HW 1 Answers for Selected Problems

1)

1.11 $\omega = \frac{3000(2\pi)}{60} = 314.16\frac{\text{rad}}{\text{sec}}$. Period P $= \frac{2\pi}{\omega} = \frac{60}{3000} = \frac{1}{50}$ sec.

1.14 $x = 0.005\sin(6t)$, $\dot{x} = 0.005(6)\cos(6t) = 0.03\cos(6t)$. Velocity amplitude is $0.03\frac{m}{s}$. $\ddot{x} = -6(0.03)\sin(6t) = -0.18\sin(6t)$. Acceleration amplitude is $0.18\frac{m}{s^2}$. Displacement, velocity and acceleration all have the same frequency.

1.15 $f = 0.2x$

2) $\phi(t) = \frac{2}{3}e^{-3t} + 2t - \frac{2}{3}$

3a) $\omega = -\frac{2\tau_f}{J}t + \omega_0$

3d) $\theta_{final} = \frac{J\omega_0^2}{4\tau_f}$; Note: you can solve for this analytically or graphically

Supplemental Problem Set 1:

1.12 $\omega = 5\frac{rad}{s}$. $Period\ P = \frac{2\pi}{\omega} = \frac{2\pi}{5} = 1.257\ s.$ $Frequency\ f = \frac{1}{P} = \frac{5}{2\pi} = 0.796\ Hz.$

1.13 $Speed = \frac{40(5280)}{3600} = 58.6667\frac{ft}{s}$. $Frequency = \frac{58.6667}{30} = 1.9556\ times\ per\ second.$

4a) $y(t) = \frac{F}{b}\left(1 - e^{\frac{-b}{m}t}\right)$

4b) $y(t) = Ae^{-2t} + \frac{6}{\sqrt{592}}\sin(12t - tan^{-1}(6)) = \frac{9}{37}\left(e^{-2t} - \cos(12t) + \frac{1}{6}\sin(12t)\right)$

4c) $x(t) = \frac{1}{50}e^{-10t} + \frac{1}{5}t - \frac{1}{50}$

To be worked by 8/26:

3.5 $(v_0\sin\theta)t_H$, $t_H = \frac{-2v_{0_y} \pm \sqrt{4v_{0_y}^2 + 8gH}}{2g}$, $v_{0_y} = v_0\cos\theta$, $v_0 = \sqrt{\frac{2gL}{\tan\theta}}$

3.8 $m\ddot{x} = \frac{R_3}{R_2R_1}M - mg$

3.9 $mL^2\ddot{\phi} - mgLsin(\phi) = 0$

3.12
a) the mass m_1 will lift m_2 if $2m_1 - m_2\sin(\theta) > 0$
b) the mass m_1 will lift m_2 if $1 - (\mu_d\cos(\theta) + \sin(\theta)) > 0$

3.13 $\dot{v} = \frac{f}{m_c + 2m_w + 2\frac{I_W}{r_W^2}} = 4.032\frac{\text{m}}{\text{s}^2}$

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3.19 $I_e\dot{\omega}_1 = T_1 - \frac{m_2 gR}{N} + \frac{m_3 gR}{N} = T_1 - \frac{gR}{2}(m_3 - m_2)$

3.28 This problem ignores the wheel inertia. $(2\mathrm{m_r} + \mathrm{m_f} + \mathrm{m_b})\dot{V} = (2\mathrm{m_r} + \mathrm{m_f} + \mathrm{m_b})\mathrm{g}\sin(10°)$

3.31 $(mR^2 + I)\dot{\omega} = Rfcos(\phi)$

3.39 $a_{G_x} = \frac{23.544\mu_s \cos(\theta)}{4.6-\mu_s} - g\sin(\theta)$

Supplemental Set 2:

3.10 $\ddot{x}_B = -\frac{2}{3}g = -6.54\frac{m}{s^2}; \ddot{x}_A = \frac{1}{3}g = 3.27\frac{m}{s^2}$

3.11 $m_e\dot{v}_A = F_A - \frac{(m_L+m_C)}{2}g$ where $m_e = \frac{I_B}{R_B^2} + \frac{I_C}{4R_C^2} + \frac{m_L+m_C}{4}$

3.20 $I_e = I_s + I + mR^2$

3.29 $\left(m_1 + m_2 + \frac{I}{R^2}\right)\ddot{x} = m_1 gsin(\beta) - m_2 gsin(\phi)$

3.34 $a_{G_x} = g\sin(\theta) - \mu_d g\cos(\theta)$