbook only.
3. Only non-programmable calculators are allowed.

1. (30%) Establish the equations of motion of the following systems using Lagrange's Equations and find the corresponding [*M*], and [*K*] matrices, assuming small displacement. (15% each)

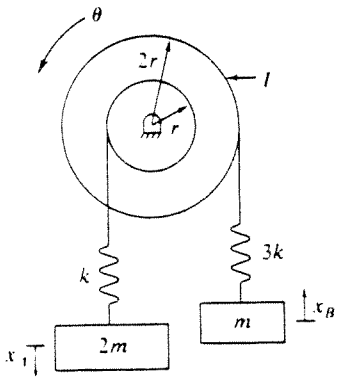



(1)



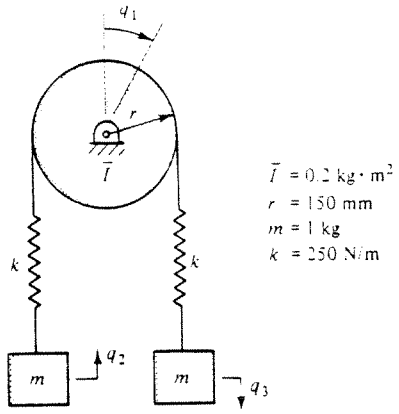

(2)

2. (20%) For the system shown, find the stiffness matrix of the system using the definition of the stiffness influence coefficient.

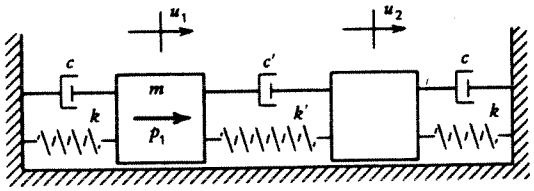


3. (10%) The natural frequencies of a three-degree-of-freedom system are found to be $\omega_1 = 1$, $\omega_2 = 3$, $\omega_3 = 6$. Derive the frequency equation (polynomial equation from the determinant).

4. (20%) For the system shown in the figure, find natural frequency and mode shapes.




5. (20%) For a 2-DOF system shown, determine the steady-state response using mode superposition method.




$p_1 = P_1 \cos \Omega t$
$k = 987, \quad k' = 217, \quad m = 1$
$c = 0.6284, \quad c' = 0.0628$