Note:

1. The solutions may not necessarily appear in order. Mark, however, the number of problems for your solutions clearly. Test takers are responsible for not being able to show the problem number clear.
2. Write your answer down clearly, cleanly, and precisely.

1. 20pts The shaft has a square-threaded screw with a lead of 8 mm and a mean radius of 15 mm. If it is in contact with a plate gear having a mean radius of 30 mm, determine the resisting torque **M** on the plate gear which can be overcome if a torque of $7\text{N}\cdot\text{m}$ is applied to the shaft. The coefficient of static friction at the screw is $\mu_B = 0.2$. Neglect friction of the bearings located at A and B. *Write your final answer in the form: M =* _____ .

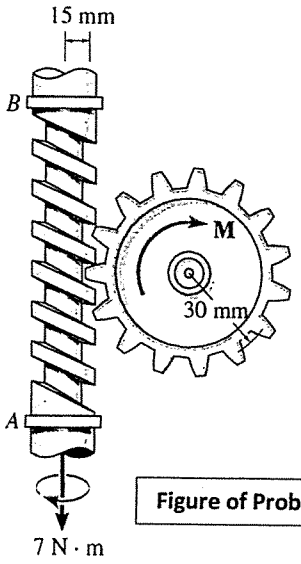

Figure of Prob. 1

2. 15pts Draw **(a)** shear diagram (7pts), and **(b)** moment diagram (8pts) for the beam. The support at A offers no resistance to vertical load.

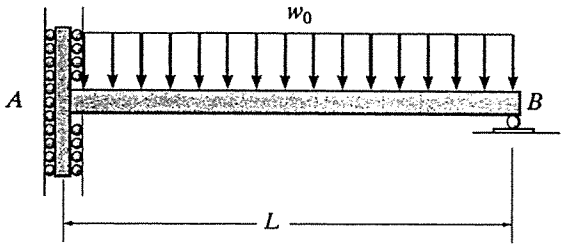

Figure of Prob. 2

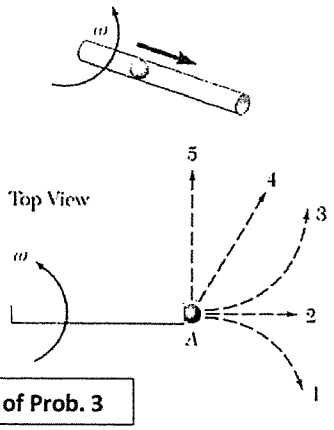

Figure of Prob. 3

3. 5pts Marble A is placed in a hollow tube, and the tube is swung in a horizontal plane causing the marble to be thrown out. As viewed from the top, which of the following choices best describes the path of the marble after leaving the tube? (a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (*Must give explanation to support your answer.*)

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4. 30pts A hemisphere (not semicircle) of weight W and radius r is released from reset in the position shown. Determine **(a)** the distance from the center of gravity G to the point O (10pts), **(b)** the minimum value of μ_s (the coefficient of static friction) for which the hemisphere starts to roll without sliding (10pts), **(c)** the corresponding acceleration of Point B and its direction (10pts). *Write your final answer in the form:* **(a)** $\overline{OG} =$ _____ . **(b)** $\mu_{s,min} =$ _____ . **(c)** $(a_B, direction) =$ (_____ , _____) . *No credit will be granted without detailed calculation.*

5. 20pts A tape moves over the two drums shown. Neglect frictions between the tape and drums. Drum A weighs 0.6 kg and has a radius of gyration of 20 mm, while drum B weighs 1.75 kg and has a radius of gyration of 30 mm. In the lower portion of the tape the tension is constant and equal to $T_A = 4N$. Knowing that the tape is initially at rest, determine (a) the required constant tension T_B if the velocity of the tape is to be v = 3 m/s after 0.24 s (10pts), (b) the corresponding tension in the portion of tape between drums, T_{AB} (10pts). *Write your final answer in the form:* **(a)** $T_B =$ _____ . **(b)** $T_{AB} =$ _____ .

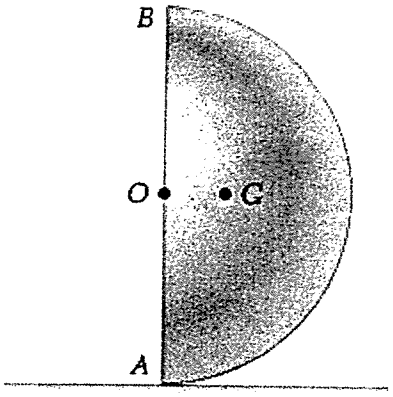

Figure of Prob. 4

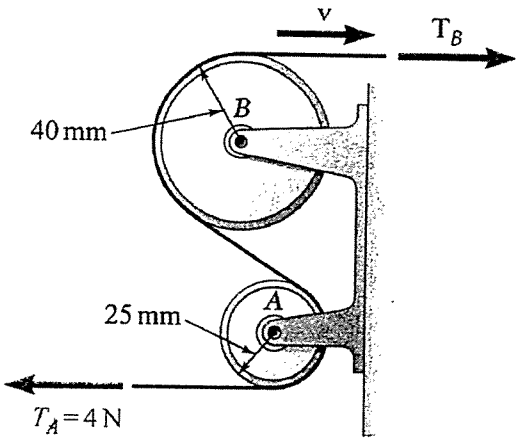

Figure of Prob. 5

6. 10pts The simplest type of vibrating motion is undamped free vibration, as shown. The block has a mass *m* and is attached to a spring having a stiffness *k*. Determine **(a)** the natural frequency, ω_n, of the system (5pts), and **(b)** the displacement of the mass with initial displacement and velocity equal to u_0 and v_0, respectively (5pts). *Write your final answer in the form:* **(a)** $\omega_n =$ _____. **(b)** Displacement solution: _____. *No credit will be granted without detailed derivation.*

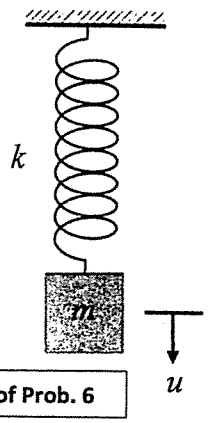

Figure of Prob. 6

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