Engineering Analysis 2

Winter Quarter 2024

Design Project 1 (300 points)

Problems:

1. **(a)** A 90-lb load is suspended from three interconnected cables AD, AB and AC as shown in Figure 1. Cable AB is connected to a spring with a stiffness, of k (lb/ft), attached to a wall on the right. Cable AD lies in the x–y plane (AD is inclined at an angle of a° to the negative y-axis) and cable AC lies in the x–z plane (the slope of AC is specified as ¾ rise-over-run). Determine the force in the cables AD, AB and AC as functions of a° (Write out the explicit form of the functions). Plot the forces for different values of angle a° ($0.1° \le a \le 25°$). **100 points (40 for equations and 60 for plots)**
   Hint: There should be 3 separate equations and 3 separate 2D plots.
   (b) The stretch of the spring, s (ft) is related to the force in the Cable AB, f_{AB} (lb) and the spring stiffness, k (lb/ft), by the relationship $f_{AB} = k*s$. Determine the stretch of the spring as a function of a° and k. Then plot in 3D the stretch of the spring for different values of angle a° ($0.1° \le a \le 25°$) and k ($100 \le k \le 500$). **50 points**

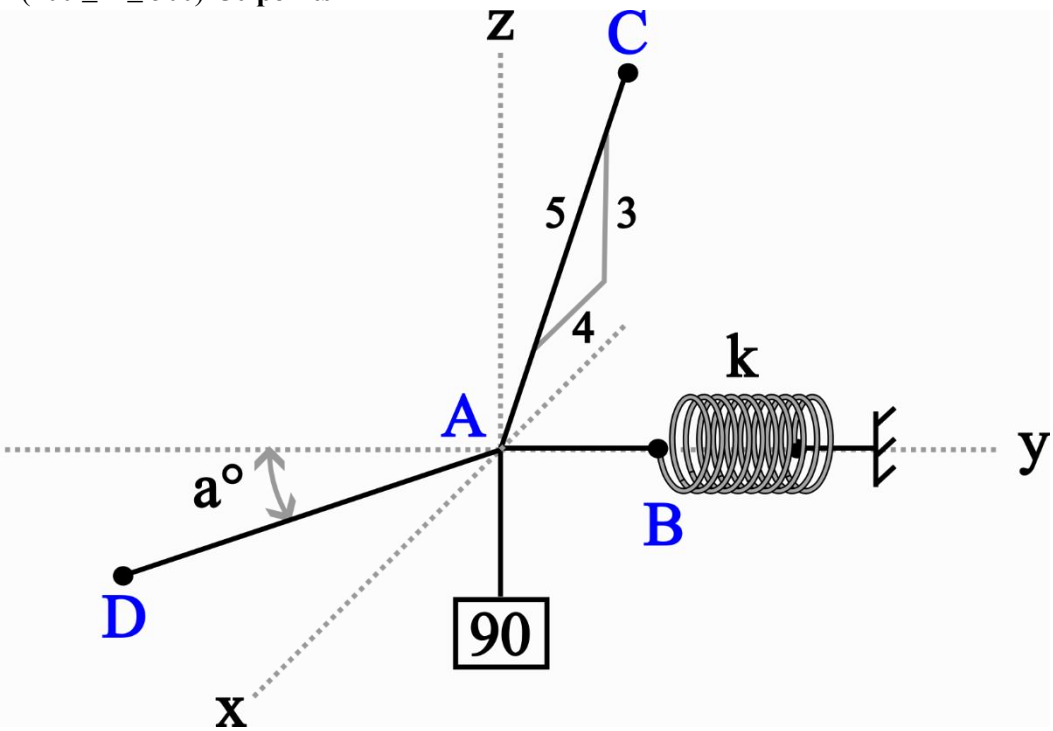

Figure 1: Three cable-system with a suspended weight

2. Two forces, F_1 and F_2 are acting on the eye-bolt as shown in Figure 2. It is required that the resultant of the two forces act along the x-axis and $F_1 = 800$ N. Find the magnitude of F_2 and the value of θ° (θ is positive in the clockwise direction of the x-axis) for which F_2 is minimum. **50 points**

Hint: Using the Sine rule, plot the force F_2 as a function of the angle θ° ($30° \leq \theta \leq 120°$). Then find the minimum value of F_2 and the corresponding θ°.

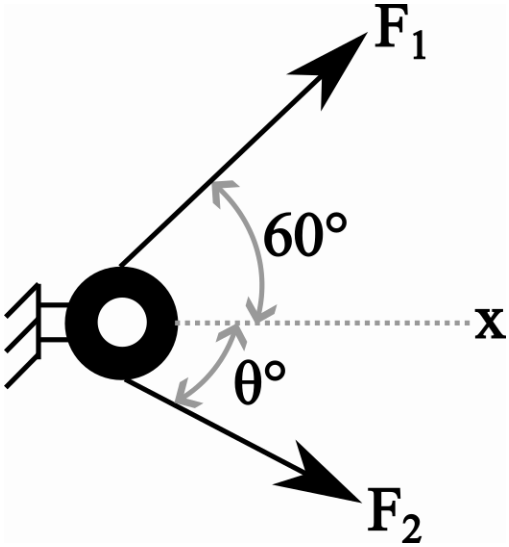

Figure 2: Eye-bolt with two inclined forces

MATLAB REPORT Rubric

The report should include as a minimum:

1. **Cover Page**: Title, author, date, pages numbered. All figures and tables must be labelled, numbered, and referenced by number in the body of the report. (5 points)

2. **Problem Statement**: Givens, unknowns, and sketches. This part must clearly define the problem to a reader who is not familiar with the project and should include any images or sketches necessary to explain the original problem. Feel free to use the image included in the original assignment. (10 points)

3. **Theory Manual**: Derive any equations/formulas you used, and number them for reference. Equations should be typed. Define your variables, draw free-body diagrams of the global system and any "cuts" you make, and include anything else that is necessary to explain the solution method. Note that this is a typed report. **All equations and work must be typed and presented professionally.** Hand-drawn figures are fine, provided they are neat and scanned clearly. (30 points)

4. **Programmer Manual**: Explain the logic of your code and the methods used to implement your solution. Things to include are a table with variables used and their description, a table of user-built functions used and their description, flowcharts, explanations of main program/subroutines, etc. (15 points)

5. **Results and Analysis**: Include output figures and calculation results, as well as commentary and physical meaning of results. This should include written explanations and commentary, not just tables or code output. Figures should be referenced and explained in the text as well as the numerical results. Include output figures and calculation results. (40 points)

6. **Appendix**: Include your MATLAB code here.

Upload on Canvas:

1. A pdf document with all the above sections
2. The MATLAB code (.m or .mlx) files.

Other notes: The best reports are not necessarily the longest; be clear and explain exactly what the reader needs to understand.