7.1) For the rise, we have $L = 50\text{mm}$, $\beta = 120° = \frac{2\pi}{3}$.

$$S = \frac{L}{2}\left(1 - \cos\frac{\pi\theta}{\beta}\right)$$

$$= \frac{50}{2}\left(1 - \cos\frac{\pi\theta}{\frac{2\pi}{3}}\right)$$

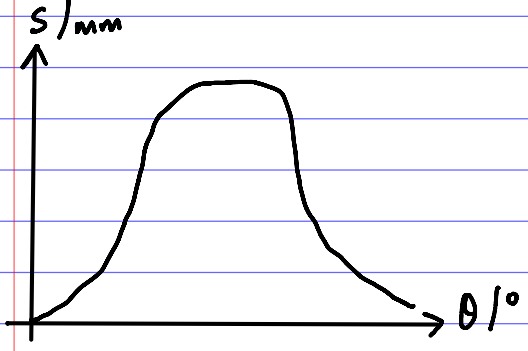
$$= 25\left(1 - \cos\frac{3\theta}{2}\right)$$

The return starts at $180°$ and ends at $300°$, so we have $L = 50\text{mm}$, $\beta = 120° = \frac{2\pi}{3}$.

$$S = \frac{L}{2}\left(1 - \cos\frac{\pi(\theta_e - \theta)}{\beta}\right)$$

$$= \frac{50}{2}\left(1 - \cos\frac{\pi\left(\frac{5}{3}\pi - \theta\right)}{\frac{2\pi}{3}}\right)$$

$$= 25\left(1 - \cos\frac{5\pi - 3\theta}{2}\right)$$



7.2) For the rise, we have $L = 25\text{mm}$, $\beta = 180° = \pi$,
The follower displacement would be:

$$s = L\left(\frac{\theta}{\beta} - \frac{1}{2\pi}\sin\frac{2\pi\theta}{\beta}\right)$$

$$= 25\left(\frac{\theta}{\pi} - \frac{1}{2\pi}\sin\frac{2\pi\theta}{\pi}\right)$$

$$= \frac{25}{\pi}\left(\theta - \frac{1}{2}\sin 2\theta\right)$$

The follower velocity would be:

$$\dot{s} = \frac{25}{\pi}(w - w\cos 2\theta)$$

$$= \frac{25w}{\pi}(1 - \cos 2\theta)$$

The follower acceleration would be:

$$\ddot{s} = \frac{25w}{\pi}(2w\sin 2\theta)$$

$$= \frac{50w^2}{\pi}\sin 2\theta$$

At $w = 100\text{rpm} = \frac{10}{3}\pi\ \text{rads}^{-1}$, $\theta = 60° = \frac{\pi}{3}$,

$$s = \frac{25}{\pi}\left(\frac{\pi}{3} - \frac{1}{2}\sin\left(\frac{2\pi}{3}\right)\right)$$

$$= 4.887527737\text{mm}$$

$$\dot{s} = \frac{25\left(\frac{10}{3}\pi\right)}{\pi}\left(1 - \cos 2\left(\frac{\pi}{3}\right)\right)$$

$$= 125\text{mms}^{-1}$$

$$\ddot{s} = \frac{50\left(\frac{10}{3}\pi\right)^2}{\pi}\sin 2\left(\frac{\pi}{3}\right)$$

$$= 1511.49947\text{mms}^{-2}$$

$$\approx 1510\text{mms}^{-2}$$

7.3) For the first 100° of the motion cycle,

$$s = 0$$

The rise starts at 100° and ends 160°, and $L = 20\,mm$, $\beta = 60^\circ = \frac{\pi}{3}$,

$$s = \frac{L}{2}\left(1 - \cos\frac{\pi(\theta - \theta_i)}{\beta}\right)$$

$$= \frac{20}{2}\left(1 - \cos\frac{\pi\left(\theta - \frac{5}{9}\pi\right)}{\frac{\pi}{3}}\right)$$

$$= 10\left(1 - \cos\left(3\theta - \frac{5}{3}\pi\right)\right) \quad \text{Rise}$$

For the dwell at 20mm from 160° to 210°,

$$s = 20$$

For the return from 210° to 360°, $s = 20mm$, $\beta = 150^\circ = \frac{5}{6}\pi$,

$$s = \frac{L}{2}\left(1 - \cos\frac{\pi(\theta_e - \theta)}{\beta}\right)$$

$$= \frac{20}{2}\left(1 - \cos\frac{\pi(2\pi - \theta)}{\frac{5}{6}\pi}\right)$$

$$= 10\left(1 - \cos\left(\frac{12\pi - 6\pi}{5}\right)\right) \quad \text{Return}$$

7.4) 1) A full cycle for the cam takes:

$$t = 3 + 1.5 + 3 + 1.5$$
$$= 9s$$
$$\omega = \frac{2\pi}{T}$$
$$= \frac{2\pi}{9}$$
$$\approx 0.6981 rads^{-1}$$

2) For the rise starting at $\theta = 0^\circ$ and ending at $\theta = 3\left(\frac{2\pi}{9}\right) = \frac{2}{3}\pi$, $L = 50mm$, $\beta = \frac{2}{3}\pi$

$$s = L\left(\frac{\theta}{\beta} - \frac{1}{2\pi}\sin\left(\frac{2\pi\theta}{\beta}\right)\right)$$
$$= 50\left(\frac{\theta}{\frac{2}{3}\pi} - \frac{1}{2\pi}\sin\left(\frac{2\pi\theta}{\frac{2}{3}\pi}\right)\right)$$
$$= \frac{25}{\pi}\left(3\theta - \sin 3\theta\right)$$

$$v = \frac{25}{\pi}\left(3\omega - 3\omega\cos 3\theta\right)$$
$$= \frac{75\omega}{\pi}\left(1 - \cos 3\theta\right)$$

$$a = \frac{75\omega}{\pi}\left(3\omega\sin 3\theta\right)$$
$$= \frac{225\omega^2}{\pi}\sin 3\theta$$

For the dwell starting at $\theta = \frac{2\pi}{3}$, ending at $\theta = \pi$,

$$s = 50$$
$$v = 0$$
$$a = 0$$

For the return starting at $\theta = \pi$, ending at $\theta = \frac{5}{3}\pi$, $L = 50mm$, $\beta = \frac{2\pi}{3}$,

$$s = L\left(\frac{\theta_e - \theta}{\beta} - \frac{1}{2\pi}\sin\frac{2\pi(\theta_e - \theta)}{\beta}\right)$$
$$s = 50\left(\frac{\frac{5}{3}\pi - \theta}{\frac{2\pi}{3}} - \frac{1}{2\pi}\sin\frac{2\pi\left(\frac{5}{3}\pi - \theta\right)}{\frac{2\pi}{3}}\right)$$
$$= \frac{25}{\pi}\left(5\pi - 3\theta - \sin(5\pi - 3\theta)\right)$$

$$v = \frac{25}{\pi}\left(-3\omega - (-3\omega)\left(-\cos(5\pi - 3\theta)\right)\right)$$
$$= \frac{75\omega}{\pi}\left(-1 + 1\left(-\cos(5\pi - 3\theta)\right)\right)$$
$$= -\frac{75\omega}{\pi}\left(1 + \cos(5\pi - 3\theta)\right)$$

$$a = -\frac{75\omega}{\pi}\left(-3\omega\sin(5\pi - 3\theta)\right)$$
$$= \frac{225\omega^2}{\pi}\sin(5\pi - 3\theta)$$

For the final dwell from $\theta = \frac{5\pi}{3}$ to $\theta = 2\pi$,

$$s = 0$$
$$v = 0$$
$$a = 0$$