Solutions

2.1

- $\sin\phi = r\sin\theta/l = 50\sin 45°/200 = 0.1768$, so $\phi = \mathbf{10.18}°$.
- $x = r\cos\theta + \sqrt{l^2 - r^2\sin^2\theta} = 35.4 + 196.9 = \mathbf{232.2}$ mm.
- Stroke $= 2r = \mathbf{100}$ mm.

2.2

- (a) $M = 3(n-1) - 2j_1 = 3\times 5 - 2\times 7 = \mathbf{1}$.
- (b) $M = 3(n-1) - 2j_1 - j_2 = 3\times 4 - 2\times 5 - 1 = \mathbf{1}$: the cam is a two-freedom pair, so it removes one.

2.3

- $s + l = 30 + 100 = 130 \le p + q = 90 + 70 = 160$: Grashof.
- With the shortest link fixed, both neighbours turn fully: a **double-crank** (drag link).

3.1

- (a) $s + l = 50 + 130 = 180 \le 120 + 90 = 210$: Grashof, and the shortest link is the crank, so it is a crank-rocker.
- (b) Crank pin $B = (0, 50)$, rocker pivot $O_4 = (130, 0)$: $BO_4 = \sqrt{130^2 + 50^2} = \mathbf{139.3}$ mm, at $-21.0°$ from B.
- Cosine rule in triangle BCO_4: $\cos\alpha = (b^2 + BO_4^2 - c^2)/(2b\,BO_4) = 0.7688$, so $\alpha = 39.8°$.
- $\theta_3 = -21.0° + 39.8° = \mathbf{18.7}°$.
- $C = B + 120(\cos 18.7°, \sin 18.7°) = (113.7, 88.5)$ mm, so $\theta_4 = \operatorname{atan2}(88.5, 113.7 - 130) = \mathbf{100.5}°$.

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