NAME: ______________________________    Section: ___________

RIN: _________________________________

Wednesday, February 24, 2016
5:00 – 6:50

Please state clearly all assumptions made in order for full credit to be given.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Points</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Good Luck
Problem #1 (25)

Consider the four points A(2, -4, -1), B(-4, 3, 5), C(6, 9, -3) and D(x, y, z) in a 3D Cartesian coordinate system.

a) Express vector $\mathbf{AC}$ in a Cartesian vector form.  
   
   (4)

b) Express vector $\mathbf{BC}$ in a Cartesian vector form.  
   
   (4)

c) Point D creates a parallelogram ABCD (AB//CD and AD//BC). Determine $x$, $y$ and $z$. 

   (6)

d) Find the magnitudes $|\mathbf{AC}|$, $|\mathbf{AD}|$ and $|\mathbf{DC}|$. 

   (6)

e) Find the angle $\theta$ between the vectors $\mathbf{AC}$ and $\mathbf{AD}$. Provide your result in degrees. 

   (5)

\[
\begin{align*}
\text{a) } & \quad \mathbf{AB} = \\
\text{b) } & \quad \mathbf{BC} = \\
\text{c) } & \quad x = \\
& \quad y = \\
& \quad z = \\
\text{d) } & \quad |\mathbf{AC}| = \\
& \quad |\mathbf{AD}| = \\
& \quad |\mathbf{DC}| = \\
\text{e) } & \quad \theta = 
\end{align*}
\]
Problem #2 (25)

Two forces are applied on a particle O as shown in the figure below. The angles $\alpha$ and $\beta$ are the coordinate direction angles of $F_2$.

a) Express the force $F_1$ in a Cartesian vector form. (4)

b) Express the force $F_2$ in a Cartesian vector form. Note that $z$ component is negative. (5)

c) Find the resultant force $F_R$ in a Cartesian vector form. (2)

d) Find the unit vector from O to P, $\mathbf{u}_{OP}$. (4)

e) Find the vector component of $F_R$ along OP, $F_{R/OP}$. (6)

f) Find the vector component of $F_R$ perpendicular to OP, $F_{R\perp OP}$. (4)

\[ F_1 = \]
\[ F_2 = \]
\[ F_R = \]
\[ \mathbf{u}_{OP} = \]
\[ F_{R/OP} = \]
\[ F_{R\perp OP} = \]
Problem #3 (25)

A 200-kg engine is being supported by a chain and two cables connected at C. Angle $\theta = 30^\circ$.

a) Identify the particle to be analyzed  

b) Draw a FBD of the particle to be analyzed showing all the forces acting on it.  

c) Determine the magnitude of the force $P$ and in cable $AC$  

<table>
<thead>
<tr>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P =$</td>
<td></td>
</tr>
<tr>
<td>$T_{AC} =$</td>
<td></td>
</tr>
</tbody>
</table>
Problem #4 (25)

Solve the following system of linear equations using the Gauss-Jordan Elimination method:

\[
\begin{align*}
2x - 4y + 2z &= -5 \\
3x + 2y - 5z &= -19.5 \\
-5x - 3y - 2z &= 2
\end{align*}
\]

a) Write the augmented matrix

b) Use elementary row operations to obtain the reduced row echelon form

c) Write the solution for the three variables \(x\), \(y\), and \(z\)

Show all details of the elementary row operations (no credit will be given for unsupported answers).

\[
\begin{align*}
a) \\
\end{align*}
\]

\[
\begin{align*}
c) \\
x &= \\
y &= \\
z &=
\end{align*}
\]