1. Please explain the following terms: center of mass, center of gravity, and centroid. Then, determine their positions for the composite material shown in Fig. 1. Noted that all materials are homogeneous with a constant thickness t. (18%)

2. Calculate the moment and forces (x and y directions) acting on the free support at point O in order to maintain the bar in a state of equilibrium (Fig. 2). Noted that the bar has mass m. (17%)

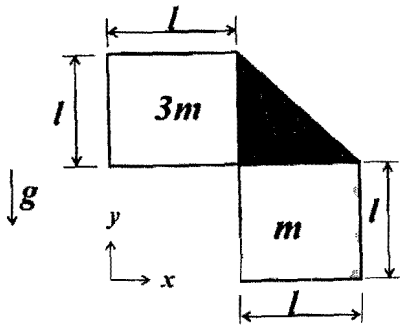

Figure 1

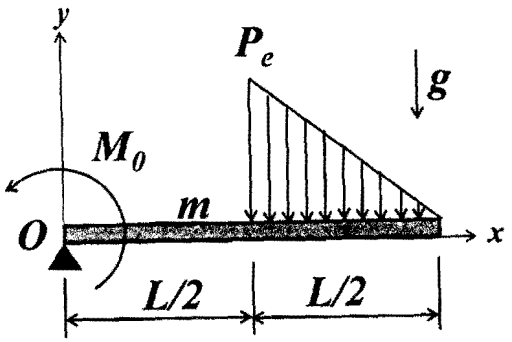

Figure 2

3. A horizontal circular plate rotates with a constant angular velocity ω_0 (Fig. 3). A point mass m moves in the radial direction within a frictionless slot in the plate. Find the forces acting on the mass. (Assuming that the point mass moves with a constant velocity v_0 relative to the plate.) (18%)

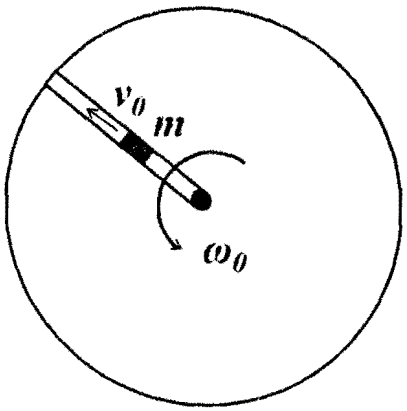

Figure 3

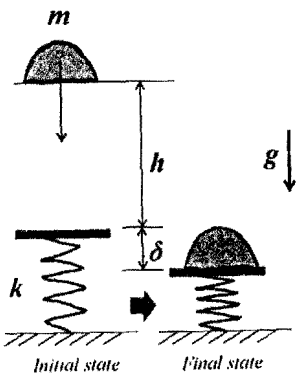

Figure 4

(背面仍有題目,請繼續作答)

4. A clump of clay (mass m) is dropped from a height h onto a platform connecting with a linear spring of constant stiffness k (Fig. 4). Assuming that the clay maintains contact with the platform during the rest of the process. Without considering the mass of the platform, determine :
   (a) The maximum deflection δ of the spring. (14%)
   (b) Compare the deflection with the static spring deflection δ_s produced by the clay. (8%)

5. A nematode (mass m, volume V, effective radius r) accidentally drops into a container filled with liquid (density ρ, viscosity η) as shown in Fig. 5. The initial velocity is zero. Assuming that the effects due to geometry can be neglected. Determine the motion under the assumption that the drag force is given by Stokes Law ($F_D=6\pi\eta r\dot{z}$).
   (a) Draw the free body diagram of the worm. (5%)
   (b) Determine the terminal velocity of the dropping worm. (8%)
   (c) Sketch a graph showing the worm's traveling distance as a function of time. (6%)
   (d) Sketch a graph showing the worm's velocity as a function of time. (6%)

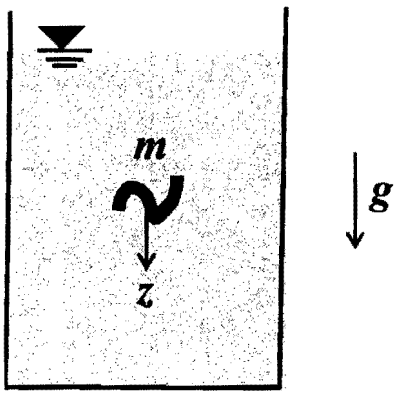

Figure 5