

1. Block diagram of a general, closed loop system is given in Figure 1 Express the closed loop response of the system for reference input  $r$  and disturbance  $d$ ? [ $y = G_{yr}r + G_{yd}d \rightarrow G_{yr} = ?, G_{yd} = ?$ ]

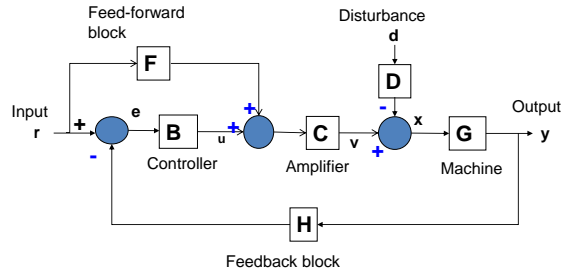


Figure 1: Block diagram of a general closed loop system.

2. Assume that  $F = D = 0$ ,  $H = 1$ ,  $B = K$ ,  $C = 1$ ,  $G = K_v/[(s + a)s]$  in the following questions (See Figure 2). Express the error  $e(s) = r(s) - y(s)$  for a given reference input  $r$  and disturbance  $d$ ?

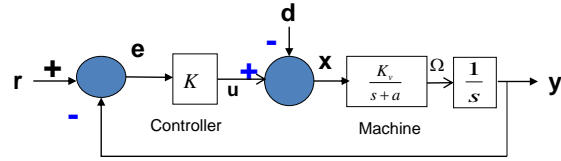


Figure 2: Block diagram of reduced system

3. What is the steady error ( $e_{ss}$ ) for a ramp input  $r(t) = ft$  and step disturbance  $d(t) = d_0$  ?
4. If the reference input is given in the following form,  $r(t) = r_0$  for  $t \geq 0$ , express the response  $y(t)$  while disturbance  $d = 0$ ? Assume  $a = 10$ ,  $K_v = 10$ ,  $K = 0.9$  and  $r_0 = 10$ .
5. Express the frequency response function (FRF) of the closed loop system  $G_{yr}(j\omega)$ ? (i.e. Magnitude  $|G_{yr}(j\omega)| = 20 \log_{10} |y(j\omega)/r(j\omega)|$  and phase  $\phi(j\omega)$  when the disturbance  $d = 0$ ). Assume  $a = 10$ ,  $K_v = 10$ ,  $K = 0.9$  and  $r_0 = 10$ . Calculate approximate FRF at frequencies  $\omega = 0.1, 1, 10, 100$  (rad/s)