ME 270 – Spring 2011 Final Exam

Final Exam

Please review the following statement:

I certify that I have not given unauthorized aid nor have I received aid in the completion of this exam.

Signature: __________________________________________

INSTRUCTIONS

Begin each problem in the space provided on the examination sheets. If additional space is required, use the yellow paper provided to you.

Work on one side of each sheet only, with only one problem on a sheet.

Each problem is worth 20 points.

Please remember that for you to obtain maximum credit for a problem, it must be clearly presented, i.e.

- The coordinate system must be clearly identified.
- Where appropriate, free body diagrams must be drawn. These should be drawn separately from the given figures.
- Units must be clearly stated as part of the answer.
- You must carefully delineate vector and scalar quantities.

If the solution does not follow a logical thought process, it will be assumed in error.

When handing in the test, please make sure that all sheets are in the correct sequential order and make sure that your name is at the top of every page that you wish to have graded.

Instructor’s Name and Section:

Section 1: J. Jones 9:30 – 10:20 a.m. Section 2: V. Kumar 2:30 – 3:20 p.m.

Problem 1 _________
Problem 2 _________
Problem 3 _________
Problem 4 _________
Problem 5 _________
Total ____________
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PROBLEM 1 (20 points) – Prob. 1 questions are all or nothing.

PROBLEM 1A. (5 points)

FIND: In your own words, please state the following:

Newton’s 1st Law =

Newton’s 2nd Law =

Newton’s 3rd Law =

PROBLEM 1B. (5 points)

FIND: Determine the angle between the cables AC and AB.

\[ \theta = 51.75^\circ \]
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PROBLEM 1C. (5 points)

FIND: A) Determine the moment vector of the force $\vec{F}$ about the point A.

B) Determine the magnitude of the moment about the axis A-B.

\[ \overrightarrow{M_A} = 20 \hat{i} - 125 \hat{j} + 110 \hat{k} \text{ N-m} \]  

\[ |\overrightarrow{M_{AB}}| = -88 \text{ N-m} \]  

(3 pts.)  

(2 pts.)

PROBLEM 1D. (5 points)

FIND: Identify all the zero force members in the truss structure shown below.
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PROBLEM 2 (20 points) – Prob. 2 questions are all or nothing.

Problem 2A (5 points)

FIND: After deploying the parachute, the space shuttle has a deceleration given by \( a = -0.004 \ v^2 \) where \( v \) is in m/s and \( a \) is in m/s\(^2\). Determine the time required for the velocity to decrease from 80 m/s to 10 m/s.

\[
t = 21.88 \text{ s}
\]

(5 pts.)

Problem 2B. (5 points)

GIVEN: A car traveling over the crest A of a hill where the radius of curvature is 200 ft.

FIND: Find the maximum speed for which the wheels will stay in contact with the road at A.

\[
v = 86.25 \text{ ft/s}
\]

(5 pts)
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Problem 2C (5 points)

FIND: The motorcyclist is riding along a horizontal circle on the inside of a cylindrical wall. If the coefficient of static friction between the tires and the wall is 0.6, what is the smallest possible speed of the motorcycle?

\[ v = 8.09 \text{ m/s} \] (5 pts.)

Problem 2D. (5 points)

FIND: The walkway ABC of the footbridge is stiffened by adding the cable ADC and the short post of length L. If the tension in the cable is not to exceed 500 lbs, what is the smallest value of L for which the 185 lb person can be supported at B?

\[ L = 1.506 \text{ ft} \] (5 pts.)
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PROBLEM 3. (20 points)

GIVEN: The structure is subjected to a distributed vertical load and a single 100 N point force as shown. The angled bar is supported by a fixed support at B and is in static equilibrium.

FIND:

a) Determine the equivalent magnitude and location of the distributed load shown. (6 points)
b) Draw a FBD including the equivalent loading. (4 points)
c) Find the reactions at fixed support B. (10 points)

\[ B_x = -80 \text{N} \]
\[ B_y = 106.6 \text{N} \]
\[ M_B = 708.3 \text{ N-m} \]
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PROBLEM 4. (20 points)

Given: The front-wheel suspension of an automobile is shown in the figure. The pavement exerts a vertical force of 2700 N on the tire.

Find:

a) Draw a free body diagram of each of the individual members (Wheel and the member BC together, CD, AB, and AD. (4 points)
b) Determine the forces acting on the spring, and at the joints A and B. (14 points)
c) Express the forces at the joints A and B acting on the member AB in vector form. (2 points)

Hint: Identify two-force member(s) first before proceeding to solve the problem.

\[
\begin{align*}
B_x & = 1246N \\
B_y & = -2700N \\
A_x & = 112.8N \\
A_y & = 2972N \\
F_s & = -5784N
\end{align*}
\]
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Problem 5 (20 points)

**GIVEN:** To study the performance of a race car, a high-speed motion-picture camera is positioned at A. The camera is mounted on a mechanism which permits it to record the motion of the car as the car travels on a straightway BC. Use the following values: \( b = 50 \text{ ft}; \theta = 40^\circ; \)
\( \dot{\theta} = -0.05 \text{ rad/s}; \ddot{\theta} = 0.001 \text{ rad/s}^2. \)

**FIND:**

a) On the artwork provided, sketch the path coordinate unit vectors \((u_t, u_n)\) and polar coordinate unit vectors \((u_r, u_\theta)\). (4 points)

b) Write the velocity and acceleration of the car in terms of path coordinate unit vectors. (2 points)

c) Express the path coordinate unit vectors in terms of the polar coordinate vectors (4 points)

d) Determine the speed of the car. (5 points)

e) Determine the magnitude of the acceleration of the car. (5 points)

\[
\begin{align*}
V & = 4.26 \text{ ft/s} \\
\dot{V} & = -0.442 \text{ ft/s}^2
\end{align*}
\]