ME 562 Advanced Dynamics
Summer 2010
HOMEWORK # 1

Assignment Due: 06/09/2010

Q1. Problem 1-1: Forces **P** and **Q** are applied to a particle of mass *m*. The magnitudes of these forces, P and Q, are constant but the angle θ between their lines of action can be varied, thereby changing the total force, and hence the acceleration of the particle. Suppose that the magnitudes of these forces are such that the maximum possible acceleration is three times as large as the minimum possible acceleration. Now, the forces are arranged at an angle such that the acceleration attained by the particle is the mean of the maximum and minimum accelerations. Find the angle θ between the forces.

Q2. Problem 1-3: Consider a triad of vectors (not necessarily unit vectors) $\mathbf{e_1}$, $\mathbf{e_2}$, and $\mathbf{e_3}$. Let them be represented in terms of the Cartesian basis **i**, **j**, and **k** as:

$$\underline{e}_1 = l_1\underline{i} + l_2\underline{j} + l_3\underline{k},$$
$$\underline{e}_2 = m_1\underline{i} + m_2\underline{j} + m_3\underline{k},$$
$$\underline{e}_3 = n_1\underline{i} + n_2\underline{j} + n_3\underline{k}.$$

(a) Find the three equations that must be satisfied by the coefficients $l_1, l_2, l_3, m_1, m_2, m_3, n_1, n_2, n_3,$ if the vectors $\mathbf{e_1}$, $\mathbf{e_2}$, and $\mathbf{e_3}$ are unit vectors.

(b) Find the additional equation that must be satisfied by the coefficients $l_1, l_2, l_3, m_1, m_2, m_3, n_1, n_2, n_3,$ if the unit vectors are also coplanar.

(c) If the unit vectors $\mathbf{e_1}$, $\mathbf{e_2}$, and $\mathbf{e_3}$ are also mutually orthogonal, what additional equations must be satisfied by the coefficients $l_1, l_2, l_3, m_1, m_2, m_3, n_1, n_2, n_3$.

Q3. Example 1-1: Consider the particle of mass *m* that is supported by a massless though rigid wire of length *l* that is attached to a point O of a box. The box has a constant acceleration **a** to the right.

(a) Define the position of the mass particle in an inertial reference frame, draw its free-body diagram, and show the forces acting on the particle,

(b) Then write the acceleration of the particle and derive the differential equations of motion for the mass particle in terms of the angle θ. Note that there are two equations.

(c) Finally, obtain equations for steady state motion of the particle. This is the situation in which $\dot{\theta}$ *and* $\ddot{\theta}$ are zero.