**Homework – Block Diagrams**

1. Show the following
2. The transfer function of two systems in parallel, as seen below, is equal to the sum of the transfer functions **(5-points)**



1. The transfer function of two systems in series (cascade), as seen below, is equal to the product of the transfer functions **(5-points)**



1. Calculate the transfer function $C(s)/R(s)$ for the following **(5-points each)**







1. A feedback control system is given below. The plant transfer function is $G\_{p}\left(s\right)=\frac{5}{0.2s+1}$



1. Write the plant’s differential equation that relates $c(t)$ and$ m(t)$. **(5-points)**
2. Modify the equation of part (A) to yield the differential equation that relates $c\left(t\right)$and$ r(t)$. The compensator and sensor transfer functions are given by $G\_{c}\left(s\right)=10$ and$ H\left(s\right)=1$. **(5-points)**
3. Derive the system transfer function from the results of part (B) **(5-points)**
4. Derive the system transfer function $C(s)/R(s)$ **(5-points)**
5. The transfer function pole term $ (s+a)$ yields a time constant $ τ=1/a$ where $ a$ is real. Find the time constants for the both the open-loop and closed-loop systems **(5-points)**
6. Repeat Question 3 but with the transfer functions$ G\_{c}=2$, $ G\_{p}=\frac{3s+8}{s^{2}+2s+2}$, and $ H\left(s\right)=1$. For part (e), recall that the transfer function underdamped pole terms $ [\left(s+a\right)^{2}+b^{2}]$ yields a time constant $ τ=1/a$ **(25-points)**.
7. Repeat Question 3 but with the transfer functions$ G\_{c}=2$, $ G\_{p}=\frac{5}{s^{2}+2s+2}$, and $ H\left(s\right)=3s+1$ **(25-points)**.