

Massachusetts Institute of Technology
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16.01/16.02 Unified Engineering I, II
Fall 2003

Problem Set 6

Name : _____

Due Date: 1/00/314

	Time Spent (min)
C14	
C15	
C16	
U2	
M1	
Study Time	

Announcements :

Problem C14. (Unified Computers and programming)

1. Design an Ada95 package to:
 - a. Accept 9 integers and store them in a 1-dimensional array
 - b. Display the unsorted array as a 3x3 matrix assuming:
 - i. Data is in row-major order
 - ii. Data is in column-major order
 - c. Sort the array using the *bubble sort* algorithm.

Turn in a hard copy of your algorithm.

2. Implement your package in Ada95 and write a test program to demonstrate its functionality. Turn in a hard copy of your code listing (package and test program) and an electronic copy of your code.

Problem C15. (Unified Computers and programming)

1. Write an algorithm to invert a 3x3 matrix. Your algorithm should account for singularities and non-invertible matrices.
2. Implement your algorithm using the matrix package. Turn in a hard copy of your code listing and an electronic copy of your code.

Problem C16. (Unified Computers and programming)

1. An aircraft in flight is characterized by:
 - a. Aircraft number
 - b. Latitude
 - c. Longitude
 - d. Heading
 - e. Velocity

Define an Ada95 record that contains the description of an aircraft.

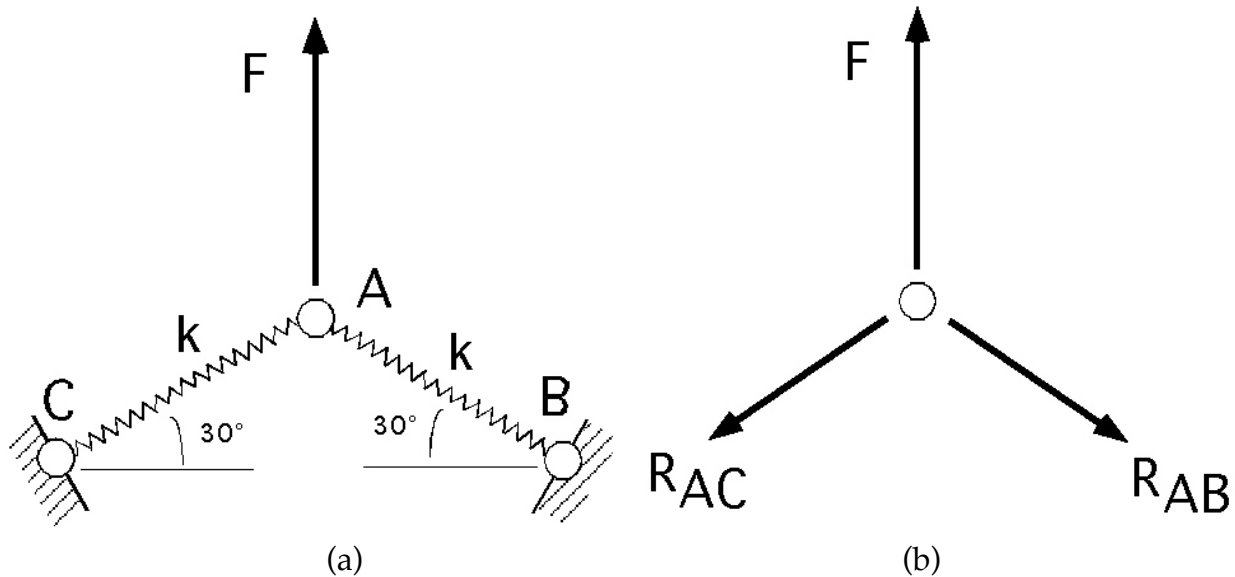
2. Write an Ada95 program to:
 - a. Create an array of 10 aircraft (using user input).
 - b. Sort the aircraft in ascending order, based on Latitude
 - c. Compute the distances between the first aircraft and all other aircraft.

Turn in a hard copy of your algorithm and code listing and an electronic copy of your code. Turn in the results based on the test data provided to you.

Hint: Use WGS-84 to transform the latitudinal and longitudinal separation into nautical miles.

Problem M1 (Materials and Structures)

The figure (a) below shows a 2-dimensional structure consisting of a pair of springs, CA and AB joined at point A. A force F is applied in a symmetric manner so that angles FAC and FAB are both 120° . Angle CAB is also 120° . The springs are joined or attached by hinges at A, B and C which can rotate freely. Your task is to determine the displacement of point A. You can assume that the springs are sufficiently stiff that the deflections and the displacements are small, so that the geometry of the structure will not change significantly due to the loading.



- (i) Determine the *forces* in the springs. Assume that the springs can be replaced by reaction forces, R_{AB} and R_{AC} acting in the same directions as the springs (i.e at angles of 30° to the line AC) as shown in figure (b). Apply equilibrium to calculate the forces R_{AB} and R_{AC} .
- (ii) Calculate the *extension* of each spring. You can assume that the extension of the each of the springs is determined by the spring constant, k , and the force in the spring R , such that the spring will elongate by an amount, δ , according to: $R = k\delta$
- (iii) Calculate the *deflection* (displacement) of point A. Use the results from part (b) as the extension of the springs. Use trigonometry, and the knowledge that the springs each remain attached at C and B and are joined at A, to calculate how much point A displaces.

Unified Engineering I
Problem U2 (Unified Concepts)

Fall '03

Dimensions and units are fundamental to the language of engineering. This question is an exercise in this important topic. You may have to use common sense and perhaps a little research to answer some of the questions. The tables in the front of Crandall, Dahl, and Lardner should be helpful. The SI, British, and other unit systems all have well-defined units and symbols, Answers which are not accompanied by the correct symbol or unit are not eligible for full credit, in this question and in the rest of Unified.

a) **Conversion.** A strong cyclist is generating a steady 0.4 hp. How much power is this in SI and British units?

b) **Estimation.** The cyclist also generates waste heat at a rate of three times the mechanical power. If the cyclist's body wasn't being continuously cooled, roughly how long could he maintain this power output?

Hint: Assume the human body has the same heat capacity as water.

c) **Analysis.** You will learn in Fluids that the aerodynamic lift L and pitching moment M on a wing depend on the air density ρ , air velocity V , wing area S , and wing chord c . Good approximations to measured data are found to be:

$$L = \frac{1}{2}\rho V^2 S C_L$$
$$M = \frac{1}{2}\rho V^2 S c C_M$$

What are the dimensions of the lift coefficient C_L and the pitching moment coefficient C_M ?

d) **Scaling.** If the wing in c) is geometrically scaled down by a factor of 1/2, and is operated in the same airflow conditions as the full-size wing, how much do you expect the lift and the moment to change?