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.

Please circle your instructor’s name and section:

Nauman  Nauman  Cook  Murphy
9:30-10:20  11:30-12:20  2:30-3:20  9:00-10:15

Problem 1 ________

Problem 2 ________

Problem 3 ________

Problem 4 ________

Problem 5 ________

Total ____________
1a. A massless wedge (B) is used to lift Block A (which has a mass of 100 kg.) by applying force $P$. The coefficient of static friction is $\mu_s = 0.20$ between the Block A and the wedge. The coefficient of static friction is $\mu_s = 0.20$ between the wedge and the fixed bottom. Rollers are located between Block A and the vertical wall.

a. Denote the coordinate system and draw the free-body diagrams for the wedge and the block (please use the figures provided). (6 points)

b. Determine the force $P$ that will begin to lift the block (show all your work). Please place your response in the box provided. (6 points)

Answer: $P =$
1b. What is the angle between line segments CD and CE? (8 points).
2a. By inspection, determine all the zero-force members in the truss below and list them in the box provided (4 points)

Zero-force members:

2b. A 60-lb triangular block with a thickness of 1-ft out of the page is used retain water. The block will not slide.

a. Please determine the center of mass (\(x_c\) and \(y_c\)) for the triangular block relative to point \(O\). The block is 3-ft wide and 5-ft tall (4 points)

b. If the specific weight of the water is given as \(\gamma = 62.4 \text{ lb/ft}^3\) please determine the height of water, \(h\), that will place the triangular block in a state of impending tipping about point \(O\) (6 points)

2a.
\[x_c = \text{ ft.}\]
\[y_c = \text{ ft.}\]

2b.
\[h = \text{ ft.}\]
2c. Please state Newton’s Three Laws in order (6 points)

1st Law

2nd Law

3rd Law
3. A small-rocket launch is being tracked. At the instant shown the tracker is rotating at 2 rad/s in the CCW direction. Please indicate responses to the following in the answer space provided:

A. Determine the radius, \( r \) (2 points)
B. Draw the cylindrical and rectangular basis vectors on the rocket at the instant shown (4 points)
C. Determine the velocity of the rocket (4 points)
D. Determine the value of \( dr/dt \) for the rocket at this instant. (2 points)

3a. \( r = \)

3b. Place the coordinates on the rocket

3c. \( \mathbf{v}_{\text{rocket}} = \)

3d. \( \dot{r} = \)
3e. An ME 270 student pushes a 50 kg cart with frictionless wheels along the top of an accelerating train. The train has a constant acceleration of $1.25 \text{ m/s}^2$ to the right, and the student pushes with a constant force of 200 N.

Draw a free body diagram of the cart (2 points).

Sum forces to find the acceleration of the cart (3 points).

What is the acceleration of the cart with respect to the train? (3 points)
4. The foot pedal is used to support the mass \( m = 100 \text{ kg} \). Note that the foot pedal is an angled bracket that consists of points B, C, and the point at which the load is applied.

4a. Draw a free body diagram (with an appropriate coordinate system) of the foot pedal (B-C-load application point). Note that the interior shaft (denoted by hidden lines) is a frictionless surface that provides a negligible force to keep the system aligned. (6 points)

4b. Determine the force, \( P \), required to support the 100 kg load. (5 points)

4c. Calculate the force in link AB. Is it in tension or compression? (3 points)
4d. Write out each vector in component form and determine the resultant force in Cartesian coordinates for the figure illustrated below.
5. A 1500 kg car travels clockwise without slipping around a circular path of radius 100 m. A graph of the car’s speed is shown below.

A) At $t = 12$ sec, what distance has the car travelled? (1 point)
B) What is the maximum value (irrespective of sign) of the car’s rate of change of speed? (1 point)
C) Using path coordinates, what are the velocity and acceleration vectors of the car at $t = 3$ sec? (8 points)

*Parts D-F on next page.....*

5a. distance = ______________

5b. ______________________

5c. $v = _____e_n + _____e_t$

5d. $a = _____e_n + _____e_t$

5e. $F_{net} = _____e_n + _____e_t$

5f. $v = _____i + _____j$
Problem 5 (continued)

Suppose at the position shown, the car has a speed of 23 m/s and rate of change of speed of -17 m/s$^2$ as it travels clockwise around the track.

D) Draw a free body diagram of the car. Include a normal/tangential coordinate system. (4 points)

E) Calculate the net force in the tangential direction and the net force in the normal direction acting on the car. (4 points)

F) At the same instant, a cell phone placed on the dashboard of the car is observed to slip across the dashboard at a rate of 3 m/s. If the direction of the cell phone's path is perpendicular to the path of the car, what is the velocity of the phone with respect to a person standing at the middle of the track? (2 points)