5a)

$$G(s) = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2}$$

T.F = ?
Poles = ?

$M_p = 30\%$, $t_s = 0,05$ sec

- From the specification of M_p (Maximum Overshoot):

$$M_p = e^{-\xi\pi/\sqrt{1-\xi^2}}$$

$$0,3 = e^{-\pi\xi/\sqrt{1-\xi^2}} \Rightarrow \xi = 0,358$$

- From the specification of t_s (setting time):

$$t_s = \frac{4}{\xi.\omega_n} \Rightarrow 0,05 = \frac{4}{0,358.\omega_n} \Leftrightarrow \omega_n = 223,48 \text{ rad/sec}$$

- Since $0 \leq \xi < 1$ (Under Damped)

The system has a pair of complex conjugate Poles.

$$P_1, P_2 = -\xi.\omega_n \pm j\,\omega_n\sqrt{1-\xi^2}$$

$$P_1, P_2 = -80 \pm j\,208,7$$

- transfer Function:

$$G(s) = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2} = \frac{49934}{s^2 + 160s + 49934}$$