Unified Engineering Problem Set **Lectures: M1, M2, M3*(look-ahead)***
Week 2 Fall, 2007 **Units: M1.1, U-A, U-B, M1.2*(look-ahead)***

M2.1 ***(10 M-points)*** For the following structures, list key design considerations and discuss the relative importance of these considerations.

(a) commercial transport aircraft

(b) space satellite

(c) construction scaffolding

(d) draw-bridge

(e) pick-up truck

(f) glider

M2.2 ***(10 M-points)*** A 25 m by 25 m grid is situated in the (x_1, x_2) plane. The grid is made up of rigid rods connected at 2.5 m increments. The following set of forces act on this grid:

Force 1 acts at point (5, 5) at an angle of 30° with a magnitude of 2 N
Force 2 acts at point (12.5, -10) at an angle of 75° with a magnitude of 3 N
Force 3 acts at point (5, -7.5) at an angle of -115° with a magnitude of 3 N
Force 4 acts at point (2.5, 2.5) at an angle of -135° with a magnitude of 4 N
Force 5 acts at point (10, 10) at an angle of -250° with a magnitude of 2 N
Force 6 acts at point (-7.5, 10) at an angle of 0° with a magnitude of 2 N

(**Note:** Angles are measured positive counterclockwise relative to a line drawn parallel to the x_1-axis and through the acting point of the force.)

For this configuration:
(**NOTE:** Express the answer as a vector as appropriate.)

(a) Describe each force as a vector and neatly draw out the described configuration.

(b) Determine the total (resultant) force acting on the grid and its magnitude.

(c) Can any of the forces be expressed as a couple? If so, do so.

(d) Determine the moment acting about the origin (center) of the grid.

(e) Determine the moment acting about the lower left-hand corner of the grid.

(f) Determine the components of the moment acting about the x_2-axis and about the x_1-axis.

M2.3 ***(10 M-points)*** **LOOK-AHEAD:** ***Use U-B and M1.2 notes, CDL 1.6 with 1.4, 1.5 in review***

Consider a system of eight masses located in the x_1- x_3 plane. Each of the masses is located along the perimeter of the system with those four at the corners being of 1 kg, and those four at the midpoints between the corners being of 2 kg. The masses are connected by rigid, massless rods. Each side is 1 m in length. One force of 8 N acts parallel to the $+x_3$ direction on the mass at the lower left-hand corner, ($-x_1$, $-x_3$), of the system. A second force of 5 N acts parallel to the $-x_1$ direction on the mass at the upper right-hand corner, ($+x_1$,$+x_3$), of the system.

(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 at the origin? If so, what is the force?

(d) Can equilibrium be achieved via the application of a moment at the origin? If so, what is the moment?

(e) Can equilibrium be achieved via the application of a force and moment at the origin? If so, what are the force and moment?

(f) Can equilibrium be achieved via the application of a couple anywhere (including along the rods)? If so, what is the couple and where must it be applied?

(g) Can equilibrium be achieved via the application of a force anywhere (including along the rods)? If so, what is the force and where must it be applied?