Electronics Chapter 4 Homework
4.2, 4.6, 4.7, 4.15, 4.21, 4.25

4.2 $f(t) = 5\sin 2\pi t$ is already a fourier series, it is written as a sum (1 term) of sin waves w/ integer multiples of ω_0 (2π in this case).

4.6 see companion document

4.7a) the bandwidth is where the gain drops below $1/\sqrt{2}$, this is @ about f = 7 Hz

b) $F_{in}(t) = \frac{4}{\pi}\sin(2\pi f_0 t) + \frac{4}{3\pi}\sin(2\pi 3 f_0 t) + \frac{4}{5\pi}\sin(2\pi 5 f_0 t)$

$+ \frac{4}{7\pi}\sin(2\pi 7 f_0 t) + \frac{4}{9\pi}\sin(2\pi 9 f_0 t)$

where $f_0 = 1$ Hz

$F_{out}(t) = \frac{4}{\pi}\left[\sin 2\pi f_0 t + \frac{1}{3}\sin 2\pi 3 f_0 t + \frac{1}{5}\sin 2\pi 5 f_0 t\right.$

$+ \frac{1}{7}\left(1 - \frac{1}{4}(6\text{ Hz} - 7\text{ Hz})\sin(2\pi 7 f_0 t)\right)$

$\left. + \frac{1}{9}\left(1 - \frac{1}{4}(6\text{ Hz} - 9\text{ Hz})\sin(2\pi 9 f_0 t)\right)\right]$

$= \frac{4}{\pi}\left(\sin 2\pi f_0 t + \frac{1}{3}\sin 2\pi 3 f_0 t + \frac{1}{5}\sin 2\pi 5 f_0 t\right.$

$\left. + \frac{3}{28}\sin(2\pi 7 f_0 t) + \frac{1}{36}\sin 2\pi 9 f_0 t\right)$

c) see companion document

~~4.21 In a first~~

4.15 see companion document

4.21 In a first order system

$$\tau \frac{dx_{out}}{dt} = -x_{out} + K x_{in}$$

and $\frac{dx_{out}}{dt}$ can be approximated as

$$\frac{dx_{out}}{dt} = \frac{\Delta x_{out}}{\Delta t} = \frac{x_n - x_{n-1}}{0.1s}$$

from the graph in the companion document

$\tau = 2.86\,s$ and

$$\frac{K x_{in}}{\tau} = 1.8$$

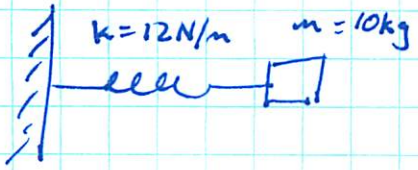
$$K x_{in} = 1.8 \times 2.86\,s = 5.14$$

to find the static sensitivity we need x_{in}, assuming $x_{in} = 1$

$$K = 5.14$$

4.25

$F_{ext} = 20N \sin(0.75t)$



drag $b = 10 \frac{Ns}{m}$

$\omega = 0.75$

$\omega_n = \sqrt{k/m} = \sqrt{1.2} \frac{rad}{s} = 1.095 \text{ rad/s}$

$\xi = \frac{b}{2\sqrt{km}} = 0.456$ (dimensionless)

$$X_0 = \frac{F_0}{k}\left(\frac{1}{\left[1-(\omega/\omega_n)^2\right]^2 + 4\xi^2(\omega/\omega_n)^2}\right)^{1/2}$$

$= 2.032 \text{ m}$

$$\phi_0 = -\arctan\left(\frac{2\xi}{\frac{\omega_n}{\omega} - \frac{\omega}{\omega_n}}\right) = -0.8663 \approx -50°$$

so

$$X(t) = 2.032\text{m} \sin\left(0.75 \frac{rad}{s} t - 0.8663 \text{ rad}\right)$$