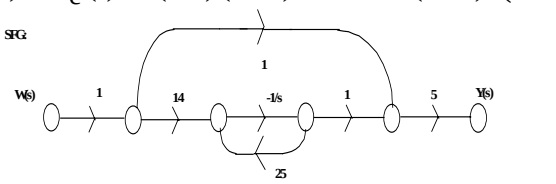
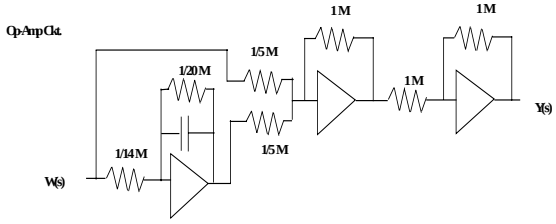
EE571 Solution to HW#25

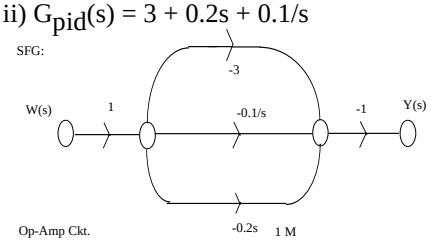
1. a) Realize the following compensators using op-amps, 1 µF capacitors, and resistors:

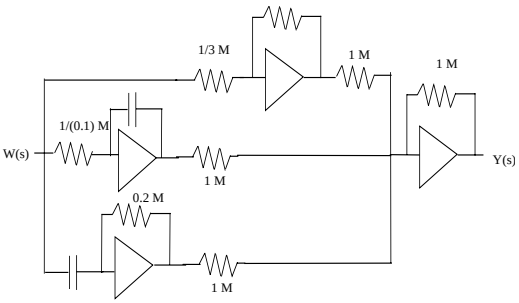
i) $G_c(s) = 5(s+6)/(s+20) = 5[1 + -14/(s+20)]$ (note: all capacitors are 1 μF)





ii) $G_{pid}(s) = 3 + 0.2s + 0.1/s$

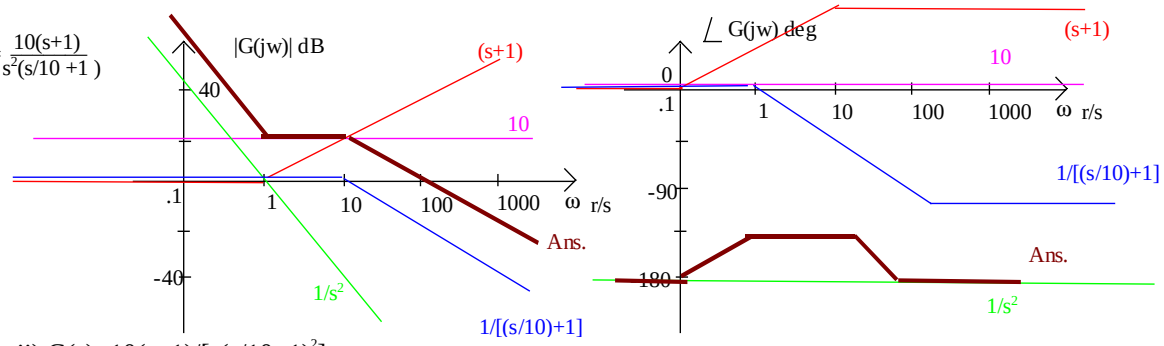




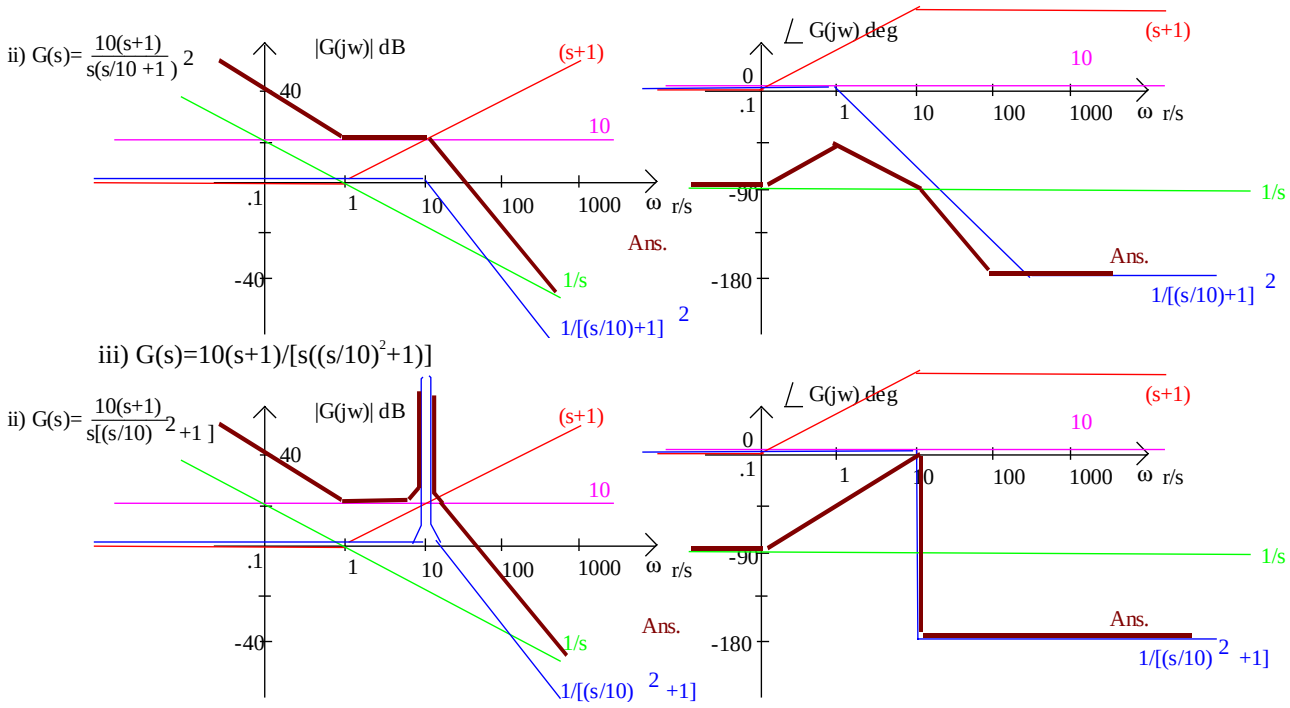
b) Use semi-log paper to construct the Bode Plots (both magnitude and phase) for the following transfer functions:

i) $G(s)=10(s+1)/[s^2(s/10 + 1)]$

ii) $G(s)=\frac{10(s+1)}{s^2(s/10 +1)}$



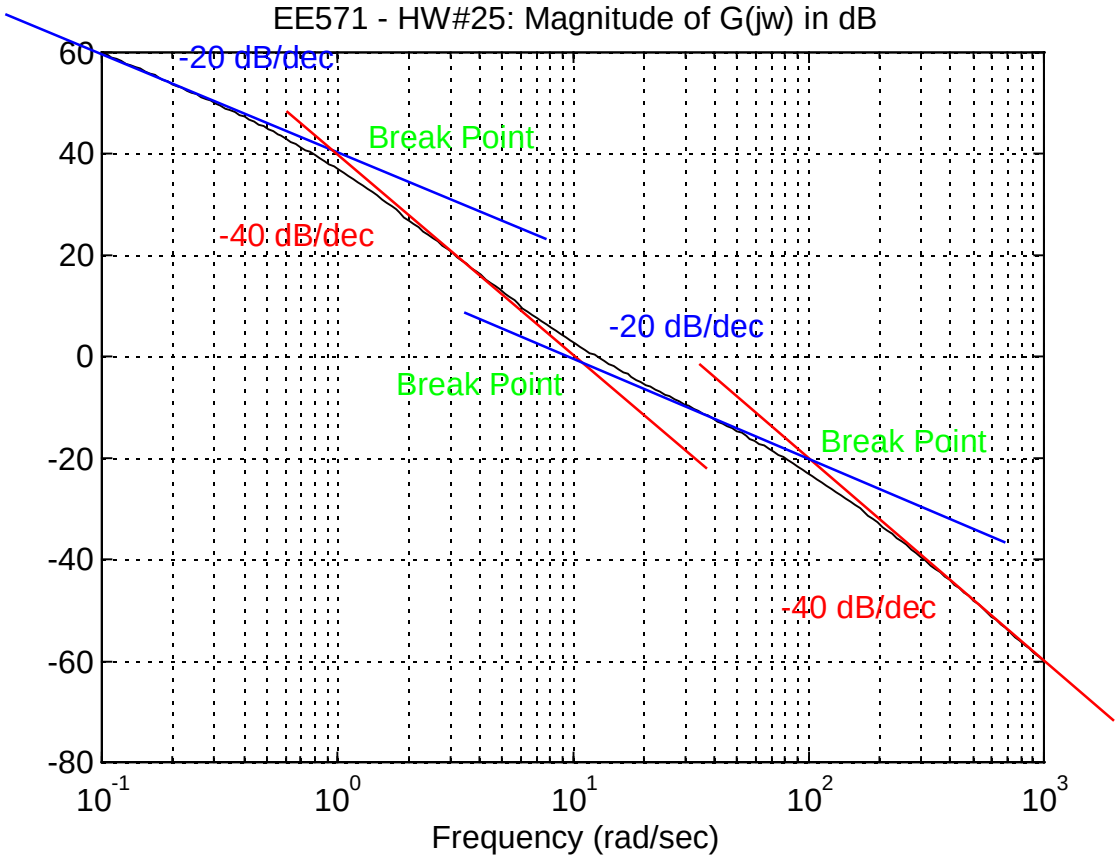
ii) $G(s)=10(s+1)/[s(s/10+1)^2]$



d) Find $\omega, |G(j\omega)|, \angle G(j\omega)$ given that G(s)=V_{out}(s)/V_{in}(s) and the following sinusoidal steady-state plot:

$\omega = 2\pi f = 2\pi \times 4 = 25.133 \text{ rad/ sec}, \quad |G(j\omega)| = |\text{Vout/ Vin}| = 6/2 = 3.0 \quad , \quad \angle G(j\omega) = -0.03/0.25 \times 360° = -43.2°$

e) Find G(s) from the following Bode Magnitude plot of $G(j\omega)$ (assume minimum phase):



From the intersection of the asymptotes, we can see that there are break-points corresponding to poles at {-1, -100}. There is a zero at {-10}. Thus, $G(s)=K(s/10 +1)/[s^m(s/1+1)(s/100+1)]$. Since the slope at low frequencies is -20 dB/dec, m=1 (i.e., type 1 system). Therefore, the value of K can be found from the gain at low frequencies. For example, at 0.1 rad/sec, the Gain is 60 dB =1000 = K/(0.1). Thus, K=100 and $G(s)=100(s/10 +1)/[s^1(s/1+1)(s/100+1)]$.