ME 460/600 Fall 2006 Midterm Soln

1) $|a| = 2.45\ m/s^2$

a) $|X| = \frac{|a|}{(2.4 \cdot 2\pi)^2} = 0.011\ m$ (1.1 cm)

b) $|X| = \frac{2.45}{(4.8 \cdot 2\pi)^2} = 0.0027\ m$ (2.7 mm)

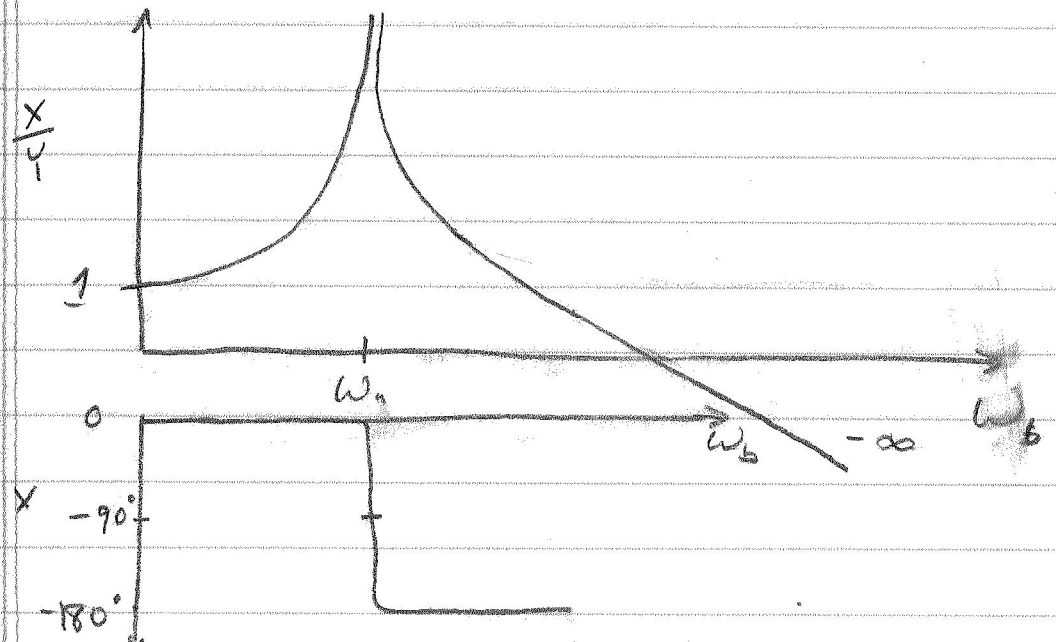
2) $X = \frac{10{,}000 + 0.01\,jw}{10{,}000 - 10w^2 + 0.1\,jw}\ Y$

b)

Y	ω_b rad/s	$\|X\|$	$\angle X$ deg
10	62.84	0.339	-180
2	207.3	0.0477	-180
1	402.1	0.0062	-180

Decimal is in the wrong place

a) I botched the problem statement for a.



3) a) It is definitely not viscous (or purely viscous)

b) It probably has a strong Coulomb (dry friction) component

4) $T = \frac{1}{2} m_1 (l_1 \dot{\theta})^2 + \frac{1}{2} m_2 (l_2 \dot{\theta})^2$

$U = m_2 g l_2 (1 - \cos\theta) + m_1 g l_1 (\cos\theta - 1)$

$\frac{d}{dt} \frac{\partial T}{\partial \dot{\theta}} = (m_1 l_1^2 + m_2 l_2^2) \ddot{\theta}$

$\frac{\partial U}{\partial \theta} = -m_1 g l_1 \sin\theta + m_2 g l_2 \sin\theta$

$(m_1 l_1^2 + m_2 l_2^2) \ddot{\theta} + g (m_1 l_1 + m_2 l_2) \sin\theta = 0$

5) see text or old soln

$$\omega_n = \sqrt{\frac{g(m_2 l_2 - m_1 l_1)}{m_1 l_1^2 + m_2 l_2^2}}$$

Problem 2, for Y: 10, f = 10Hz, long hand

$$X = \frac{10{,}000 + 0.01jw}{10000 - 10w^2 + 0.1jw}$$

$$= \frac{10{,}000 + 0.01 \cdot 2\pi \cdot 10\, j}{10{,}000 - 10(2\pi \cdot 10)^2 + 0.01 \cdot 2\pi \cdot 10\, j}$$

$$= \frac{10{,}000 + 0.6283j}{-2.948 \times 10^4 + 0.6283j}$$

$$= \frac{10000\, e^{0.0036^\circ j}}{2.948 \times 10^4\, e^{180^\circ j}}$$

$0.0036^\circ = \text{atan}\frac{0.6283}{10{,}100}$

$180 = \text{atan}\frac{0.6283j}{-2.948 \times 10^4}$ (2nd quadrant)

$$|X| = \frac{10000}{2.948 \times 10^4} = \underline{0.339}$$

$$\angle X = 0.0036^\circ - 180^\circ = \underline{-180^\circ}$$