E151 Lecture 2 – Thevenin and 2 Port Hacks

Matthew Spencer
Harvey Mudd College
ENGR151

Disclaimer

These are notes for Prof. Spencer to give the lecture, they were not intended as a reference for students. Students asked for them anyway, so I’m putting them up as a courtesy. Remember that they are not intended as a substitute for lecture.
Thevenin

- Connect circuits to the world at ports, model w/ 1 line b/c linear
- Note that Norton is literally slope intercept form of line

Example Find Thevenin Impedance 2 Ways

- Options: \( \text{voc/isc} \) (slope), simplify network (test source / derivative)
- Then I show 3rd way: test sources (derivative of circuit)

MUST SHUT OFF SOURCES for \( \text{di/dv} \). (Small wiggles go to die)
Odds and Ends

• Non-resistive impedances?
  • Just fine, have a $Z_{th}$ (general case) rather than $R_{th}$ (like homework)

![Diagram showing voltage and current relationships](image)

• What if no sources? In quadrants 1&4, dissipative, called “passive”

Dynamics Review – Initial and Final Values

• What do we want to know dynamics responses to?
  • Sines $\rightarrow$ transfer functions work great
  • Steps $\rightarrow$ ... time domain, need some trick
  • Ramps $\rightarrow$ integrated steps, next
  • Exponentials $\rightarrow$ basically ramps, next

• We can get time domain responses from xfer fn with IVT/FVT

\[
\lim_{t \to 0} f(t) = \lim_{s \to \infty} s F(s) \quad \text{IVT} \quad \lim_{t \to \infty} f(t) = \lim_{s \to 0} s F(s) \quad \text{FVT}
\]

Don’t forget that LT $F(s)$ implicitly involves initial condition, so the IC is added to IVT/FVT value
Exercise: sketch $v_o$ step for these circuits

• Break room into groups and each group does 1, I do 1$^{st}$ & 2$^{nd}$?

• Main points: IVT/FVT practice, tau is same in $t$ and $f$, AC vs. DC ckt. To find $V_i$ and $V_f$, Thevenize from cap to find tau (if only 1 cap)

• Original solutions on next few pages, often drop some details

Exercise answers
Exercise Answers

3) \( V_{ac} = 0V \)
\( V_{dc} = V \)
\( V_c = V - 4\sqrt{C} \)

- Value on the side of cap already has an "average" value
- AC coupled signals are transient
- Interesting behavior finishing Lo than 2.66

4) \( V_{dc} = \frac{R_1}{R_1 + R_2} \)
\( V_{ac} = \frac{R_1}{R_1 + R_2} \)
\( V_c = \frac{R_1}{R_1 + R_2} e^{-\frac{t}{C}} \)

- Capacitive feedback
- AC part is transient
- Parallel forward paths mean all sums zero
- Change from point A to point B
- Change in gain = change in gains
- Linked still 1st order

5) \( V_0 = \frac{V_{dc}}{V_{dc} + V_{ac}} \)