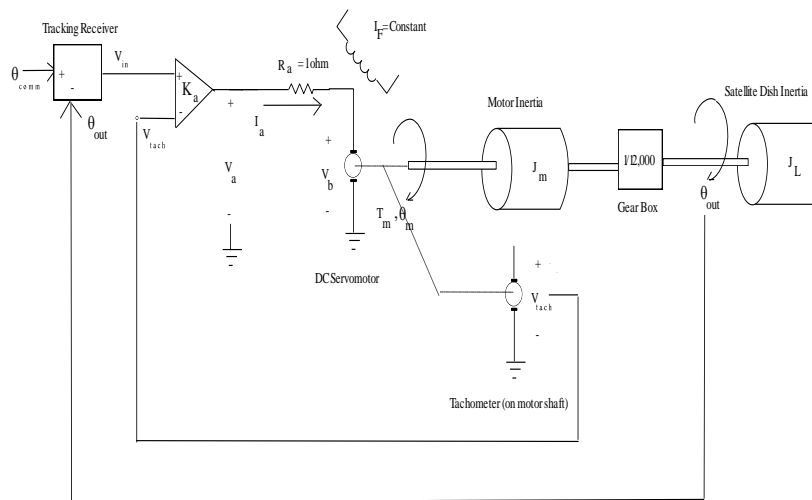


1. Since it is football season, you have decided to invest in a satellite dish. Rather than pay for a DirectTV[®] technician to come and align your dish antenna, you decide to build your own automatic tracking systems that can track a variety of satellites. The functional schematic for your design is given below.



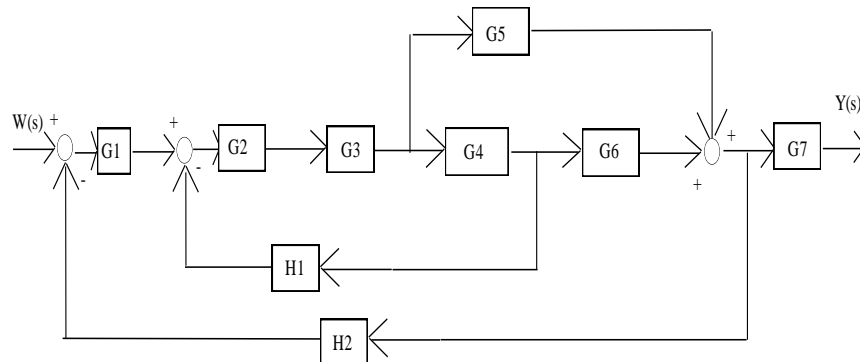
Satellite Dish Tracking System

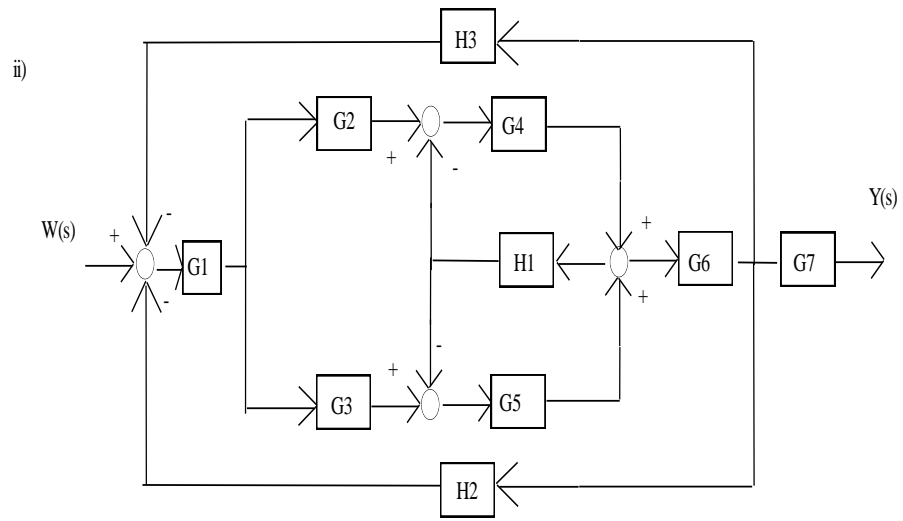
Find the transfer function for the following satellite tracking system. We have found the gain of the amplifier to be $K_a=60$. The motor torque constant is 0.5 Nm/A (i.e., $T_m = 0.5 I_a$) and the motor inertia is $J_m = .007 \text{ kgm}^2$. The tach constant is 0.04 Vs , the back emf constant is 0.75 Vs , The dish inertia is $J_L=2,880 \text{ kgm}^2$, and the gearbox ratio is $1/12,000$ (step down). There is negligible inductance and friction in this system. We have experimentally measured the transfer function of the tracking receiver to be:

$$\frac{V_1}{\theta_{comm} - \theta_{out}} = \frac{5}{1 + s/(40\pi)}$$

2. a) Use **block diagram reduction techniques** to find the overall transfer function of:

i)





b) Repeat part a) using Mason's SFG analysis.