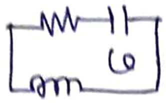
Tutorial Sheet 3, EE 302, Section S2, $8^{th}$ Feb 2024.

**Q-1**: Consider the unforced system (i.e. input (wherever it was) $\equiv 0$). for the two following circuits.


$i \equiv$ current through inductor

(Circuit 1)




$v \equiv$ voltage across capacitor.

(circuit 2)

$R > 0,\ L > 0,\ C > 0.$

write 2nd order diff eqn in
- $i$ for circuit 1
- $v$ for circuit 2

and obtain bound on $R$ for overdamping.

(Is it correct to opine that "more resistance causes more damping"?)

**Q-2**: Consider 2nd order system without zero & $0 < \zeta < 1$

$$\frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}.$$

in $\mathbb{C}$ (the s-plane)

draw
(a) - constant %OS line
(b) - constant $T_p$ line
(c) - constant $T_s$ line
(d) - constant $\omega_n$ line
(e) constant $\omega_d$ line

**Q-3**:

For each of the curves a, b, c, d, e, of Q-2, evaluate if $T_p, T_r, T_s$, %OS increase or decrease or remain constant (along these curves).

**Q-4**: For each one below, design a 2nd order transfer fn, if possible. (No zero)
(Use calculator)

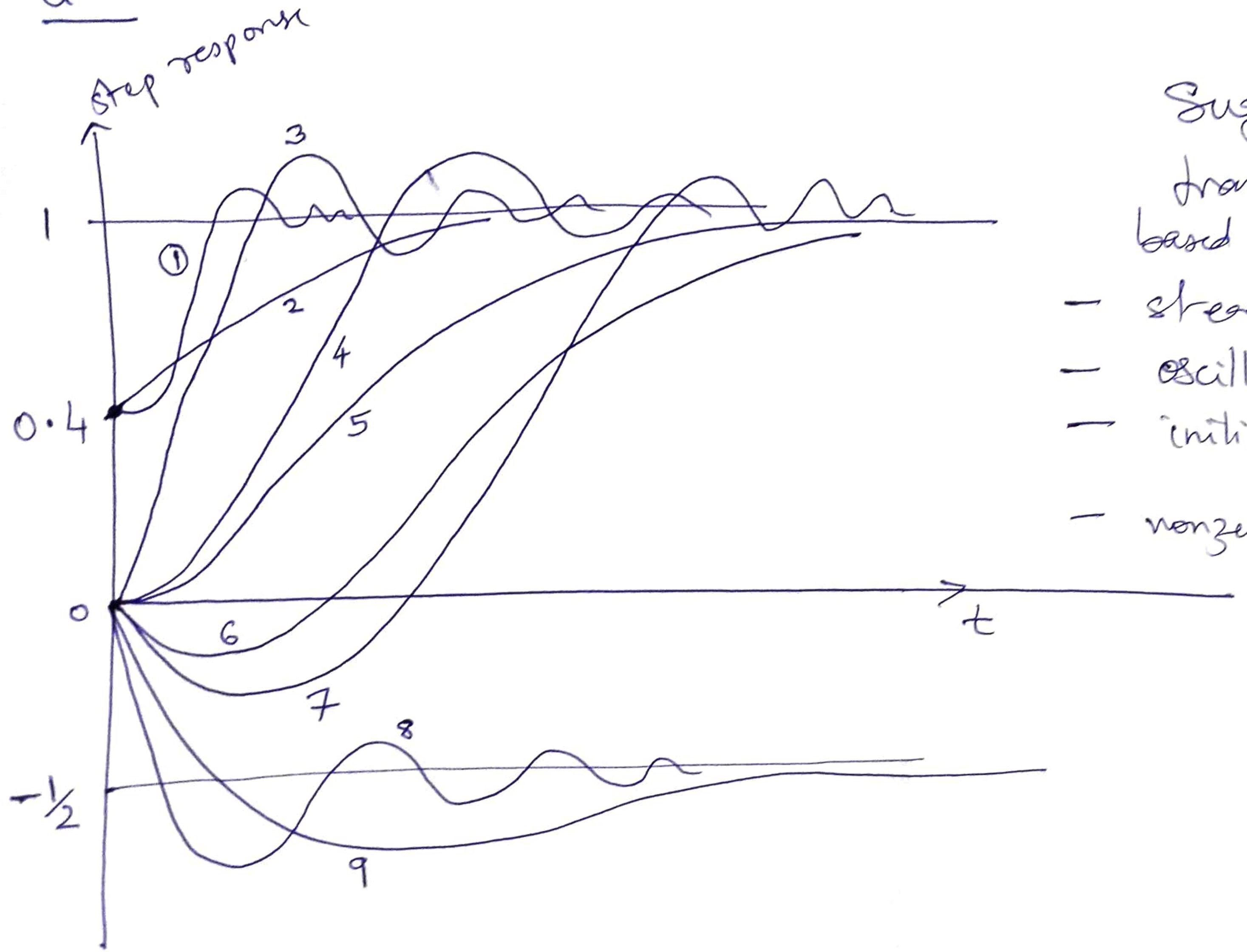
(a) 5 %OS, 10 seconds settling time.

(b) peak time 3 seconds, 50 seconds settling time.

(c) 5 %OS, 3 seconds peak time, 50 seconds settling time.

**Q-5**: For 2nd order over-damped case (without zero), for step response, show that when one pole $-b$ goes far left, then we have a 1st order representation (approximation) of the transfer fn $\frac{ab}{(s+a)(s+b)}$

## Q-6




Suggest 9 different transfer functions:
based on

- steady state value
- oscillations if any
- initial rise rate → +ve, → 0, → -ve.
- nonzero initial value.