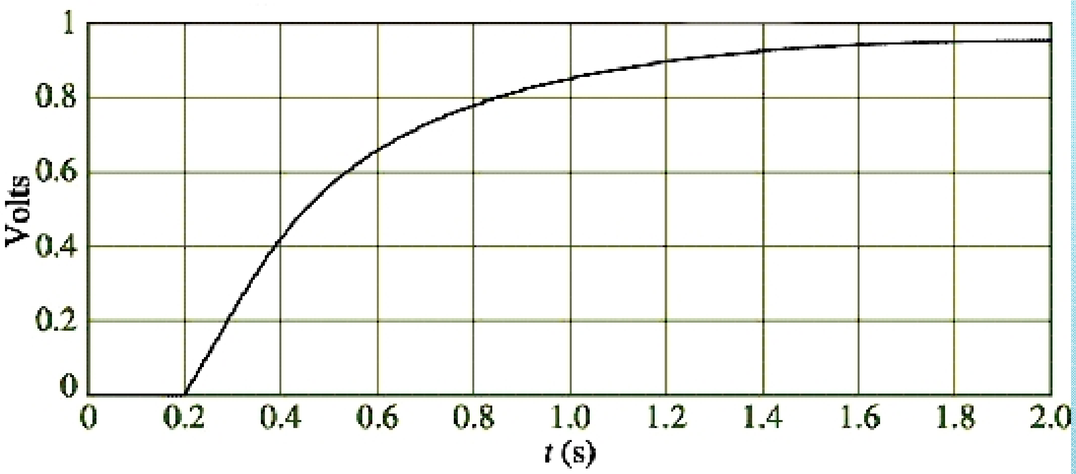
NETWORK THEORY

LECTURE 1

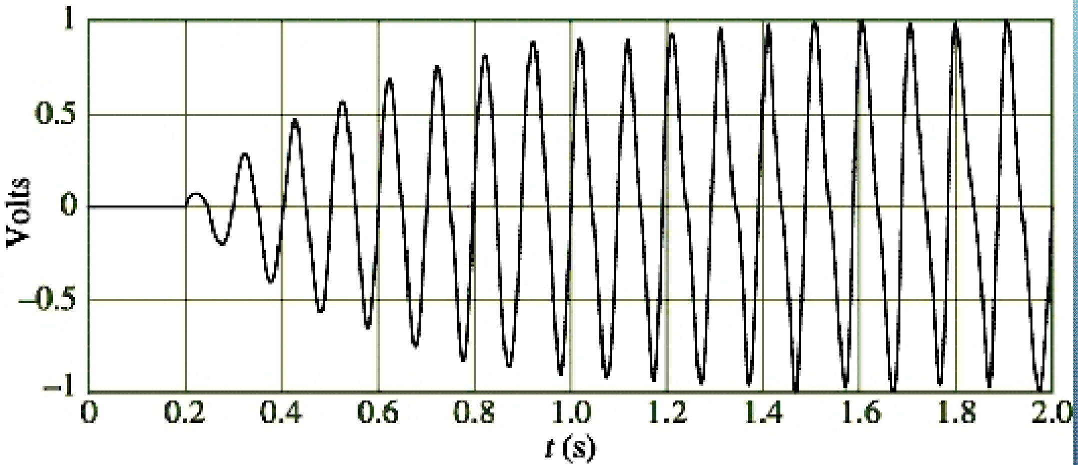
SECTION A

TOPIC COVERED : INTRODUCTION OF TRANSIENT RESPONSE

WHAT IS TRANSIENT RESPONSE



(a) Transient DC voltage



(b) Transient sinusoidal voltage

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 consists 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,

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

$$\int \frac{dx_N(t)}{x_N(t)} = \int -\frac{dt}{\tau}, \qquad x_N(t) = \alpha\, e^{-t/\tau}$$

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:

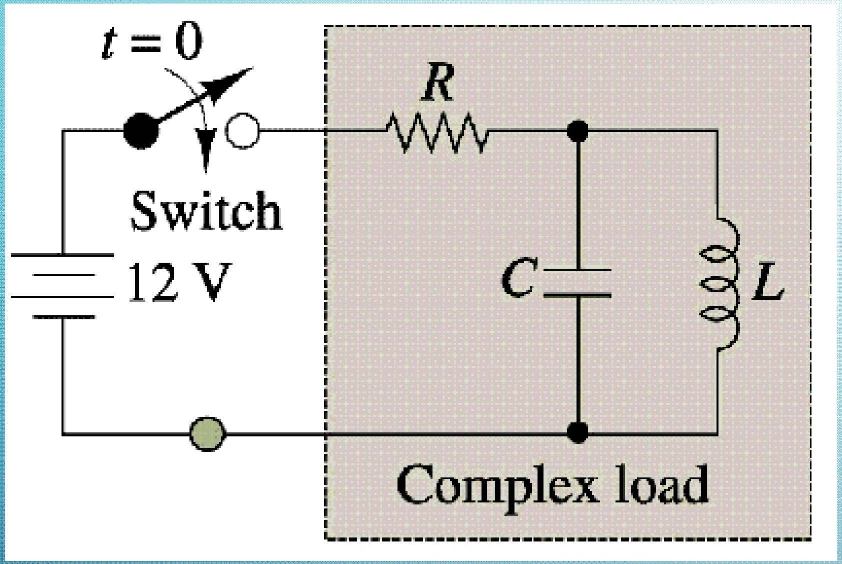
$$x(t) = [x(0) - x(\infty)] e^{-t/\tau} + x(\infty)$$

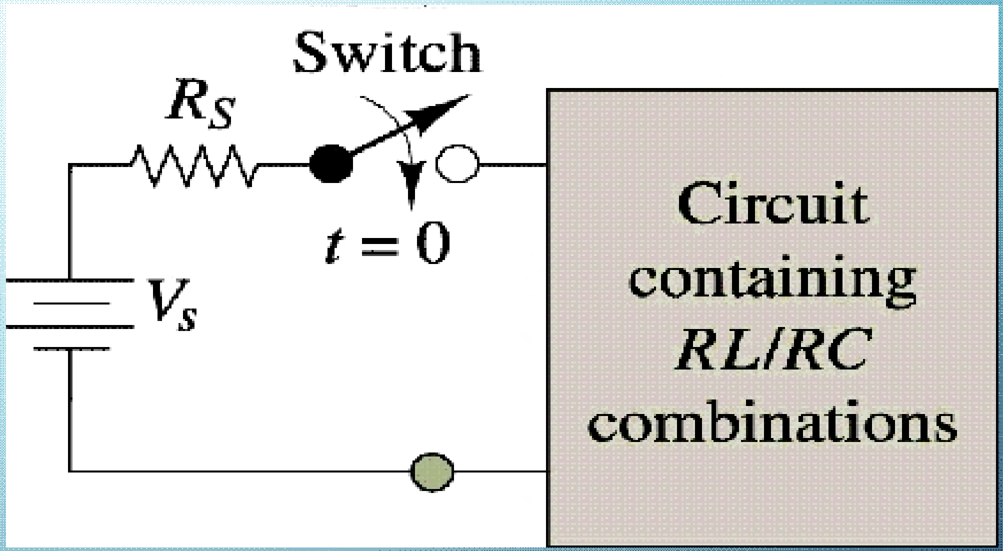
$[x(0) - x(\infty)] e^{-t/\tau}$ **called transient response**

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

Circuit with switched DC excitation

A general model of the transient analysis problem





In general, any circuit containing energy storage element

A circuit containing energy-storage elements is described by a differential equation. The differential equation describing the series *RC* circuit shown is

$$\frac{di_C}{dt} + \frac{1}{RC} i_C = \frac{dv_S}{dt}$$