Ph.D. Qualifying Examination

Dynamics

Spring 2015

Notes:

1. Duration: 2.5 hours

2. Closed book, closed notes (one sheet of formulas is allowed).

3. Suggested textbook(s) for study: any recent edition of Meriam & Kraige or Hibbeler

4. Topics covered: Newtonian dynamics of particles and rigid bodies (2-D only), including work-energy methods and impulse-momentum methods.

5. Topics NOT covered: Lagrangian methods of analysis.

6. Nature of exam: 4 problems; calculator is recommended.
Problem 1.
To anticipate the dip and hump in the road, the driver of a car applies her brakes to produce a uniform deceleration. Her speed is 100 km/h at the bottom A of the dip and 50 km/h at the top C of the hump, which is 120 m along the road from A. If the passengers experience a total acceleration of 3 m/s² at A and if the radius of curvature of the hump at C is 150 m, calculate (a) the radius of curvature \( \rho \) at A, (b) the acceleration at the inflection point B, and (c) the total acceleration at C.
Problem 2.

The tractor A is used to hoist the bale B with the pulley arrangement shown. If A has a forward velocity \( v_A \), determine an expression for the upward velocity \( v_B \) of the bale in terms of \( x \) and \( l \).
Problem 3.

At the instant shown, two forces act on the 30-lb slender rod, which is pinned at O. Determine the magnitude of force F and the initial angular acceleration of the rod so that the horizontal reaction that the pin exerts on the rod is 5 lb directed to the right.
For the slender rod: \( I_G = \frac{1}{12}ml^2; \ I_o = \frac{1}{3}ml^2. \)
Problem 4.

The collar of negligible size has a mass of 0.25 kg and is attached to a spring having an unstretched length of 100 mm. If the collar is released from rest at A and travels along the smooth guide, determine its speed just before it strikes B.