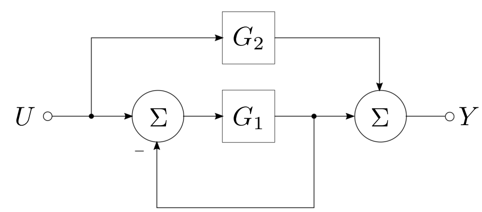
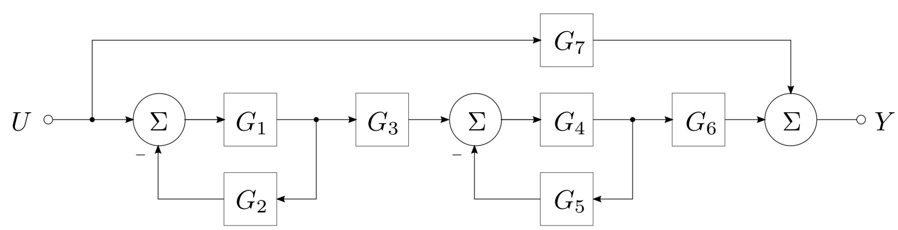
ASE3093 Automatic Control / AUS3204 Applied Control Engineering
Homework #3

1) *Block-diagram algebra.* For each block diagram below, reduce the diagram and obtain the transfer function $Y(s)/U(s)$.

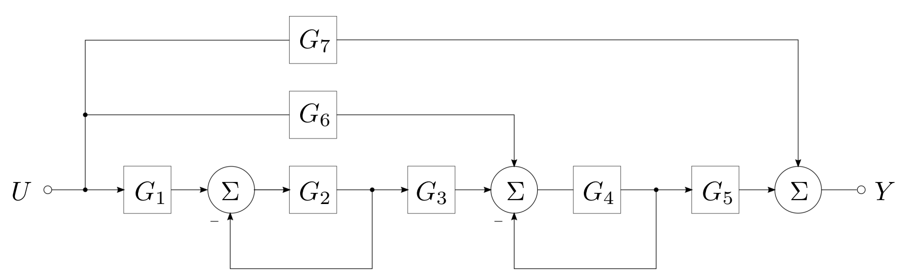
a)



b)

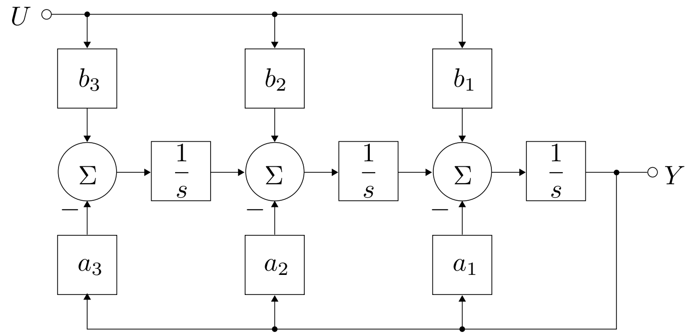


c)

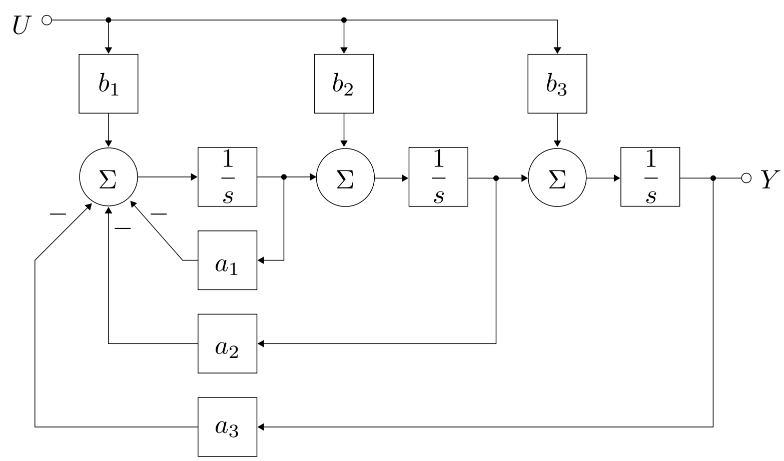


2) *Canonical forms.* Determine the transfer function $Y(s)/U(s)$ for each of the following block diagrams. All constants a_i and b_i are real numbers.

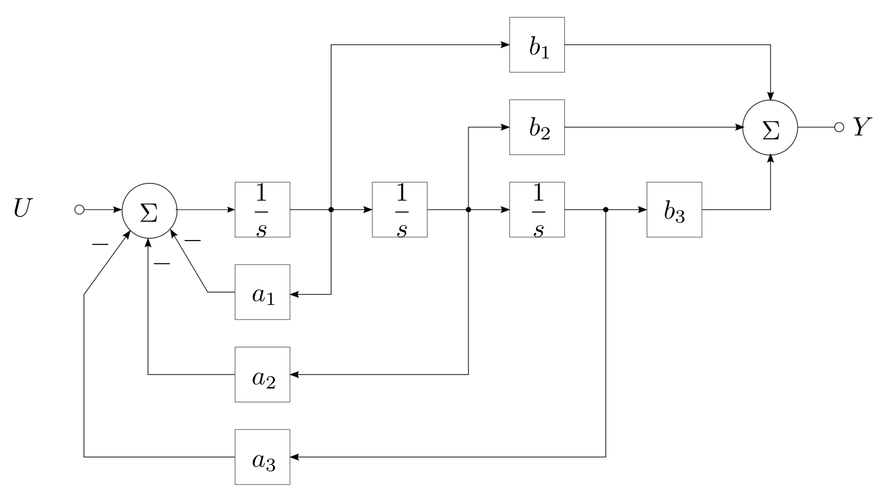
a)



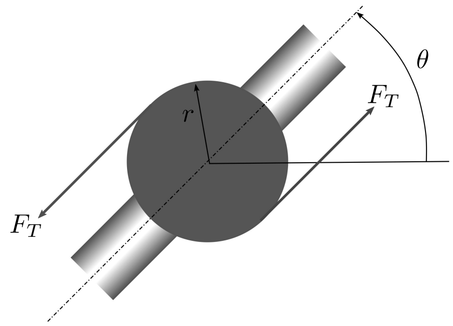
b)



c)



3) *Satellite attitude control.* We wish to analyse the attitude-control system of a satellite. The control input is a thrust F_T applied at a distance r from the satellite's centre of mass, and a disturbance force F_d acts in the same direction. The rotational dynamics are



$$I\ddot{\theta} = 2r\big(F_T + F_d\big),$$

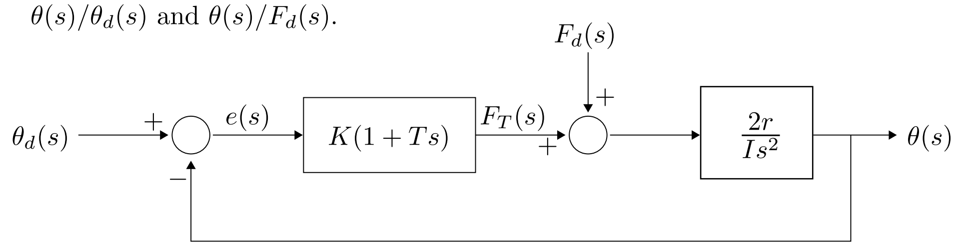
where I is the moment of inertia.

To achieve the control objective, the attitude angle θ is measured and a proportional–derivative (PD) controller of the form

$$K(s) = K\big(1 + Ts\big)$$

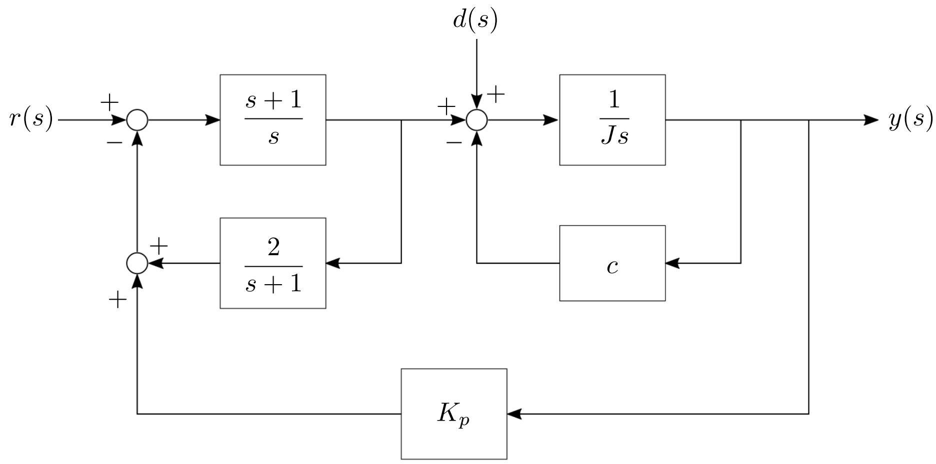
is used in a unity-feedback configuration.

a) For the block diagram shown below, find the closed-loop transfer functions $\theta(s)/\theta_d(s)$ and $\theta(s)/F_d(s)$.



b) The closed-loop performance is governed by K and T. Determine conditions on K and T such that the closed-loop damping ratio is at least ζ_d with $0 < \zeta_d < 1$.

4) *Multiple inputs.* Answer the following questions for the system below.



a) Derive the transfer functions $G_r(s) = \dfrac{y(s)}{r(s)}$ and $G_d(s) = \dfrac{y(s)}{d(s)}$.

b) Can the output be written as $y(s) = G_r(s)r(s) + G_d(s)d(s)$? Explain why.