

E151 Lecture 3 – Introduction to Diodes

Matthew Spencer
Harvey Mudd College
ENGR151

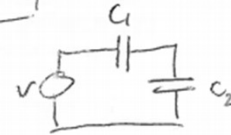
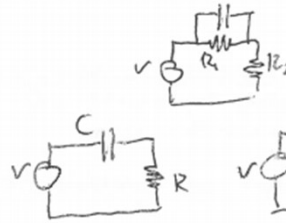
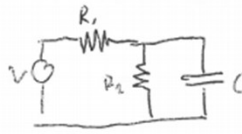
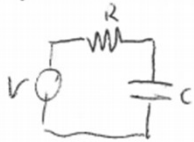
Disclaimer

These are note 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.

Exercise: sketch v_o step for these circuits

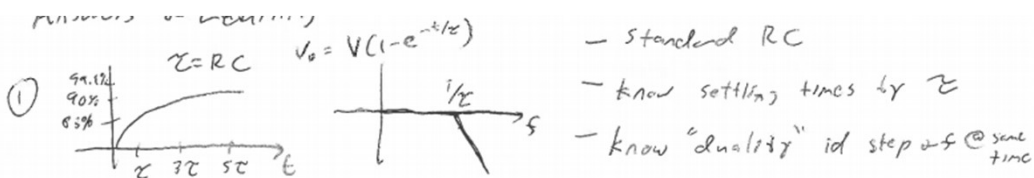
- Break room into groups and each group does 1, I do 1st & 2nd ?

Dynamics Review



- 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



② $V_{DC} = \frac{R_2}{R_1 + R_2} V$

$V_{AC} = 0V$

$\tau = C \cdot R_{Th} = C \cdot \frac{R_1 R_2}{R_1 + R_2}$

$\hookrightarrow v_o = \frac{R_2}{R_1 + R_2} V (1 - e^{-t/\tau})$

or $v_o = \frac{R_2 \parallel 1/s}{R_1 + R_2 \parallel 1/s}$

$= \frac{R_2 / Cs}{R_1(R_2 \parallel 1/Cs) + R_2 / Cs}$

$= \frac{R_2}{R_1 R_2 Cs + R_1 + R_2}$

$= \frac{R_2}{R_1 + R_2} \cdot \frac{1}{R_{Th} Cs + 1}$

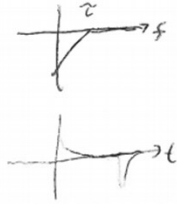
— can thevenize storage elements to find τ
— can fall back on impedance if stuck

Non-interacting!

— separate DC & AC behavior!

Exercise Answers

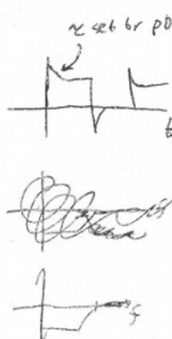
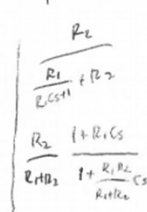
③ $V_{DC} = 0V$
 $V_{AC} = V$
 $\tau = RC$
 $V_o = V e^{-t/RC}$



- Value on far side of cap already has an "average" value
 - AC coupled signals are transient
 ↳ interesting behavior turning bursts on & off

⑤ $V_o = \frac{\sqrt{\omega C_2}}{\sqrt{\omega C_1} + \sqrt{\omega C_2}} = \frac{C_1}{C_1 + C_2}$

④ $V_{DC} = \frac{R_2}{R_1 + R_2} V$
 $V_{AC} = V$
 $\tau = R_1 R_2 C$
 $V_o = V \left(\frac{R_1}{R_1 + R_2} + \frac{R_2}{R_1 + R_2} e^{-t/\tau} \right)$



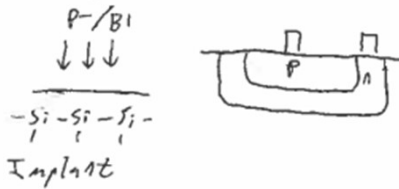
τ set by pole, not zero
 - capacitive feedthrough
 - ac part is transient
 - parallel forward paths means oblique zero
 ↳ change from gain A to gain B
 - change in gain & change in f
 linked & still 1st order

capacitive divider
 - output is DC floating but will stay up coupling or if load (scope probe)
 - frequency independent!

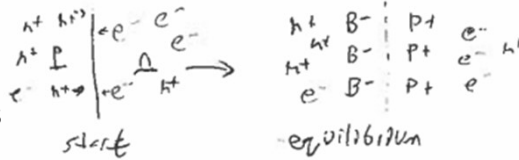
Diodes – 1st Nonlinear Element

- What are diodes
 - PN Junctions
 - One way current valves
 - Exponential I-V devices

- Construction

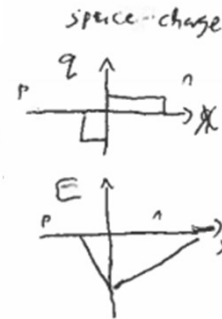


- Why not a resistor?



• Recombination leaves fixed q

- Also,
- Field points right to left
 - minority drift cancels majority diffusion
 - Net charge imbalance makes P+



• full field raises, rev. lowers q balance
 $E_{crit} \dots$ breakdown