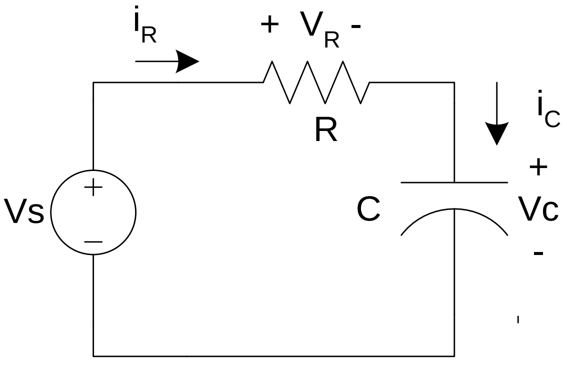
NETWORK ANALYSIS AND SYNTHESIS

Unit – III
Transient Circuit Analysis

- Natural response and forced response,
- Transient response and steady state response for arbitrary inputs (DC and AC),
- Evaluation of time response both through classical and Laplace methods.

Circuit Analysis for RC Circuit



Apply KCL

$$i_R = i_C$$

$$i_R = \frac{v_s - v_R}{R}, i_C = C\frac{dv_C}{dt}$$

$$\frac{dv_C}{dt} + \frac{1}{RC}v_R = \frac{1}{RC}v_s$$

v_S is the source applied.

Solution to First Order Differential Equation

Consider the general Equation

$$\tau \frac{dx(t)}{dt} + x(t) = K_s f(t)$$

Let the initial condition be $x(t = 0) = x(0)$, then we solve the differential equation:

$$\tau \frac{dx(t)}{dt} + x(t) = K_s f(t)$$

The complete solution consits of two parts:

- the homogeneous solution (natural solution)
- the particular solution (forced solution)

The Natural Response

Consider the general Equation

$$\tau \frac{dx(t)}{dt} + x(t) = K_s f(t)$$

Setting the excitation $f(t)$ equal to zero,

$$\tau \frac{dx_N(t)}{dt} + x_N(t) = 0 \;\; or \quad \frac{dx_N(t)}{dt} = -\frac{x_N(t)}{\tau}$$

$$x_N(t) = \alpha e^{-t/\tau}$$

It is called the natural response.

The Forced Response

Consider the general Equation

$$\tau \frac{dx(t)}{dt} + x(t) = K_s f(t)$$

Setting the excitation $f(t)$ equal to F, a constant for $t \geq 0$

$$\tau \frac{dx_F(t)}{dt} + x_F(t) = K_S F$$

$$x_F(t) = K_S F \quad for \; t \geq 0$$

It is called the forced response.

The Complete Response

Consider the general Equation

$$\tau \frac{dx(t)}{dt} + x(t) = K_S f(t)$$

The complete response is:

- the natural response +
- the forced response

$$x = x_N(t) + x_F(t)$$
$$= \alpha e^{-t/\tau} + K_S F$$
$$= \alpha e^{-t/\tau} + x(\infty)$$

Solve for α,

$$for\ \ t = 0$$
$$x(t=0) = x(0) = \alpha + x(\infty)$$
$$\alpha = x(0) - x(\infty)$$

The Complete solution:

$$x(t) = [x(0) - x(\infty)]e^{-t/\tau} + x(\infty)$$

$[x(0) - x(\infty)]e^{-t/\tau}$ **called transient response**

$x(\infty)$ **called steady state response**

THANKS….

Queries Please…