(10%) 1. Answer the following questions in English.
(注意：本題須以英文作答，不得以中文作答)

(a) Dynamics is that branch of mechanics which deals with the accelerated motion of a body. Dynamics has two distinct parts — kinematics and kinetics. Describe the difference between kinematics and kinetics.

(b) The mechanical efficiency of a machine is defined as the ratio of the output of useful power produced by the machine to the input of power supplied to the machine. Why is the efficiency of a machine always less than 1?

(20%) 2. The ball has a mass of 2 kg and a negligible size. It is originally traveling around the horizontal circular path of radius $r_o = 0.5\,\text{m}$ such that the angular rate of rotation is $\dot{\theta}_o = 1\,\text{rad/s}$. By applying a force F the cord ABC is pulled downward through the hole with a constant speed of $0.2\,\text{m/s}$. Neglect the effects of friction between the ball and horizontal plane.

(a) Derive the equation of motion of the ball in the θ direction.

(b) Determine the radial distance r of the ball from the hole at the instant its speed is $1.0\,\text{m/s}$.

(c) Determine the tension the cord exerts on the ball at the instant $r = 0.1\,\text{m}$.

(d) Determine the amount of work done by F in shortening the radial distance from $r = 0.5\,\text{m}$ to $r = 0.1\,\text{m}$.

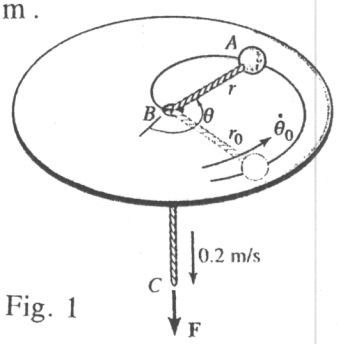

Fig. 1

(20%) 3. At a given instant, the disk rolls without slipping such that it has an angular velocity $\omega = 2\,\text{rad/s}$ and angular acceleration $\alpha = 4\,\text{rad/s}^2$. The peg at A is fixed to the disk and located above the disk center O with $OA = 0.5\,\text{ft}$. Point I lies on the periphery of the disk of radius 0.7 ft and contacts with a smooth plane. At this instant, determine

(a) the velocity of point A and the angular velocity of the slotted link BC,

(b) the accelerations of point I and point A,

(c) the angular acceleration of the slotted link BC.

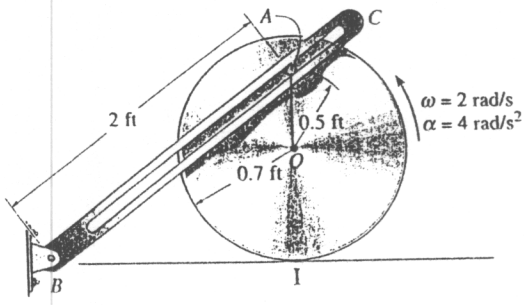

Fig. 2

(背面仍有題目,請繼續作答)

4. Please state or explain, **in English only**, each of the following terms: (a) conservation of mechanical energy, (b) eccentric impact, (c) viscous damped forced vibration. [15]
5. As shown in Fig. 3, the small gear has a mass m and may be treated as a uniform disk. If it is released from rest at $\theta = 0^{\circ}$, and rolls along the fixed internal gear, please determine the angular velocity of the small gear and that of the radial line AB at the instant $\theta = 90^{\circ}$. [20]
6. As shown in Fig. 4, four spheres are connected to shaft AB. If the mass of C and E are 2 kg and 3 kg, respectively, please determine the mass of D and F and the angles of the rods, θ_D and θ_F, so that the shaft is dynamically balanced, i.e., so that the bearings at A and B exert only vertical reactions on the shaft as it rotates. The mass of the rods can be neglected. [15]

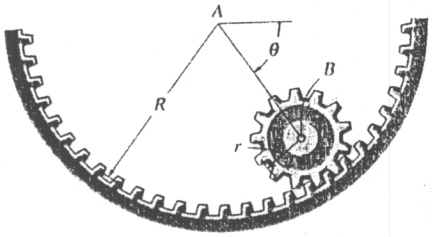

Fig. 3

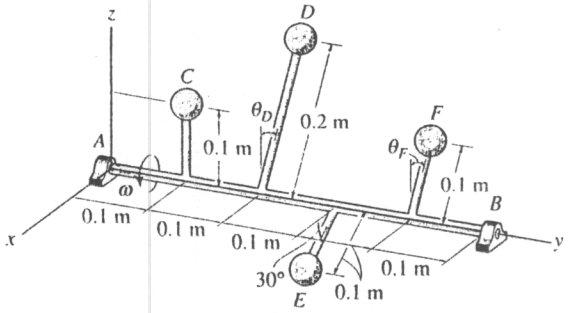

Fig. 4