Q.1)

a) $$G(s) = \frac{(1-5s)(1-2s)e^{-0.5s}}{(12s+1)(6s+1)(0.3s+1)}$$

Taylor expansion $\quad e^{-0.5s} \approx (1-0.5s)$

b) Taylor series approximation. FOPTD -

$$\frac{1}{12s+1} \cdot \left(e^{-0.5-2-5-6-0.3}\right)^{s} \Rightarrow \frac{1}{12s+1} \cdot e^{-13.8s}$$

$\tau = 12$

plot on matlab.

c) Skogested FOPTD $\quad \tau_2 = 6$

$$\frac{1}{12s+1} \cdot \frac{1}{\left[\left(12+\frac{6}{2}\right)s+1\right]} \cdot e^{(-0.5-2-5-3-0.3)s}$$

$$\Rightarrow \frac{1}{(15s+1)} \quad e^{-10.8s}$$

d) $G(s) = \dfrac{Ke^{-\theta s}}{\tau s+1}$ ~~given~~ found $\theta = 10.3$

$m = 0.0453$ $m = \dfrac{KM}{\tau}$, from graph, $K = 1$,

$\therefore \tau = 1/m = 22.1$

f) $\dfrac{(1-\tau_a s)e^{-\theta s}}{(\tau_1 s+1)(\tau_2 s+1)}$

$\tau_a = 5$

$\tau_1 = 12$ $\therefore$ by taylor approx,

$\tau_2 = 6$

$$\frac{(1-5s)\, e^{-0.5s-2s-0.3s}}{(12s+1)(6s+1)}$$

$$\Rightarrow \frac{1-5s}{(12s+1)(6s+1)}\, e^{-2.8s}$$

by skogestad,

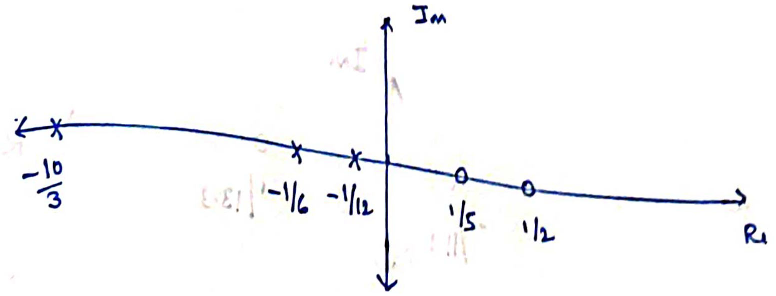
$$\frac{(1-5s)e^{-0.5s-2s-0.15s}}{(12s+1)((6+0.15)s+1)}$$

$$\Rightarrow \frac{(1-5s)e^{-2.65s}}{(12s+1)(6.15s+1)}$$

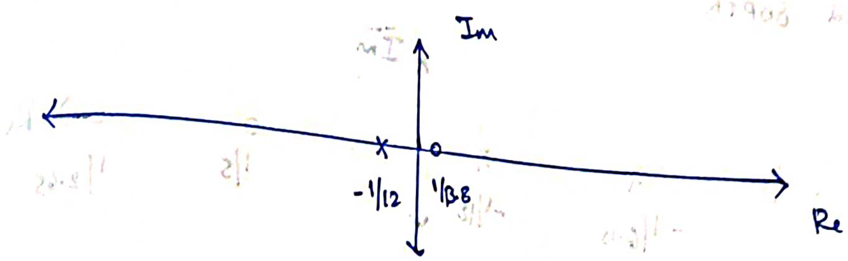
On zooming the graph,

Skogested gives better.

a)


Im
-10/3
-1/6
-1/12
1/5
1/2
Re

b)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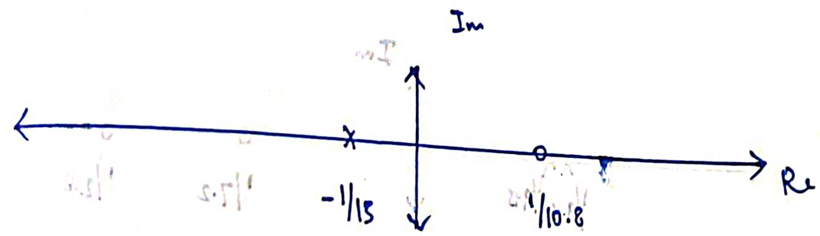
1/13.8
Re

c)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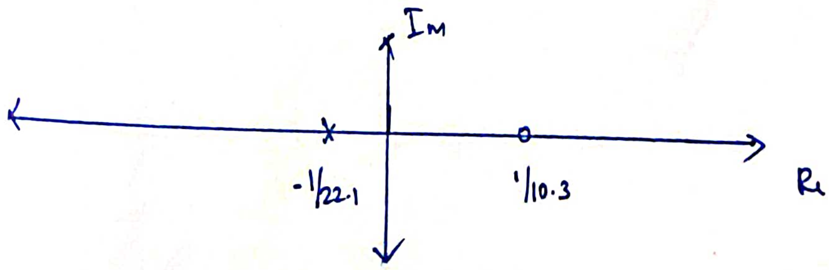
d)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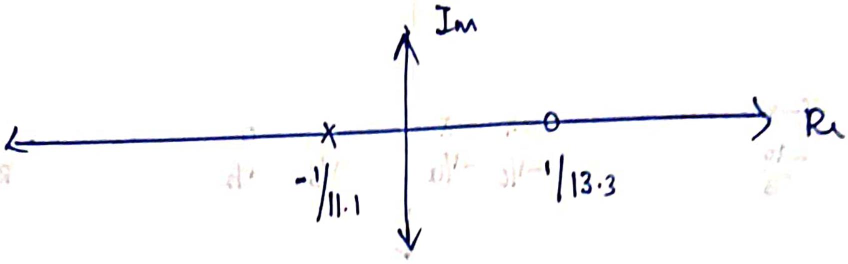
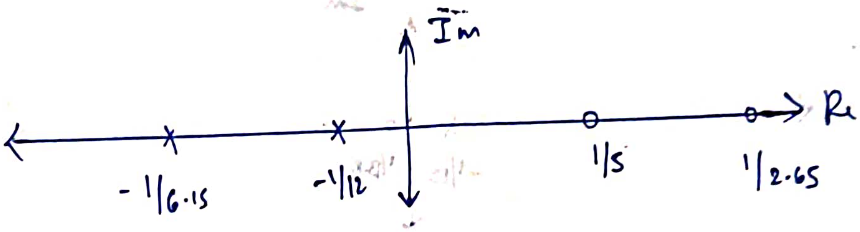
-1/22.1
1/10.3
Re

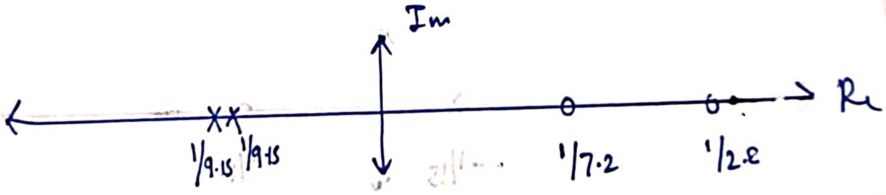
e)



f) Skogerted SOPTD



g) Non liner



the two ~~po~~ poles are almost equal