1.

Transient Response	Steady State
1. It is the response of a system to a change from an equilibrium	It is an equilibrium condition of a circuit or network that occurs as the effects of transients are no longer important
2. System is unstable during transient response.	During steady state a system is in relative stability.
3. It provides information about	It gives information about
i) Initialization (when system responded to input) ii) Rate of rise of output w.r.t. time iii) Nature of response : exponential or oscillatory	i) Steady State error ii) Nature of error (constant or varying w.r.t. time) iii) Accuracy of system

2. Steps to find out Transient Response Solution

The source is made to zero then the differential equation converts to homogeneous version.

Generalized procedure for finding transient solution

General form of diff. eqⁿ is given by

$$D(P).y(t) = N(P) f(t) \quad \text{--- (1)}$$

eqⁿ (1) represents the non-homogeneous diff eqⁿ in operator form.

homogeneous version of diff. eqⁿ is obtained by setting $f(t) = 0$ i.e.

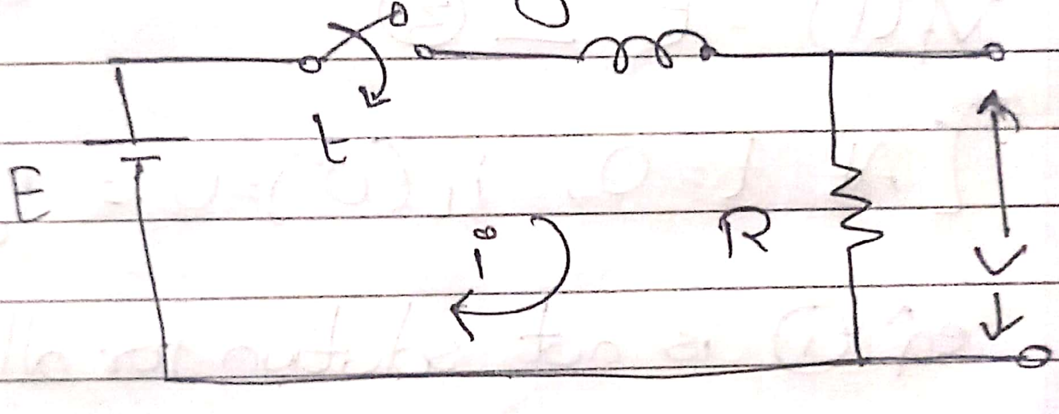
$$D(P).y(t) = 0 \quad \text{--- (2)}$$

Since, only exponential function qualifies as a solution to the diff. eqⁿ. the P operator can be replaced by the algebric multiplier 'S'. So,

$D(s)\,y(t) = 0$ —— (3)

$D(s)$ is the denominator polynomial of the networks function $G(s)$ and $D(s) = 0$ represents the characteristics eqⁿ.

Consider following circuit:



Applying KVL when switch is closed i.e. at $t = 0^+$

$E = LPi + Ri$ —— (1)

Now,

$V = \frac{E * R}{LP + R} \Rightarrow VLP + VR = ER$

$\Rightarrow \frac{L}{R} VP + V = E$

$\Rightarrow \frac{L}{R}\frac{dV}{dt} + V = E$ —— (2) which is non-homogeneous eq^n.

At steady state (i.e. $t \to \infty$). for constant source put $p = 0$

i.e. $\frac{dv}{dt} = 0$

$V_f(t) = E$ — ③

[At $t = 0$, $i_L(0^-) = 0 = i_L(0^+)$]

Thus, eq^n ① is not solution for all time

Now, for transient response, homogeneous version of diff. eq^n

$\frac{1}{R}\frac{dv}{dt} + v = 0$ — ④

Since, only the exponential form satisfies the above condition So,

Let, $V_t = Ke^{st}$ be the transient solution.

From eq^n ~~to~~ 4

$$\frac{L}{R}\frac{d}{dt}\left(Ke^{st}\right) + Ke^{st} = 0$$

$$\Rightarrow \frac{L}{R} K s e^{st} + Ke^{st} = 0$$

$$\Rightarrow Ke^{st}\left(\frac{L}{R}s + 1\right) = 0$$

$$Ke^{st} \neq 0$$

So, $$\frac{L}{R}s + 1 = 0$$

or $$s = -\frac{R}{L}$$

$$\therefore V_t = Ke^{-\frac{R}{L}t}$$

Then total solution ~~woda~~ would be

$$V = V_f + V_t$$

$$= E + Ke^{-\frac{R}{L}t} \quad \text{--- } 5$$

Here K is unknown and can be found

by using initial conditions.

Initial condition:

At $(t = 0^-)$

$i(0^-) = 0$, $V(0^-) = 0$ [switch open]

At $(t = 0^+)$,

$i(0^+) = i(0^-) = 0$ (current through inductor cannot change instanteneously)

or, $V(0^+) = 0$

Now, for $t = 0^+$, eq^n 5 becomes

$V(0^+) = E + Ke^{-\frac{R}{L}(0^+)}$

$\Rightarrow 0 = E + K$

$\therefore K = -E$

Hence, eq^n 5 becomes,

$V = E - Ee^{-\frac{R}{L}t} = E(1 - e^{-\frac{R}{L}t})$

which is the required solution.