UNIVERSITY OF TORONTO

FACULTY OF APPLIED SCIENCE AND ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

First Year - MEC100S

DYNAMICS

Final Examination

Examiner: Jean W. Zu **Date: April 19, 2004** **Time: 9:30-12:00**

Instructions:

1. Answer all the questions.
2. 5 questions only and each question is worth 20%.
3. Aid sheet provided (only).
4. Only non-programmable calculators are allowed.

1. A small box of 1 kg at A is launched by a spring initially compressed with 0.2 m from its undeformed length as shown in Fig. 1. The spring constant is 1000 N/m. The kinetic friction coefficient between the box and the inclined surface is 0.2.
    a) Determine the velocity of the box A at exit B.
    b) Find the maximum gap, d, between the launcher at B and the landing platform at C.

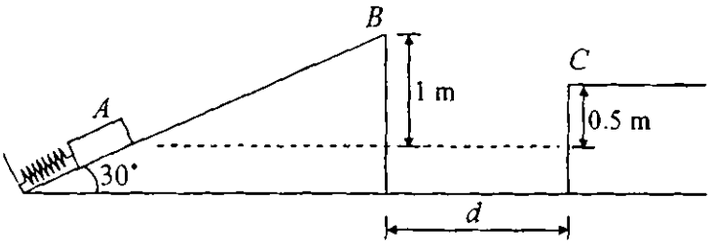

Figure 1

2. The spool shown in Fig. 2 starts from rest and rolls without slipping up the 15° incline under the application of constant force P. After the center of the spool travels 2.4 m, the speed of that center is 1.5 m/s.
    a) Find the velocity of the center of the spool after that center has traveled 1.2 m.
    b) Find the acceleration of point A after the full 2.4 m travel.
    c) Find the acceleration of point B after the full 2.4 m travel.

Express all answers in terms of the rectangular co-ordinates provided.

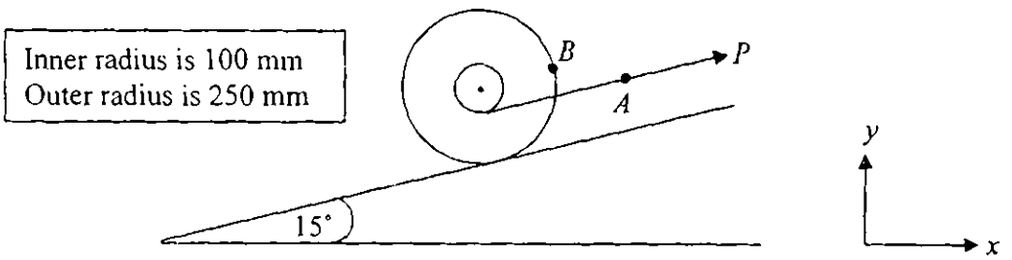

Figure 2

3. Link CB shown in Fig.3 rotates with an angular velocity $\omega_{CB} = 2$ rad/s and angular acceleration $\alpha_{CB} = 4$ rad/s^2. Determine the angular velocity and angular acceleration of the disk at this instant.

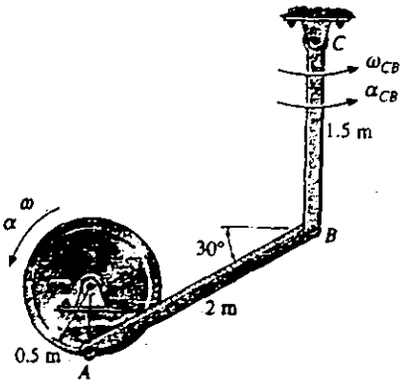

Figure 3

4. The uniform 40 kg slender bar AC shown in Fig. 4 rotates in a vertical plane about the pin at B. The ideal spring AD has a spring constant $k = 20$ N/m and undeformed length $L_0 = 3$ m. The bar is released at rest in the position $\theta = 0$. When the bar reaches the horizontal position, find:

   a) angular velocity of the bar.
   b) force at pin B.

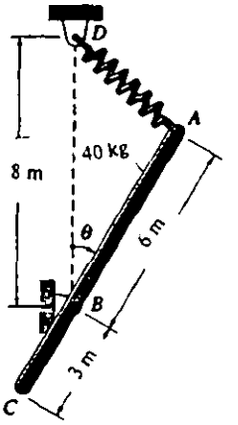

Figure 4

5. A spring-mass-damper system has mass of 150 kg, stiffness of 1500 N/m and damping coefficient of 200 kg/s. Calculate the undamped natural frequency, the damping ratio, and the damped natural frequency. Is the system overdamped, underdamped, or critically damped?