**HOMEWORK 2**

**Solve any 5 of the following problems.**

Please remember to put your name, the date it is due, and the homework number at the top of your completed assignment. The following rules will be followed in working and turning in homework:

1. Work all problems using a sharp black pencil on one side of A4 paper. A prospective engineer should perform his work in a manner that would be professional. (Paper torn out of notebooks will not be graded.)
2. Each problem should be numbered clearly. Separate problems to be worked on the same page with a heavy horizontal line across the page (use a ruler).
3. Your writing should be neat and legible. Your sketches should be neat and clear. Use a ruler if necessary.
4. Your solution should proceed step by step. Don't skip critical steps. Partial credits cannot be given if you don't show your steps in arriving at your answer. Always write the algebraic equation(s) used preceding the numerical solution.
5. Always include a sketch or free body diagram where necessary.
6. Box-in your final answer and make them stand out. Red pencil is for the instructor’s use only.
7. Use proper units.
8. Staple your work in the upper left-hand corner. Write your name, the date it is due, and the homework number on the top of the first page.
9. Turn in your homework at the beginning of class time.
10. You may discuss the problems with your classmates, but you are responsible for your own works.

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1. The motion of a particle is defined by the position vector \( \mathbf{r} = A(\cos t + t \sin t)\mathbf{i} + A(\sin t - t \cos t)\mathbf{j} \), where \( t \) is in seconds. Determine the values of \( t \) for which the position vector and the acceleration vector are (a) perpendicular, (b) parallel. (Hint: when two vectors are perpendicular, then their dot product is zero, \( \mathbf{u} \cdot \mathbf{v} = 0 \); when two vectors are parallel, then their dot product is zero, \( \mathbf{u} \times \mathbf{v} = 0 \)).

2. Water flows from a drain spout with an initial velocity of 0.76 m/s at an angle of 15° with the horizontal. Determine the range of values of the distance \( d \) for which the water will enter the trough \( BC \).
3. A golfer hits a ball with an initial velocity of magnitude $v_0$ at an angle $\alpha$ with the horizontal. Knowing that the ball must clear the tops of two trees and land as close as possible to the flag, determine $v_0$ and the distance $d$ when $\alpha = 31^\circ$.

4. A worker uses high-pressure water to clean the inside of a long drainpipe. If the water is discharged with an initial velocity $v_0$ of 10 m/s, determine (a) the distance $d$ to the farthest point $B$ on the top of the pipe that the worker can wash from his position at $A$, (b) the corresponding angle $\alpha$.

5. Shore-based radar indicates that a ferry leaves its slip with a velocity $\vec{v} = 10$ knots $\mathbf{N}$ $65^\circ$, while instruments aboard the ferry indicate a speed of 10.4 knots and a heading of $35^\circ$ west of south relative to the river. Determine the velocity of the river.
6. When a small boat travels north at 3 mi/h, a flag mounted on its stern forms an angle $\theta = 50^\circ$ with the centerline of the boat as shown. A short time later, when the boat travels east at 12 mi/h, angle $\theta$ is again $50^\circ$. Determine the speed and the direction of the wind.

7. A projectile is launched from point $A$ with an initial velocity $v_0$ of 40 m/s at an angle of $30^\circ$ with the vertical. Determine the radius of curvature of the trajectory described by the projectile $(a)$ at point $A$, $(b)$ at the point on the trajectory where the velocity is parallel to the incline.

8. The oscillation of rod $OA$ about $O$ is defined by the relation $\theta = (4/\pi)(\sin \pi t)$, where $\theta$ and $t$ are expressed in radians and seconds, respectively. Collar $B$ slides along the rod so that its distance from $O$ is $r = 10 / (t+6)$, where $r$ and $t$ are expressed in mm and seconds, respectively. When $t = 1$ s, determine $(a)$ the velocity of the collar, $(b)$ the total acceleration of the collar, $(c)$ the acceleration of the collar relative to the rod.