

Graphical Representation of Overdamped Response

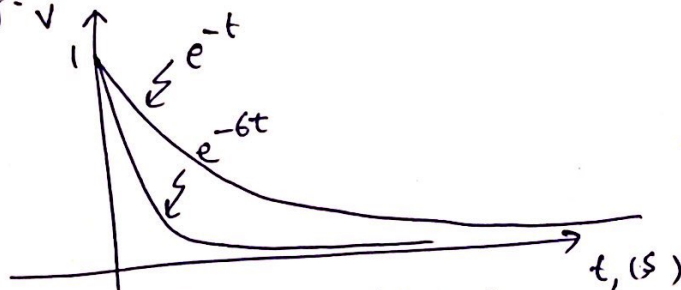
(11/331 8th Ed H2D)

Let us now see what additional information is available from the response:-

Recall:- $v(t) = 84(e^{-t} - e^{-6t})$, V

- The first term has a time constant of 1 s
- And the second term has a time constant of $\frac{1}{6}$ s.

Graphically:-



- The response of the term with $\frac{1}{6}$ s time constant is to decay more rapidly.
- It is obvious that $v(t)$ is never negative.
- Each term becomes zero as the time becomes infinite.
- $v(t)$ has a maximum when $\frac{dv(t)}{dt} = 0$ at t_m .

$$\text{So } \frac{dv}{dt} = 84(-e^{-t_m} + 6e^{-6t_m}) = 0$$

$$\text{Hence } -e^{-t_m} + 6e^{-6t_m} = 0 \quad (\text{dividing by } e^{-6t_m})$$

$$\frac{e^{-t_m}}{e^{-6t_m}} = 6$$

contd

— contd (332)

$$e^{5t_m} = 6 \quad \text{or} \quad 5t_m = \ln 6 \quad \text{so} \quad 5t_m = 1.792$$

$$t_m = 0.358 \text{ s}$$

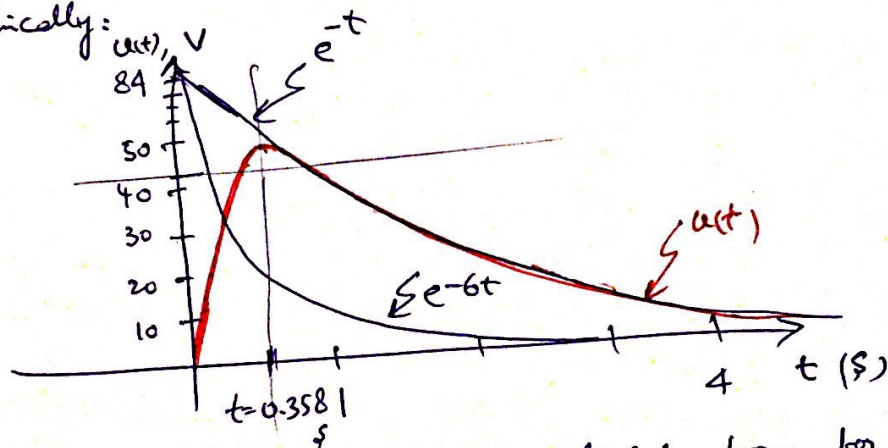
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At $t_m = 0.358 \text{ s}$

$$u(0.358 \text{ s}) = 84 \left(e^{-0.358} - e^{-6 \times 0.358} \right) = 84 (0.699 - 0.117) \\ = 58.72 - 9.83$$

$$u(t) = 49 \text{ Volts}$$

Graphically:



— The graph shows that the functional form for very large t is $84e^{-t}$, the exponential term containing the smaller magnitude of s_1 and s_2 .

— t_s , settling time is defined as the time taken to reach 1% of its maximum ^{absolute} value.

— Since $V_m = 49 \text{ V}$, putting $84(e^{-t_s} - e^{-6t_s}) = 49$
and $t_s = 5.15 \text{ s}$ for $V_m = 0.49 \text{ V}$

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