NAME: ______________________________    Section: ___________

RIN: _______________________________

Monday, May 14, 2012

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**N.B.:** You will be graded on 5 problems, 20 points per problem. Problems 1, 2, and 3 are mandatory and will be graded. Before turning in your exam, please make sure you have circled the two problems you want to be graded out of problems 4, 5 and 6.
Problem 1 (20 points)
Given the system of equations:

\[ \begin{align*} 
2y + z &= 7 \\
4x + 3y - z &= 7 \\
-4x + 4y + z &= 7 
\end{align*} \]

a) Write the system of equations in a matrix form \( AX = B \). Identify \( X \), \( A \) and \( B \). (3)
b) Calculate the determinant of matrix \( A \) using the method of cofactor expansion by expanding the first column. (5)
c) Calculate \( \text{Adj}(A) \) (5)
d) Calculate \( A^{-1} \) (3)
e) Use Cramer's rule to solve for the unknown \( y \). (4)

Note: You should show all work to receive full credit
**Problem 2 (20 points)**

The 20-lb block A and the 30-lb block B are supported by an incline that is held in the position as shown in below figure. Knowing that the coefficient of static friction is 0.15 between all surfaces of contact, determine the value of θ in degrees for which motion is impending (20 points)

Draw necessary FBDs to receive full credits
Problem 3 (20 points)

The following frame is used to support a weight of 250 N. The supports at A and E are smooth pins and at F is a smooth roller.

a) Determine the reactions at all the supports (13)
b) Determine the components of all the forces acting on member DFE (7)

Note: You need to draw all required FBD’s and show all work to receive full credit
Problem 4 (20 points)

Three smooth homogeneous cylinders A, B, and C are stacked in a V-shaped trough as shown in the figure below. Cylinder A weighs 100 lb; cylinders B and C each weigh 200 lb. All cylinders have a 5-in diameter.

a) Draw complete free body diagrams of cylinders A, B and C. (6)
b) Determine the reaction force on cylinder A exerted by cylinder B. (4)
c) Determine the minimum angle \( \theta \) for equilibrium. (8)
d) Determine the reaction force on cylinder B from the inclined surface corresponding to the value of angle \( \theta \) computed in part (c). (2)

Note: You need to show all work to receive full credit.

\begin{itemize}
  \item [a) FBD of cylinder A]
  \item [a) FBD of cylinder B]
  \item [a) FBD of cylinder C]
  \item [b) Reaction force on cylinder B from the inclined surface:]
  \item [c) Minimum angle \( \theta \) for equilibrium:]
  \item [d) Reaction force on cylinder B from the inclined surface:]
\end{itemize}
Problem 5 (20 points)

Three forces $F_1 = 4 \text{ kN}$, $F_2 = 5 \text{ kN}$, and $F_3 = 6 \text{ kN}$ are applied as shown. It is required to replace these forces by a single resultant force and a single resulting couple at O.

a) Determine the magnitude of the resulting force at O in kN
b) Determine the angles between the resultant found in part a above and the three coordinate axes in degrees
c) Determine the magnitude of the resulting couple at O in kN.m
d) Determine the angles between the resultant found in part c above and the three coordinate axes in degrees

Note: You should show all your work to receive full credit
**Problem 6 (20 points)**

A 10 ft pole is acted upon by the 840 lb force shown. Determine the tension in each cable and the reaction at the ball and socket joint at A (20 points)

Draw necessary FBDs to receive full credits

\[ T_{BD} = \]

\[ T_{BE} = \]

Reaction at A: