A1. Answer true (with ○) or false (with ×). If your answer is true, no explanation is needed; otherwise, the reason why the statement is a false is required. For each true statement, you can score 2 %, if a correct answer is given. For each false statement if your answer is correct, you can score 2 %, if the explanation is also correct; or score 1 % if no explanation is given; or 0 % with wrong explanation. Note that you will score -2 %, if the answer is wrong. [16 %]

(1) A mechanism must have a fixed link.

(2) A mechanism must have one degree of freedom.

(3) When using two Hook's joints to transmit rotation between two parallel shafts, the center lines of all the shafts (including the shaft between two joints) need be in the same plane to get unity velocity ratio of the input shaft to the output shaft.

(4) All the five-bar planar linkages with five simple revolute joints are not movable.

(5) A four-bar linkage with four revolute joints whose axes all pass a point is movable.

(6) The velocity of the instant center of two moving links may be zero.

(7) The relative velocity of the two points located at the contact position of the two bodies with a rolling pair is zero.

(8) The least number of links of the planar mechanism to transmit a rotating motion to an oscillating motion is 4.

A2. For a four-bar linkage, if the lengths of the fixed link and the two links connected with it are 100 mm, 200 mm, and 250 mm respectively, please determine the range of the length of the coupler, such that it is a double-crank mechanism.[6 %]

A3. For the position analysis of the four-bar linkage, please derive the explicit formulae (or analytical expressions) for determine the angular position of the coupler and link 4 (θ_3 and θ_4) in terms of that of the input link θ_2 and link lengths r_i, $i = 1, 2, 3, 4$. [16 %]

A4. Please determine the dimensions of the quick-return slider-crank mechanism, if the time-ratio is 1.5, the stroke of the slider is 100 mm, and the crank length is 80 mm. [12 %]

B1. (15%)

A four-thread worm has an axial pitch of 1 in. and a pitch diameter of 2 in. as shown in Fig. B1-1. The worm drives a gear having 42 teeth as shown in Fig. B1-2. Determine the lead angle of the worm and the center distance between worm and gear.
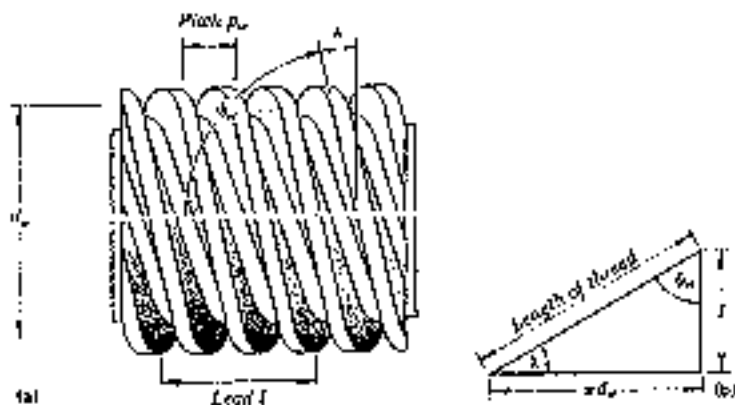

Fig. B1-1

Fig. B-1-2

B2.

A cam with a translating flat-faced follower is shown in Fig. B2. This figure depicts an inversion of the cam-follower mechanism where the cam is fixed and the follower moves relative to it. The follower originally is in the position $s = 0$ when the cam is in the position $\theta = 0$. The displacement of the follower is represented as $s = a \sin(\theta)$, which a is constant value.

1) Determine the position vector of point P as function of a, θ, and r_b. (5%)

2) Determine the equation of the family of straight lines (follower positions) that generate the cam profile envelope. (10%)

3) Determine the cam profile envelope in terms of the vector as function of θ, a, and r_b. (10%)

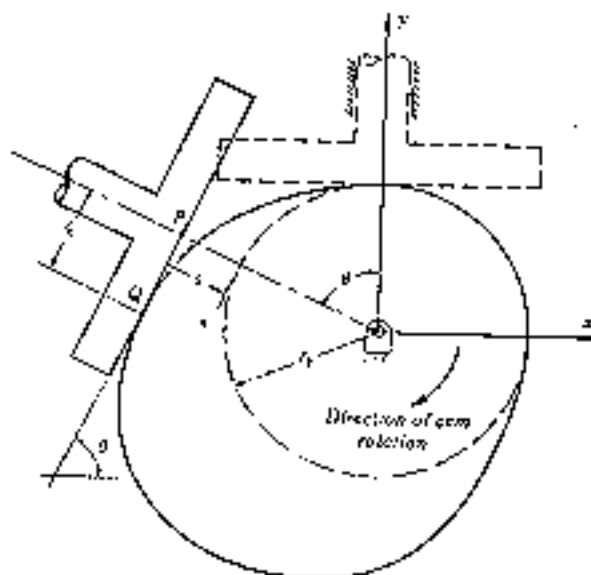4) Plot the cam profile in the x-y coordinate system. (10%)

Fig. B2