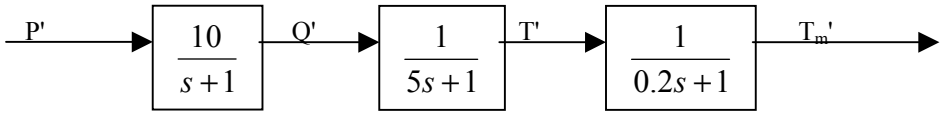
ChEE 413
Homework Handout 11
Spring 2005

1) Problem 14.1 from first edition - find the response of the first order system

$$G(s) = \left(\frac{2}{0.2s+1} \right)$$

to a sinusoidal input x(t) = sin 2t and plot it, showing the intial transient behavior. Find the long time behavior and show that the amplitude and phase angle are equal to values given by $|G(j\omega)|$ and $\angle G(j\omega)$.

2) Problem 14.3 from first edition - A perfectly stirred tank is used to heat a flowing liquid. The dynamics of the system have been determined to be approximately as shown in the drawing:



P is the power applied to the heater
Q is the heating rate of the system
T is the actual temperature in the tank
T_m is the measured temperature

A test has been run with P' varied sinusoidally as P' = 0.5 sin(0.2t). Under these conditions, the measured temperature is $T_m' = 3.464 \sin(0.2t+\phi)$.
Find a value for the maximum error between T' and T_m' if the sinusoidal input has been applied for a long time.

3) Problem 14.4 from first edition - Find expressions for for transfer functions representing pure integration and differentiation elements:
a) G(s) = 1/s
b) G(s) = s

4) Problem 14.5 from first edition - For each of the following transfer functions, sketch the asymptotic Bode diagram for the amplitude ratio. For each case, find the actual amplitude ratio and phase angle at ω = 0.1, 1, and 10.

a) $\dfrac{10}{(10s+1)(s+1)}$

b) $\dfrac{10}{(10s+1)(s+1)^2}$

c) $\dfrac{10(s+1)}{(10s+1)(0.1s+1)}$

d) $\dfrac{10(-s+1)}{(10s+1)(0.1s+1)}$

e) $\dfrac{10}{s(10s+1)}$

f) $\dfrac{10(s+1)}{s(10s+1)(0.1s+1)}$

5) Problem 14.8 from first edition - For the transfer function:

$$G(s) = \frac{5(s+1)e^{-2s}}{(3s+1)(2s+1)}$$

evaluate the amplitude ratio and phase angle of each component of G(s) and plot them along with the composite functions.