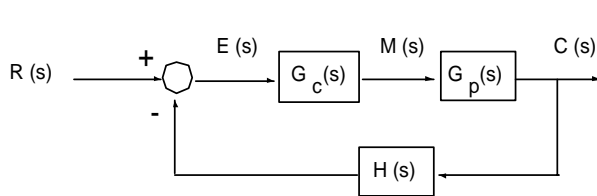


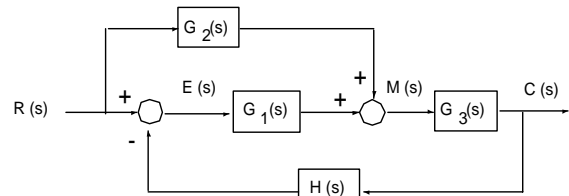
Homework – Block Diagrams and Transfer Functions

Due Next Week – No Electronic Copies will be graded

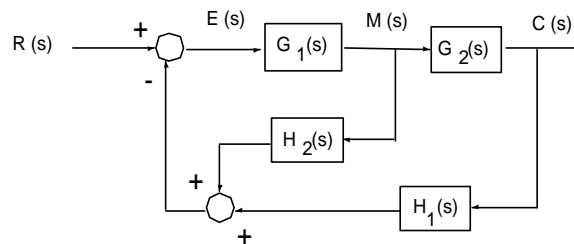
1. By writing algebraic equations and eliminating variables, calculate the transfer function $C(s)/R(s)$ for the following systems (5 points each)



(a)

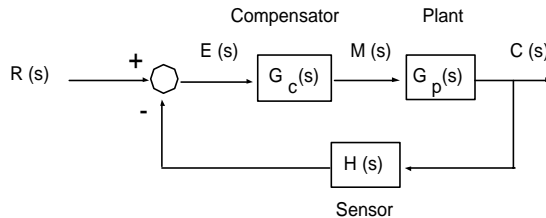


(b)



(c)

2. A feedback control system diagram and plant transfer function are given below.



$$G_p(s) = \frac{5}{0.2s + 1}$$

- Write the differential equation of the plant that relates $c(t)$ and $m(t)$ (5 points)
- Modify the equation of question (a) above to yield the system differential equation. This equation relates $c(t)$ and $r(t)$. The compensator and sensor transfer functions are given by $G_c(s) = 10$ and $H(s) = 1$ (5 points)
- Derive the system transfer function from the results of question (b) (5 points)
- It is shown in question 1-a that the closed-loop transfer function of the system in the above figure is given by

$$\frac{C(s)}{R(s)} = \frac{G_c(s)G_p(s)}{1 + G_c(s)G_p(s)H(s)}$$

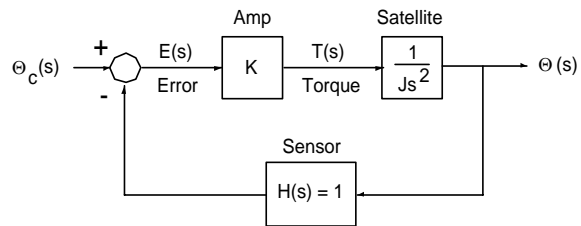
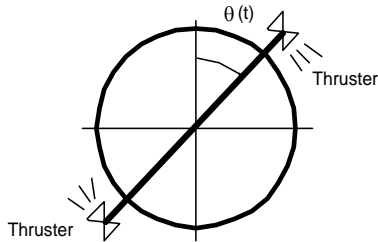
Use this relationship to verify the results in question (c) above (5 points)

- Recall that the transfer function pole term $(s + a)$ yields a time constant $\tau = 1/a$ where a is a real number. Find the time constants for both the open-loop and closed-loop systems (5 points)

3. Repeat question 2 (a through e) with the following transfer functions (25 points)

$$G_c(s) = 2 \quad G_p(s) = \frac{5}{s^2 + 2s + 2} \quad H(s) = 3s + 1$$

4. A satellite is connected to the closed-loop control system shown below. The torque is directly proportional to the error signal



Derive the transfer function $\Theta(s)/\Theta_c(s)$ where $\theta(t) = \mathcal{L}^{-1}[\Theta(s)]$ is the commanded attitude angle (5 points)