Date.....

(Q3) The OLTS of cl/b system is

$$G(s) = 10^3 / s(1 + s/1192)$$

It has a PM of 50° at wgc = 10^3 r sec^{-1}. A time delay is introduced in the system reducing the PM to 40. The max time delay

Original system $G(s) \cdot 10^3/(1 + s/1192)$

$\omega_{pc} = \infty$ rd sec^{-1} } 2nd order system

GM = ∞

PM = 50°

$\omega_{gc} = 10^3$ rad/s

After delay $G(s) = 10^{-3} e^{-Ts} / s(1 + s/1192)$

$$G(j\omega) = 10^3 \cdot e^{j\omega t} / j\omega(1 + j\omega/1192))$$

$$\angle G(j\omega) = \frac{(0)\ (57.3\ \omega T)}{(90°)\ \tan^{-1}\omega/1192)}$$

$$52.3\,\omega T - 90° = \tan^{-1}(\omega/1192)$$

Now as per ques, PM = 40° new

$$PM = 180 + \phi$$

$$40 = 180 + \phi = -140$$

$\phi \angle G(j\omega)$ / $\omega = \omega_{gc} = 10^3$ r/sec (remains same)

$$-140 = -90 - 57.3 \times 10^3 T - \tan^{-1}\left(\frac{10^3}{1192}\right)$$

$$T = 0.174 \times 10^{-3}\ s$$