Solve for $\ddot{\phi}$:

$$g\theta + (-g\phi - l\ddot{\phi} - \ddot{x}) + l\ddot{\phi} + \ddot{x} - g(\theta - \phi) = 0$$

$$g(\theta - \phi) - g(\theta - \phi) = 0$$

$$0 = 0$$

hmm...

Okay, as on p. 75, let's eliminate ϕ:

$$x_m = x + l\sin\phi + d\sin\theta$$
$$\approx x + l\phi + d\theta$$

$$\phi = \frac{x_M - x - d\theta}{l} \quad \rightarrow \quad \ddot{\phi} = \frac{\ddot{x}_M - \ddot{x} - d\ddot{\theta}}{l}$$

For the 1st EoM:

Thus, $$g\left(\frac{x_M - x - d\theta}{l}\right) + l\left(\frac{\ddot{x}_M - \ddot{x} - d\ddot{\theta}}{l}\right) + d\ddot{\theta} + \ddot{x} = 0$$

$$\frac{g}{l}(x_M - x - d\theta) + \ddot{x}_M = 0$$

Fourier transform:

$$\frac{g}{l}(\tilde{x}_M - \tilde{x} - d\tilde{\theta}) - \omega^2\tilde{x}_M = 0$$

$$\rightarrow \quad (\omega_0^2 - \omega^2)\tilde{x}_M = \omega_0^2(\tilde{x} + d\tilde{\theta})$$

For the 2nd EoM:

$$g\theta + d\ddot{\theta} + l\left(\frac{\ddot{x}_M - \ddot{x} - d\ddot{\theta}}{l}\right) + \ddot{x} + \frac{I}{md}\ddot{\theta} = 0$$

$$g\theta + \ddot{x}_M + \frac{I}{md}\ddot{\theta} = 0$$

Fourier transform:

$$\rightarrow \quad g\tilde{\theta} - \omega^2\tilde{x}_M - \frac{I}{md}\omega^2\tilde{\theta} = 0$$

$$\tilde{\theta} = \omega^2\tilde{x}_M$$