EF 151 Final Exam, Spring, 2013

Remove this sheet AFTER the exam starts and place your name and section on the next page.

Instructions:

- Do not open the test until you are told to do so.
- Write your final answer in the box provided.
- If you finish with less than 5 minutes remaining, please stay seated until the exam is over.
- Stop work immediately when time is over; pass exams to the aisle; stay seated until all exams are collected.

Guidelines:

- Assume 3 significant figures for all given numbers unless otherwise stated
- Show all of your work – no work, no credit
- Include units for all answers
- Include directions for all vectors

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<th>111 Front</th>
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<td>1a</td>
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Mass Moments of Inertia:

Center of Mass:
1. (7 pts) A lost marathoner runs 6.7 miles north, then 3.6 miles east, then 11.3 miles south. Determine how far and in what direction she must run to get back to her starting point.

2. (7 pts) A squirrel starts running at position (2.7\hat{i} + 3.4\hat{j}) meters with an initial velocity of (6\hat{i} + 2\hat{j}) m/s and a constant acceleration of (−3\hat{i} + 4\hat{j}) m/s². Determine the speed of the squirrel when she is at her maximum x position.

3. (7 pts) Chris is jogging at a constant speed of 6.3 ft/s. Daniel starts from rest and runs towards Chris with a constant acceleration of 2.8 ft/s². They meet 8.0 seconds later. How far apart were they when Daniel started running?

4. (7 pts) An airpane pilot wishes to fly 300 miles due west. A wind of 35mph is blowing towards the south. If the speed of the plane in still air is 115mph, how long will it take to reach her destination?
5. (7 pts) Kilauea, a volcano in Hawaii, ejects a hot lava rock with a speed of 25 m/s at an angle of 35° above the horizontal. The rock strikes the ground at an altitude 20m lower than its starting point. Calculate the horizontal distance the rock traveled.

6. (7 pts) A 10 kg box with two applied forces is sliding down an incline as shown. Determine the magnitude of the acceleration. \( F_{RD} = K \Delta \) required

7. (7 pts) A 2.0 gram bullet traveling 360m/s strikes a tree, penetrating to a depth of 0.15m. Determine the magnitude of the average force exerted on the bullet.

8. (7 pts) A package is shot up an incline by a compressed spring. The package is not attached to the spring. The initial compression of the spring is 0.61 meters and there is a constant friction force of 30 N between the package and the incline. Determine the speed of the block after it has traveled 4.2 meters up the incline.
9. (7 pts) A 2 kg object moving to the right at 4 m/s has a direct collision with a 3 kg object moving to the left at 5 m/s. After the collision, the 2 kg object has a velocity of 6 m/s to the left. Determine the coefficient of restitution between the two objects.

10. (7 pts) We want a 3280 pound car to climb a 14° hill at a steady speed of 48 mph. Assume a retarding force of 180 lb from internal friction and wind resistance. The transmission of the car is 78% efficient. What is the required engine horsepower? (1 hp = 550 ft-lb/sec) (FBD required)

11. (7 pts) A car starts from rest and is going around a circular track. The car is increasing speed at a rate of 8 ft/s² and it will start to slip when the total acceleration is 14 ft/s². The car begins to slip after 7 seconds. What is the radius of the track?

12. (7 pts) Determine the x-coordinate of the center of mass of this object. All dimensions are in cm.
13. (7 pts) A wheel with a mass moment of inertia of 0.82 kg·m² starts from rest and is spun up at a constant rate to a speed of 600 rpm in 8 seconds. What torque was required during the spin-up?

9 problems – 1 pt each – circle the correct answer

14. Chris is trying to tighten the lug nut (normal RH threads) on his truck as shown. The specs say it should be torqued to 120 ft-lb. His wrench is 12 inches long. Assuming he pushes or pulls perpendicular to the end of the wrench, what force does he need to apply?
   A. 120 lb up
   B. 120 lb down
   C. 10 lb up
   D. 10 lb down

15. Which of the following must be true if a net force of F is acting on an object?
   A. The object is moving in the direction of F
   B. The object is accelerating in the direction of F
   C. There is work being done on the object
   D. The object will spin about its center of mass

16. A battle ship simultaneously fires two shells with the same initial speed. Based on the picture, which enemy ship gets hit first?
   A. Ship A
   B. Ship B
   C. Both will be hit at the same time

17. A boy and a girl (same mass) are riding on a frictionless merry-go-round which is turning at a constant rate. The boy is near the edge and the girl is closer to the center of rotation. Who has to hold on tighter?
   A. The boy (near edge)
   B. The girl (near center)
   C. Both require the same non-zero force
   D. No force is required to stay on

18. A falling object has reached terminal velocity. Which statement is NOT true?
   A. The net force is 0
   B. The drag force is 0
   C. The acceleration is 0
   D. The velocity is constant
   E. The momentum is constant

19. Which type of graph could be used to determine impulse without additional information?
   A. Force vs distance
   B. Force vs velocity
   C. Force vs time
   D. Distance vs time
   E. Velocity vs time
   F. Acceleration vs time

20. Four children are riding on the outside edge of a merry-go-round. Ignore friction in the rotation of the merry-go-round and consider the “system” of the children plus the merry-go-round. What value remains constant as one child walks toward the center?
   A. Center of mass
   B. Angular velocity
   C. Angular momentum
   D. Moment of inertia

21. A car is traveling north. The traffic light ahead turns red, so the driver applies the brakes. As the car is slowing down, in which direction is the angular acceleration vector of one of the wheels?
   A. North
   B. South
   C. East
   D. West
   E. Up
   F. Down

22. A spinning bicycle wheel is hung by a rope. The spinning wheel slowly rotates about the z-axis. This is an example of:
   A. Concession
   B. Precession
   C. Recession
   D. Tangential acceleration
   E. Bates’ 2nd Law of Rotational Motion
   F. Conradian Motion