Section: ______  Name: ____KEY____

Student Number: ____________________________

"Aggies do not lie, cheat, or steal, nor do they tolerate those who do." — Aggie Code of Honor

By my signature below I pledge that my conduct on this exam is consistent in every way with the Aggie Code of Honor:

Signature: ______________________________________

1. This exam consists of Six (6) problems that are equally weighted
2. Some problems have multiple parts.
3. Be sure to carefully read and properly analyze each question that is asked. Do not jump to unfounded conclusions, but also do not overlook or oversimplify problems either.
4. Be sure to show all work, including sketches, Free Body Diagrams, and calculations, and organize your solution procedure as clearly and systematically as possible.
5. Work problems in the space provided on the exam sheets.
6. Work efficiently, neatly, and use pencil.
7. Clearly indicate final answers by enclosing in a "box" or place answer in box if box is provided. Include any and all appropriate units.

| Problem 1: | _______ / 10 |
| Problem 2: | _______ / 10 |
| Problem 3: | _______ / 10 |
| Problem 4: | _______ / 10 |
| Problem 5: | _______ / 10 |
| **TOTAL:** | _______ / 50 |
Problem 1 (20 points). The mobile shown is in equilibrium. Fish B weighs 1.5 lbs. Ignore the weights of the bars and strings. Determine the weights of fish A, C, and D. Enter your results in the blanks provided. Show all work and all necessary free body diagrams to receive full credit.

\[ \sum M_E = 0 \]
\[ T_2 \cdot 6 - 1.5(z) = 0 \]
\[ T_2 = 1.5 \text{ lb} \]

\[ \sum F_y = 0 \]
\[ T_1 - 1.5 - 1.5 = 0 \]
\[ T_1 = 2.0 \text{ lb} \]

\[ W_C = \frac{1}{2} (1.11) \]
\[ W_C = 1.389 \text{ lb} \]

\[ W_{DA} = 0.5 \text{ lb}, \ W_{FAC} = 1.389 \text{ lb}, \text{ and } W_{FAD} = 0.111 \text{ lb} \]

\[ \sum M_C = 0 \]
\[ W_A \cdot 12 - T_1 (13) = 0 \]
\[ W_A = 0.5 \text{ lb} \]

\[ \sum F_y = 0 \]
\[ 7 - W_A - T_1 = 0 \]
\[ T_3 = 2.5 \text{ lb} \]
Problem 2 (20 points). The weightless bar OA is held in place by weightless cables AB and AC as shown. Bar OA is supported by a ball and socket at O as shown. The suspended load of lumber exerts a downward force of 600 lb at point A of the bar as shown. Determine the magnitudes of the tensions in cables AB and AC. In addition determine the magnitudes and directions of the three support reactions at point O. Show your results on a FBD of member OA. Show all work and all necessary free body diagrams to receive full credit.

\[ \vec{AC} = -15 \hat{\imath} - 20 \hat{j} + 5 \hat{k} \]

\[ |\vec{AC}| = 25.5 \]

\[ \vec{t}_{AC} = -0.588 \hat{\imath} - 0.785 \hat{j} + 1.96 \hat{k} \]

By inspection

The structure is symmetric and loaded symmetrically

\[ |\vec{t}_{AC}| = |\vec{t}_{AB}| \]

and

\[ \vec{t}_{AB} = -0.588 \hat{\imath} - 0.785 \hat{j} + 1.96 \hat{k} \]

\[ \vec{t}_{OA} = 25 \hat{\imath} + 20 \hat{j} + 45 \hat{k} \]

\[ \tau_{OA} = 0 \hat{\imath} + 1.8 \hat{j} + 0.6 \hat{k} \]

\[ \vec{F}_{OA} = -0.588 \tau_{AC} \hat{\imath} - 0.785 \tau_{AC} \hat{j} + 1.96 \tau_{AC} \hat{k} \]

\[ \vec{F}_{AB} = +0.588 \tau_{AB} \hat{\imath} - 0.785 \tau_{AB} \hat{j} + 1.96 \tau_{AB} \hat{k} \]

\[ \vec{W} = 600 \hat{\imath} + 0 \hat{j} + 0 \hat{k} \]

\[ \tau_{AC} = \tau_{AB} \]

\[ \sum F_x = 0 \]

\[ -0.588 \tau_{AC} + 0.588 \tau_{AB} = 0 \]

\[ \tau_{AC} = \tau_{AB} \]

\[ \sum F_y = 0 \]

\[ \tau_{AB} - 0.785 \tau_{AC} - 0.785 \tau_{AB} + 1.57 \tau_{AB} = 0 \]

\[ 1.57 \tau_{AB} = 0.8 \tau_{OA} \]

\[ \tau_{OA} = 1.963 \tau_{AB} \]

\[ \vec{F}_{OA} = 1.963 \tau_{AB} \]

\[ \sum F_z = 0 \]

\[ 1.963 \tau_{AC} + 1.963 \tau_{AB} + 6 \tau_{OA} - 600 = 0 \]

\[ 1.57 \tau_{AB} = 600 \]

\[ \tau_{AB} = 382.16 \text{ lb} \]

\[ \tau_{AB} = 382.2 \text{ lb} \]

\[ \vec{F}_{OA} = 750.3 \text{ lb} \]
\[ \sum F_x = 0 \\
O_x - 600.24 = 0 \\
O_x = 600.24 \]

\[ \sum F_z = 0 \\
O_z - 450.2 = 0 \\
O_z = 450.2 \]

\[
\overrightarrow{T_{AC}} = -224.7 \hat{x} - 300.0 \hat{y} + 74.9 \hat{z} \\
\overrightarrow{T_{AR}} = 224.7 \hat{x} - 300.0 \hat{y} + 74.9 \hat{z}
\]
Problem 3 (20 points). Calculate the magnitudes of the forces in members MK, MI, and HI for the truss shown. Indicate whether the members are in tension or compression. Enter your results in the blanks provided. Show all work and all necessary free body diagrams to receive full credit.

By Inspection

\[ F_{HI} = 0 \]

\[ \sum M_I = 0 \]

\[ F_{MK} (1) - 1 (4) - z (6) - 1 (8) = 0 \]

\[ F_{MK} = 24 \text{ KN T as shown} \]

\[ \sum F_y = 0 \]

\[ F_{MI} = 8.944 \text{ KN} \]

\[ F_{MK} = 24 \text{ KN T}, F_{MI} = 8.944 \text{ KN}, \text{ and } F_{HI} = 0 \]
Problem 4 (20 points). Member ABC is pinned at A to a rigid support and pin connected to member DE at point B. Member DE is pinned at D to a rigid support and pin connected to member ABC at B. A flexible rope is attached to member ABC at point C. The rope extends over a frictionless, massless pulley that is attached to member DE as shown. There is an 80 lb force applied to the end of the rope as shown. Calculate all forces acting on members ABC and BDE and show them on free body diagrams of members ABC and BDE. Ignore the weights of the members and the rope. Show all work and all necessary free body diagrams to receive full credit.

\[ \Sigma F_x = 0 \]
\[ -80 + E_x = 0 \]
\[ E_x = 80 \]

\[ \Sigma F_y = 0 \]
\[ E_y + 80 = 0 \]
\[ E_y = -80 \]

\[ \Sigma F_x = 0 \]
\[ 80 - D_x = 0 \]
\[ D_x = 80 \]

\[ \Sigma M_B = 0 \]
\[ 80(y) - D_x(y) = 0 \]
\[ D_x = \frac{80}{y} \]

\[ \Sigma F_x = 0 \]
\[ 80 + B_x - 90 = 0 \]
\[ B_x = 10 \]

\[ \Sigma F_y = 0 \]
\[ -80 + By - Dy = 0 \]
\[ By - Dy = 80 \]

\[ \Sigma M_A = 0 \]
\[ 170(x) - 80(y1) - By1(13) = 0 \]
\[ By = 20.92 \] (as shown)

\[ \Sigma F_x = 0 \]
\[ A_x - 170 = 0 \]
\[ A_x = 170 \] (as shown)

From step 2:
\[ By - Dy = 80 \]
\[ Dy = 129.2 \] (as shown)
Internal Force at Point A
Problem 5 (20 points). Member CDAEBF is pinned at point C and supported by a roller at point F. Member EGH is attached to member CDAEBF by a pin at point E. The two members are connected by a cable between points D and H. Calculate the internal forces and moment acting at point A. Show these forces on a properly oriented free body diagram. Show all work and all necessary free body diagrams to receive full credit.

FBD - Look at sketch.

∑ F = 0
-600 (1) + F_y (1,0) = 0
\[ F_y = 750 \text{ N} \]

∑ F_y = 0
750
- C_y + F_y = 0
\[ C_y = 750 \text{ N} \]

∑ F_x = 0
- C_x + 600N = 0
\[ C_x = 600 \text{ N} \]

∑ M_E = 0
\[ \frac{1}{2} T_{AD} (1,0) - 600 (1) = 0 \]
\[ T_{AD} = 620.82 \text{ N} \]

\[ \frac{1}{2} T_{AD} = 300 \]

\[ \frac{2}{5} T_{AD} = 600 \text{ N} \]

∑ F_x = 0
-600 + F_x + P_A = 0
\[ P_A = 300 \text{ N} \]

∑ F_y = 0
-750 + 600 - V_A = 0
\[ V_A = -150 \text{ N} \]

∑ M_C = 0
\[ M_A = -600 (1,2) - 600 (1,0) + 750 (1,2) = 0 \]
\[ M_A = 330 \text{ N} \cdot \text{m} \]
Member ABC

Member DBE