1. a)

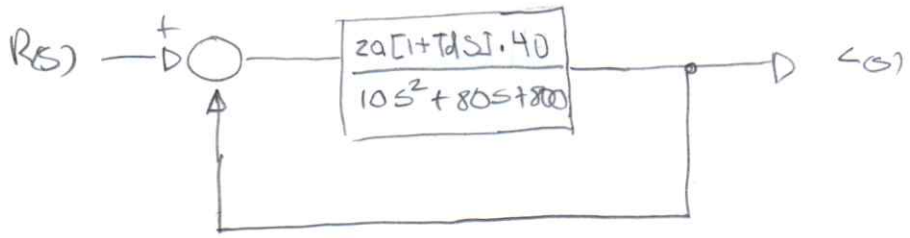
$$m(t) = 20\left[e(t) + \frac{1}{T_i}\int e(t)\,dt + T_d \frac{d}{dt} e(t)\right]$$

$$M(s) = 20\left[E(s) + \frac{1}{T_i s}\cdot E(s) + T_d s\, E(s)\right]$$

$$= 20\, E(s)\left[1 + \frac{1}{T_i s} + T_d s\right]$$

$$\therefore \quad \frac{M(s)}{E(s)} = 20\left[1 + \frac{1}{T_i s} + T_d s\right]$$

Se $\frac{1}{T_i} = \phi \Rightarrow \frac{M(s)}{E(s)} = 20\,[1 + T_d s]$



$$\frac{800\,[1+T_d s]}{10s^2+80s+800} = \frac{80[1+T_d s]}{s^2+8s+80} = GH(s)$$

$$D(s) = s^2+8s+80+80\,[1+T_d s]$$

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$$= s^2+8s+80+80+80T_d s$$

$$= s^2 + (8+80T_d)s + 160 = \phi$$

$$w_n = \sqrt{160}$$

$$\xi = 1$$

$$\therefore \quad 8+80T_d s = 2.\xi.w_n$$

$$= 2.1.\sqrt{160}$$

$$T_d = \frac{2.\sqrt{160}-8}{80}$$

$$= 0,216 \text{ seg}$$