Hence

$$Y_1^*(s) = \frac{K_P R^*(s)\, G^*(s)}{1 + K_D H^*(s) + K_P G^*(s)}$$

for $K_P = 2$

$$\boxed{\frac{Y_1(z)}{R(z)} = \frac{2\, G(z)}{1 + K_D H(z) + K_P G(z)}}$$

$$Y_2^*(s) = \frac{K_P R^*(s)\, H^*(s)}{1 + K_D H^*(s) + K_P G^*(s)}$$

$$\boxed{\frac{Y_2(z)}{R(z)} = \frac{2\, H(z)}{1 + K_D H(z) + K_P G(z)}}$$

Now put value of $G(z)$ and $H(z)$

$$\frac{Y_1(z)}{R(z)} = \frac{0.26\,(z+1)}{z^2 2.26z + 1 + K_D(0.52)(z-1) + 0.26(z+1)}$$

$$\frac{Y_2(z)}{R(z)} = \frac{(1.04)(z-1)}{z^2 - 2.26z + 1 + K_D(0.52)(z-1) + 0.26(z+1)}$$

f Denominator of pulse transfer functions

$$D(z) = z^2 2.26z + 1 + K_D(0.52)(z-1) + 0.26(z+1)$$

$$= z^2 + z(-2.26 + 0.26 + K_D(0.52)) + (1 + 0.26 - K_D(0.52))$$

Apply Jury test for order 2

$$|a_2| < a_0, \quad D(1) > 0, \quad D(-1) > 0$$

$a_0 = 1$

$$|1.26 - K_D(0.52)| < 1$$

$$-1 < 1.26 - K_D(0.52) < 1$$

Pcse6

For this Part again same definitions for $H(s)$ and $G(s)$ will be used as in Part a)

$$G(s) = \boxed{ZOH} \rightarrow \boxed{\frac{s}{s^2-1}} \rightarrow \boxed{\frac{1}{s}}$$

$G(z)$ was already calculated

$$G(z) = \frac{0.13(z+1)}{z^2-2.26z+1}$$

$$H(s) = \boxed{ZOH} \rightarrow \boxed{\frac{s}{s^2-1}}$$

$H(z)$ was already calculated

$$H(z) = \frac{(0.52)(z-1)}{z^2-2.26z+1}$$

Again call

$$e(t) = r(t) - y_1(t)$$

$$R(s) - Y_1(s) = E(s)$$

$$\left(K_P E^*(s) - K_D Y_2^*(s)\right) \cdot H(s) = Y_2(s)$$

$$\left(K_P E^*(s) - K_D Y_2^*(s)\right) H^*(s) = Y_2^*(s)$$

$$K_P E^*(s) H^*(s) = Y_2^*\left(1 + K_D H^*(s)\right)$$

$$Y_2^*(s) = \frac{K_P E^*(s) H^*(s)}{1 + K_D H^*(s)}$$

$$\left(K_P E^*(s) - K_D Y_2^*(s)\right) \cdot G(s) = Y_1(s)$$

$$\left(K_P E^*(s) - K_D\left(\frac{K_P E^*(s) H^*(s)}{1+K_D H^*(s)}\right)\right) G^*(s) = Y_1^*(s)$$

$$\left(\frac{K_P E^*(s) + \cancel{K_P K_D E^*(s) H^*(s)} - \cancel{K_D K_P E^*(s) H^*(s)}}{1 + K_D H^*(s)}\right) G^*(s) = Y_1^*(s)$$

$$Y_1^*(s) = \frac{K_P E^*(s) G^*(s)}{1 + K_D H^*(s)}$$

$$R^*(s) - Y_1^*(s) = E^*(s)$$

$$R^*(s) = E^*(s)\left(1 + \frac{K_P G^*(s)}{1 + K_D H^*(s)}\right)$$

$$E^*(s) = \frac{R^*(s) \cdot \left(1 + K_D H^*(s)\right)}{1 + K_D H^*(s) + K_P G^*(s)}$$