Class 12: Second Order Transients

Steps for solving first- and second-order transient problems

1) Write the differential equations using KVL or KCL
2) Analyze the steady-state circuit to find initial conditions
3) Solve the differential equations

Solving second-order differential equations

1) For the **homogenous** solution

$$a\frac{d^2y}{dx^2} + b\frac{dy}{dx} + cy(t) = x(t)$$

We need to find the roots of the *characteristic equation* $as^2 + bs + c = 0$

Use the table on right to determine the homogenous solution, depending on the roots.

2) The **particular** solution is the same
3) The **general** solution is the same
4) We will have *two* **initial conditions** we will need to find the unknowns, such as

$$y(0) = y_0$$
$$\frac{dy}{dt}(0) = y_1$$

Case	**Roots**	**Homogeneous Solution**
I	Distinct real roots $s = s_1, s_2$	$A_1 e^{s_1 t} + A_2 e^{s_2 t}$
II	Complex roots $s = \sigma \pm j\omega$	$B_1 e^{\sigma t}\cos(\omega t) + B_2 e^{\sigma t}\sin(\omega t)$
III	Repeated real roots $s = s_0, s_0$	$C_1 e^{s_0 t} + C_2 t e^{s_0 t}$

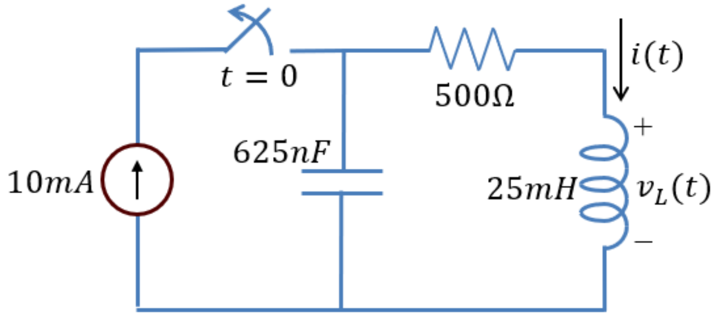
Example 1:

$$\frac{d^2y}{dt^2} + 3\frac{dy}{dt} + 2y(t) = 4, \quad y(0) = 1,\ \frac{dy}{dt}(0) = 0$$

Example 2:

$$\frac{d^2y}{dt^2} + 4\frac{dy}{dt} + 3y(t) = 0, \quad y(0) = 2,\ \frac{dy}{dt}(0) = -1$$

Example 3: Find $i(t)$



Example 4: Find $i_C(t)$