Laplace variable $S = \sigma + j\omega$

decaying / rising   sinusoidal

"transient response"   "ac or steady state response"

Types of source excitation

DC
voltage

steady state DC

DC voltage +
switch

(transient)
+
steady state DC

AC
voltage

(sinusoidal)

AC voltage + switch

(sinusoidal + transient)

steady state

More
complex
waveforms

periodic
waveforms

All blue

→ initial conditions
of L & C

t

$$\underline{\text{Time Domain}}$$

$$v(t) = V_0 \cos(\omega t + \varphi) \equiv \qquad \underline{\text{Phasor / frequency domain}}$$

$$V(\omega) = V_0 e^{j\varphi} = V_0 \underline{/\varphi}$$

$$v(t) = V_0 e^{\sigma t} \cos(\omega t + \varphi)$$

$$= V_0 e^{\sigma t} \text{Re}\{e^{j(\omega t + \varphi)}\}$$

$$= \text{Re}\{ \boxed{V_0 e^{j\varphi}} \; e^{(\sigma + j\omega)t} \}$$

$$V(s) = V_0 e^{j\varphi} = V_0 \underline{/\varphi}$$

$$s = \sigma + j\omega$$

$$\quad \underset{\text{Neper/s}}{\downarrow} \qquad \searrow \; \text{rad/s}$$

→ $$v_{in}(t) = 5 e^{-2t} \cos(3t + 45°) \, V. \qquad \text{Convert to phasor domain}$$

$$+ \text{ find } s$$

$$s = -2 + j3$$

$$V_{in}(s) = 5 e^{j45°} = 5\cos 45° + j\, 5\sin 45° = \frac{5}{\sqrt{2}} + j\frac{5}{\sqrt{2}} \; V$$

$$= 20 \times 10^{-3}(-2 + j3)$$
$$= -0.04 + j0.06 \; \Omega$$

$$\frac{1}{10 \times 10^{-3}(-2 + j3)}$$
$$= 15.38 - j23.08 \; \Omega$$

$$V_{out}(s) = V_{in}(s) \times \frac{Ls + \dfrac{1}{Cs}}{R + Ls + \dfrac{1}{Cs}}$$

$$= \frac{5e^{j45} \times \left[-15.42 + j(-23.02) \right]}{-5.4246 - j\, 23.014} = V_0 e^{j\varphi}$$

$$= 5.858 \; \underline{/24.4337°}$$

$$v_{out}(t) = V_0 e^{-2t} \cos(3t + \varphi) \; V$$

$$= 5.86 \, e^{-2t} \cos(3t + 24.434°) \; V$$