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Unified Engineering
Fall 2004

Problem Set #2

Due Date: Tuesday, Sept. 21, 2004 at 5pm

	Time Spent (minutes)
M1	
M2	
M3	
C1,C2,C3	
Study Time	

Name: ________________

Unified Engineering Problem Set #2 **Units M1.1, M1.2**
Fall, 2004

2(M).1 Consider a system of five masses each of 1 kg located in the x_1- x_3 plane. One mass is located at the origin of the plane and each of the other four masses is located along one of the four directions along the two axes and at a distance of 50 centimeters from the origin. The masses are connected by rigid, massless rods. One force of 5 N acts parallel to the $+x_3$ direction on the mass along the $+x_1$ axis. A second force of 3 N acts parallel to the $+x_1$ direction on the mass along the $-x_3$ axis.

(a) Neatly draw this configuration.

(b) This system is not in equilibrium, describe its initial motion.

For the following cases, carefully give your reasoning and express any forces and moments as vectors, as appropriate.

(c) Can equilibrium be achieved via the application of a force on the mass at the origin?

(d) Can equilibrium be achieved via the application of a moment at the origin?

(e) Can equilibrium be achieved via the application of a couple anywhere (including along the rods)?

(f) Can equilibrium be achieved via the application of a force and moment at the origin?

(extra) Repeat (f) for the case where the system of masses is accelerating in the $-x_1$ direction at a rate of $1\ m/s^2$.

2(M).2 For the following structures, list key design considerations and discuss the relative importance of these considerations.

(a) space station

(b) commercial transport aircraft

(c) glider

(d) automobile

(e) bridge

(f) step ladder

2(M).3 In this problem, we consider a Boeing 777 and learn about the modeling of the lift on a wing in order to consider the loads acting on the structure. The 777 has approximate values for the gross takeoff weight of 506,000 pounds and for the wing half-span of 100 feet. The overall weight can be considered to act at the center of the *fuselage*. The half-*span* of the wing is the distance from the *root* (where the wing connects to the *fuselage*) to the *tip*. (See the simple diagram of the geometry below.)

For structural purposes, an airplane wing can be modeled in two dimensions as a linear structural member of length s/2 (the half-*span*) emanating from the *root*. The *lift* (pressure differential between the top and bottom surfaces) on the wing can be represented as a *lineload* and thus has dimensions of [force/length]. To first order, this *lineload* of *lift* can be considered to vary linearly along the *span* of the wing with its maximum value at the *root* and with a value of zero at the *tip*. In steady flight, assume that each wing must provide sufficient *lift* to support half the total weight.

(a) Draw this configuration showing all loads.

(b) Determine the maximum magnitude of the lineload of lift and where it occurs.

(c) For one wing, determine the equipollent force system at the root for the lift.

(d) Show (best means would be via a plot) how the components of the equipollent system change/stay the same as the point at which the equipollent system acts is moved along the wing.

C&P Pset 2

This problem set will cover lectures C1, C2 and C3.

1. Modify the “Hello World” program discussed in class to display:

   “Hello World”
   “My name is XXX”

   Create a listing of the program and highlight the lines that were added to the original program. Turn in an electronic copy of your code and a hard copy of your code listing.

   Note: XXX should be replaced with your name in the program

2. Build along with your teammates, the simple rover shown in the handout **basic_robot.pdf (**available from the class website - R1).

3. Compile the basic_mindstorms_demo.adb program shown in class. What happens to the rover’s movement when the second last line in the program

   ```
   Output_Off(Output => Output_C);
   ```

   is commented out, and the modified program is compiled down to the RCX. Explain why the rover behaves as it does.

4. Write an Ada95 program to make the rover traverse a square as follows:

   a. Manually place the robot facing north
   b. Move forward for 5 seconds
   c. Turn west
   d. Move forward for 5 seconds
   e. Turn South
   f. Move forward for 5 seconds
   g. Turn East
   h. Move forward for 5 seconds.

   Is the robot back to where it started? Turn in an electronic copy of your code and a hard copy of your code listing.