Q → Why does the system have same peak overshoot for the poles i) $-10 \pm 10j$
ii) $-20 \pm 20j$

Peak overshoot M_p is given by

$$M_p = e^{\frac{-\pi\xi}{\sqrt{1-\xi^2}}}$$ → does not depend on ω_n

Here : ξ → Damping ratio
ω_n → natural frequency

For a second order system given by :

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

Poles are given by :

$$-\xi\omega_n \pm j\omega_n\sqrt{1-\xi^2}$$

In our case the magnitudes of real & imaginary parts are same

$$\Rightarrow \quad \xi\omega_n = \omega_n\sqrt{1-\xi^2}$$

$$\because \omega_n \neq 0 \quad \Rightarrow \quad \xi^2 = 1-\xi^2 \Rightarrow 2\xi^2 = 1$$

$$\boxed{\xi = \frac{1}{\sqrt{2}}}$$

Hence ξ is fixed in case i) & ii) as well and M_p depends only on ξ & not on ω_n

Hence Both the systems have same Peak overshoot and just the settling time $t_s = \begin{cases} 4T = \frac{4}{\xi\omega_n} & \text{(2\% criterion)} \\ 3T = \frac{3}{\xi\omega_n} & \text{(5\% criterion)} \end{cases}$ changes as ω_n changes.