1. **(20%)** While analyzing the accelerations of the following mechanisms as shown in Fig.1 (a), (b), (c), and (d), which mechanism(s) involve the Coriolis acceleration? Why or why not? Explain you answer. (Assume dimensions, position and velocity states of the mechanism are known)

(a) If acceleration of the point P on link 4 is to be found.

(b) If acceleration of link 4 is to be found.

(c) If acceleration of a point on Link 5 is to be found.

(d) If acceleration of point C on the collar is to be found. ($\omega(t)$ and $x(t)$ are functions of time and known.)

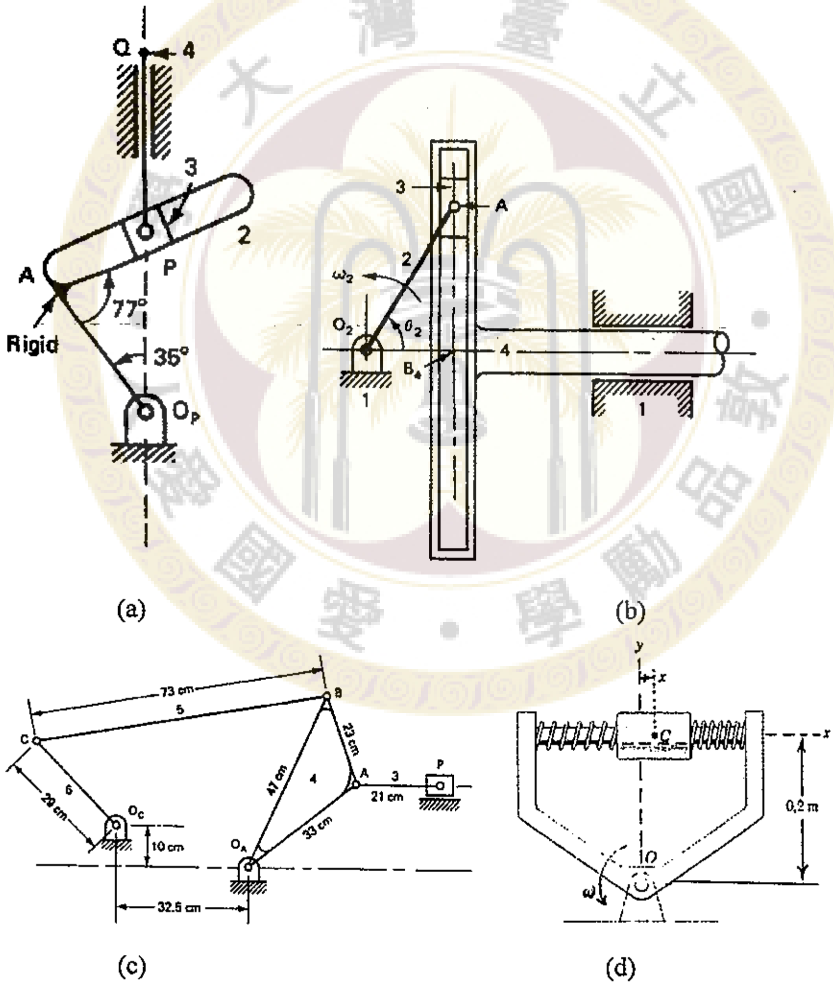

Fig. 1

2. **(10%)** Fig. 2(a) shows a solid model of a real crankshaft from an inline multi-cylinder engine with pistons, connecting rods, and flywheel. Down the end of

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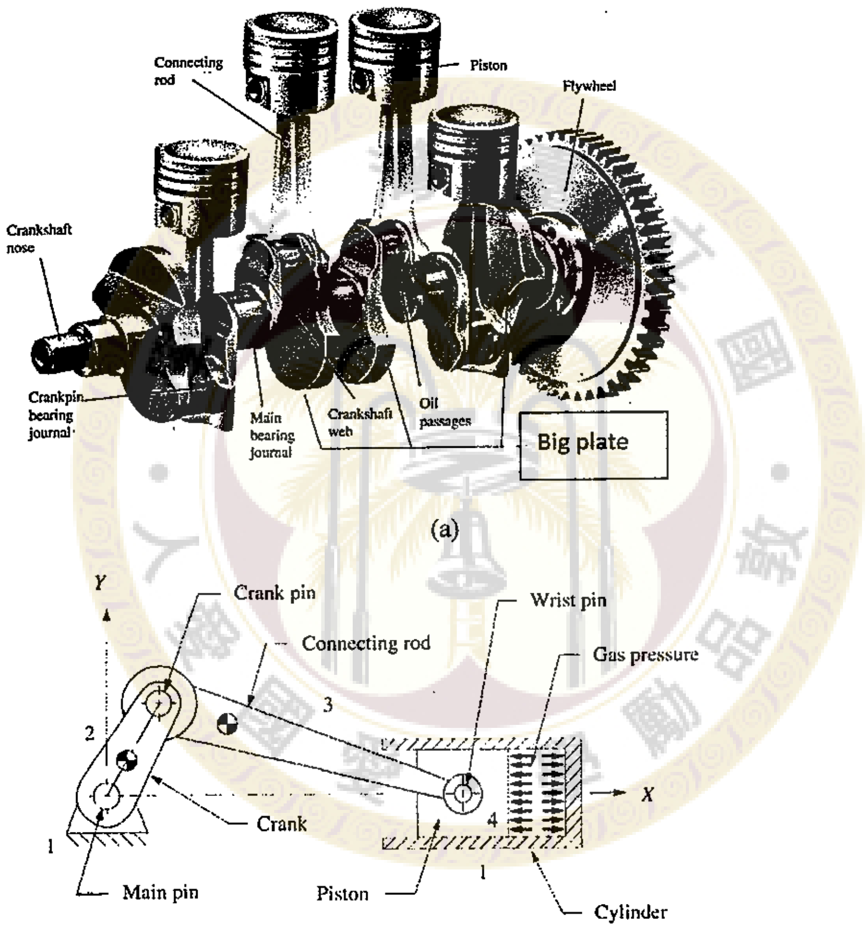
the connecting rod, the crankshaft is designed as an odd-shaped plate marked "Big plate". Such design is different from that in the Fig. 2(b) where the crank (link 2) is designed as a straight rod. (1) Can you explain why the real crankshaft is designed as in Fig. 2(a) and not as in Fig. 2(b)? (2)If the crank is designed as a straight rod as shown in Fig. 2(b), what problem may the engine have?



(a)

(b)

Fig. 2

3. **(20%)** The 800-mm diameter disk of Fig. 3 is rigidly attached to a 1000-mm long axle and rolls without slipping on a fixed surface in the x-y plane. The axle, which is perpendicular to the disk, is attached to a ball and socket joint at A and is free to pivot about A. As the disk and axle rotate about their own axis with angular velocity ω_1, the axle also rotates about a vertical axis with angular velocity ω_2 .If ω_1= 10 rad/s and $\dot{\omega}_1 = 5$ rad/s^2 at the instant shown, determine

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(a) The total angular velocity ω and total angular acceleration α of the disk at this instant.

(b) The velocity v_C and acceleration a_c of point C on the rim of the disk at this instant.

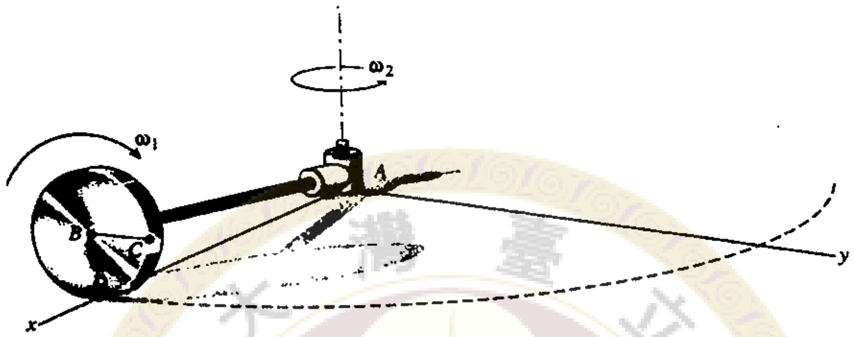

Fig.3

4. **(20%)** A 30-lb block slides on a frictionless surface as shown in Fig.4. The spring is un-stretched when bar AB is vertical and bar BC is horizontal. The weights of bars AB and BC may be neglected. Assume that oscillations remain small and determine

(a) The range of frequencies Ω for which the angular steady-state motion of bar AB is less than $\pm 5^{\circ}$.

(b) The position of the block as a function of time if the block is pulled 2 in. to the right and released from rest when t=0 and Ω= 20 rad/s.

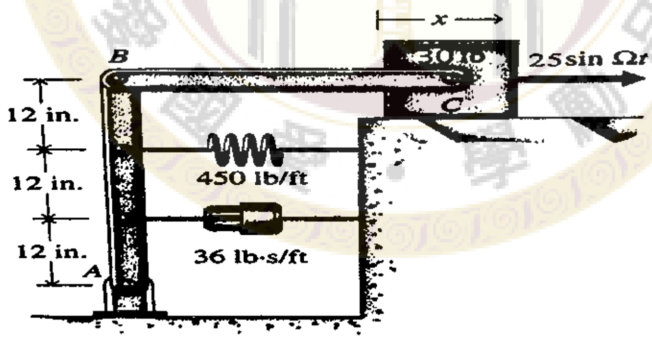

Fig.4

5. **(30%)** As shown in below (Fig. 5), a link with length L, mass m, and center of mass at distal end. A spring with stiffness K connect the link at distance r and ground at distance a. Determine

(a). the potential energy contributed by the spring in function of φ, (10%)

(b). the gravitational potential energy in function of φ, (10%).

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(c). Can this link maintain static balance status with a fixed stiffness spring? Please explain. (10%)

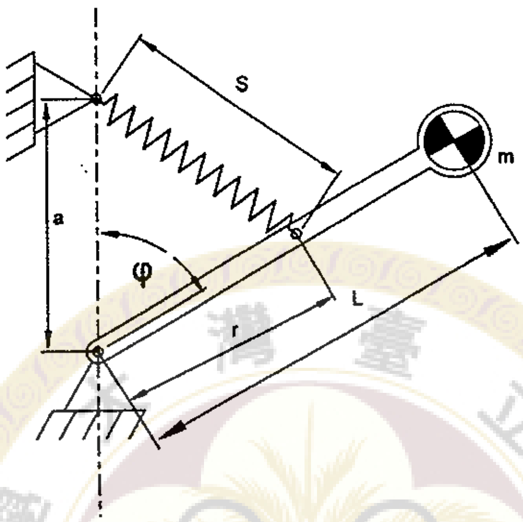

Fig.5

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