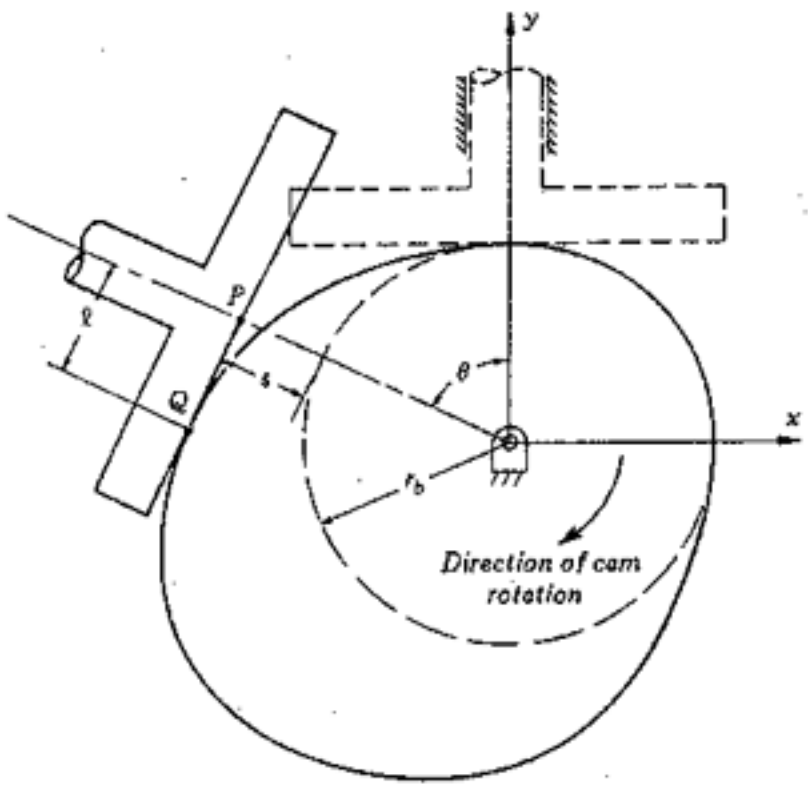
1. Derive the equation for the minimum number of teeth in a standard pinion that will mesh with a rack without involute interference. (20%)

2. A disk cam with a translating flat-faced follower is shown below. The figure shows the motion of the follower relative to the cam. This motion consists of follower translation s during cam rotation θ. Point P is the point on the follower face coinciding with the follower centerline, and point Q is the instantaneous point of contact between the cam and follower. The base circle radius is r_b.
   (a) Derive the expressions for the cam profile coordinates by using the theory of envelopes. (20%)
   (b) For a constant-angular-velocity cam, show that the maximum value of the distance l between points P and Q occurs when the follower velocity is at a maximum. (10%)



(背面仍有題目,請繼續作答)

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3. 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 can have two fixed links.

(2) A mechanism can have three degrees of freedom.

(3) A Hook's joint can be used to transmit a rotation between two shafts whose axes both pass a point and the angle between them is 90 degrees.

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

(5) A four-bar linkage with four revolute joints whose axes all pass a point is not movable.

(6) The velocity of the instant center of one moving link and the fixed link must be zero.

(7)The relative acceleration 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 3.

4. For a four-bar linkage, if the lengths of the fixed link and the two links connected with it are 400 mm, 200 mm, and 250 mm respectively, please determine the **range of the length of the coupler**, such that it is a **crank-rocker** mechanism.[10 %]

5. For the **position analysis** of the slider-crank mechanism, please derive the **explicit formulae** (or **analytical expressions**) to determine the angular position of the connecting rod and the position of the slider (θ_3 and r_4) in terms of that of the input crank θ_2 and link lengths r_2 (crank), r_3 (connecting rod) and the eccentricity r_1. [12 %]

6. Please derive the formulae to determine the maximum and minimum values of the transmission angle of a crank-rocker mechanism whose link lengths of the fixed link, the crank, the coupler and the rocker are r_1, r_2, r_3, and r_4 respectively. [12 %]