Review: Quiz 5

Session 5e for Electronics and Telecommunications
A Fairfield University E-Course
Powered by LearnLinc

Module: Semiconductor Electronics
(in two parts)

- Text: “Electronics,” Harry Kybett, Wiley, 1986, ISBN 0-471-00916-4
- References:
  - Electronics Tutorial (Thanks to Alex Pounds)
  - Electronics Tutorial (Thanks to Mark Sokos)
- Semiconductors, Diodes and Bipolar Transistors
  - 5 on-line sessions plus one lab
- FETs, SCRs, Other Devices and Amplifiers
  - 5 on-line sessions plus one lab
- Mastery Test part 3 follows this Module

Section 5: Semiconductors, Diodes and Bipolar Transistors

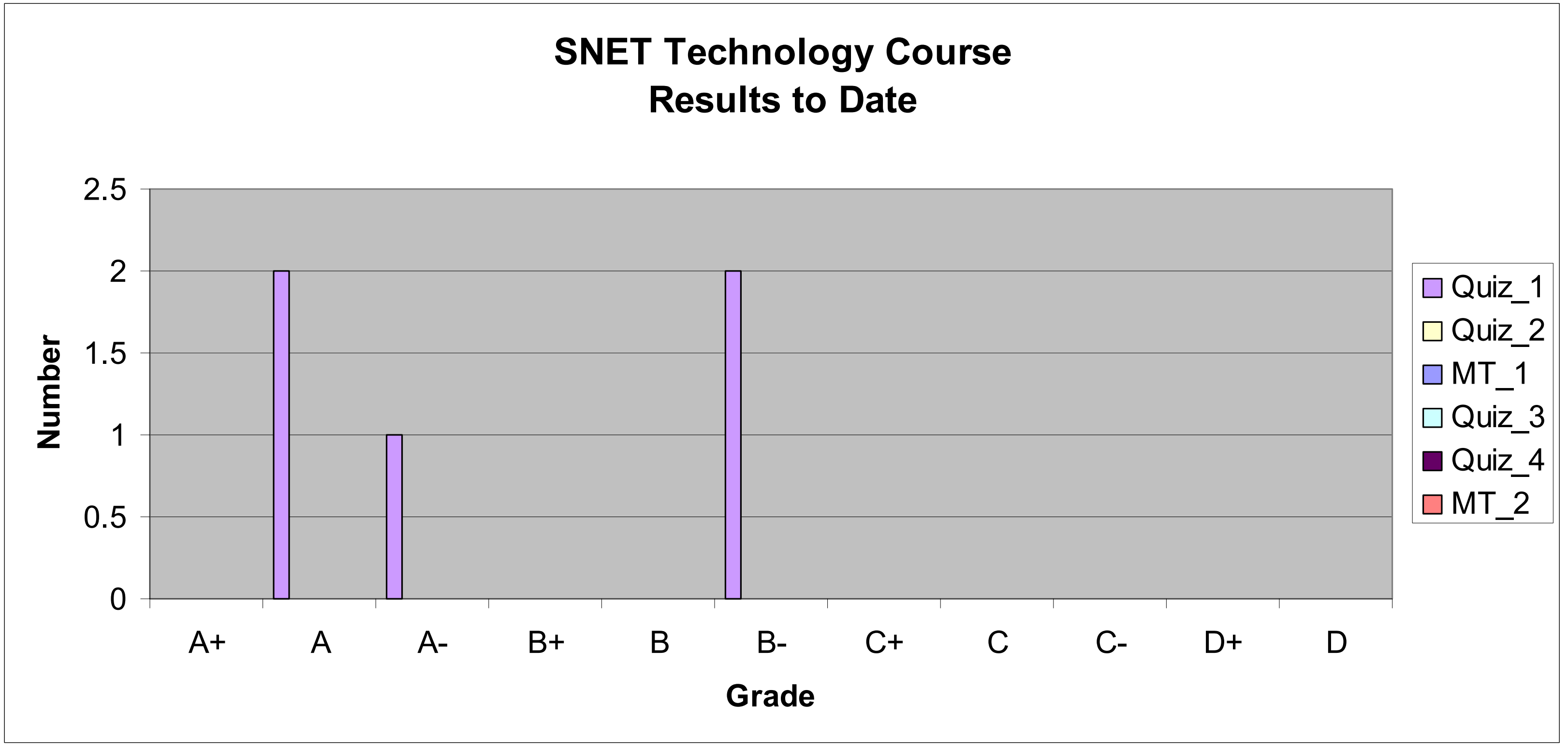
- 0BJECTIVES: This section reviews semiconductors, doping and junctions. The characteristics and application of Diodes and Bipolar Transistors are then studied.

Section 5 Schedule:

Session 5a	– 09/18	Semiconductors and Doping	Elect 1-7 1.23 – 1.39
MT2 Results	– 09/23	We'll discuss MT2	
Session 5b	– 09/25	Diodes	Kybett Chapter 2
Session 5c	– 09/30	Diode Applications	Kybett Chapter 11
Session 5d (lab - 10/05, Sat.)	– 10/02	Bipolar Transistors	Kybett pp 51 - 70
Session 5e (Quiz 4 due 10/12)	– 10/07	Transistor Amplifiers	Kybett pp 173 - 201
Session 5f (Oct 14 is a holiday)	**– 10/16**	**Review (Discuss Quiz 4)**	
Break to introduce Learnlinc version 6.1		About 2 weeks to set up the computers and retrain us	

Quiz_5 Results

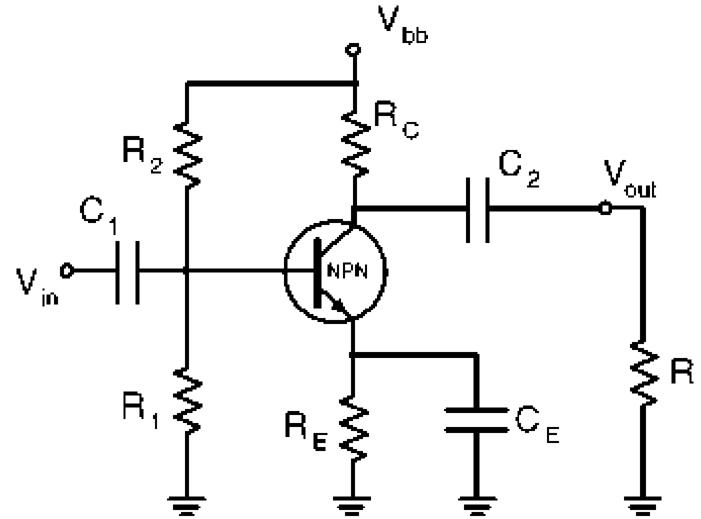
- Those that turned in their Quiz 5 so far– Nice Job.



Quiz 5

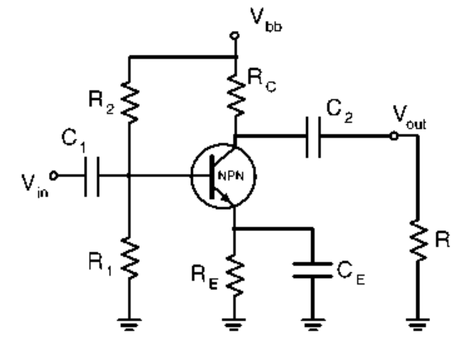
- We’ll use Appshare and Word to go over the T/F and Multiple Choice parts of Quiz_5
- The circuit will take a little longer.
  My error made it a difficult problem

Common Emitter Amplifier



- High input impedance
  - $R_1 \parallel R_2 \parallel (R_{in}+\beta*R_E)$ … $R_{in} = h_{ie} \sim 1\ k\Omega$
- High voltage gain
  - $\beta*R_C/(R_{in}+\beta*R_E)$ (general case)
  - $\sim R_C / R_E$ (no bypass capacitor)
  - $\sim \beta* R_C / R_{in}$ (fully bypassed)
- All this is true ONLY if the transistor is biased properly
  - $V_{be} \sim 0.7$ volts $\quad V_{ce} \sim V_{bb}/2$
- In our Quiz: C_1 , C_2 and C_E have large values
  - $V_{bb} = 10$ volts $\quad R_1 = 2\ k\Omega \quad R_2 = 8\ k\Omega$
  - $R_E = 100\ \Omega \quad R_C = 1\ k\Omega \quad \beta = 200$

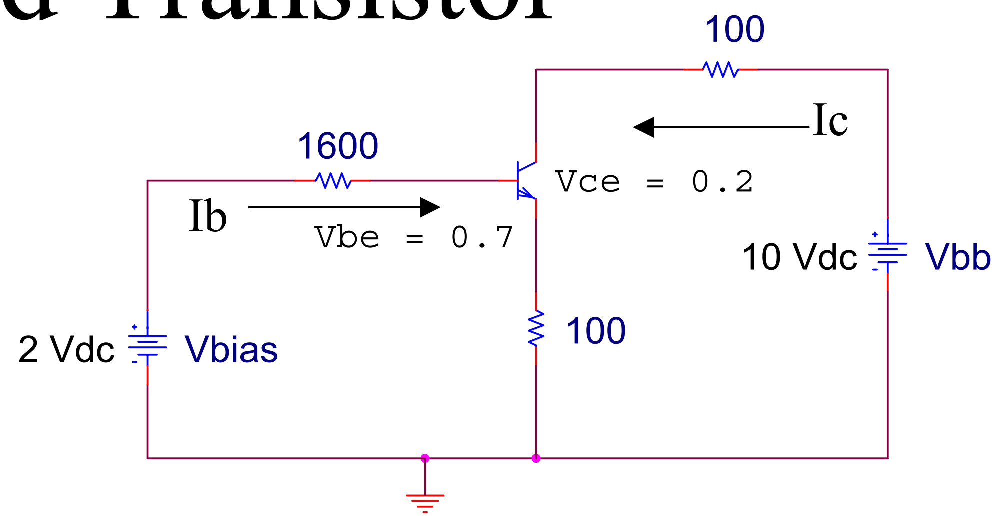
Biasing



- To find V_b:
  We have a voltage divider formed by R_1 (2k) and R_2 (8k)
  - If there is no base current: Vb = 10v*2k/(2k+8k) = 2 volts
  - The Thevenin resistance of this bias voltage is $R_1 \| R_2$ or
    1/R = 1/2 + 1/8 = 5/8 = 1/1.6 so R_{th} = 1.6 kohms
    this can be used to determine the voltage drop if I_b is not zero
- Assuming Ib is small:
  - $V_e = V_b - 0.7 = 1.3$ volts
- I_e = 1.3 volts / 100 ohms = 13 mA
- $V_c = V_{bb} - I_c{*}R_c = 10 - 0.013{*}1000 = -3$ volts … oops
- The transistor is "Saturated"
  $V_{ce} \sim 0.2$ volts - We have to start over and it's not easy
  note: This is good stuff, but NOT required for the MTs

Saturated Transistor

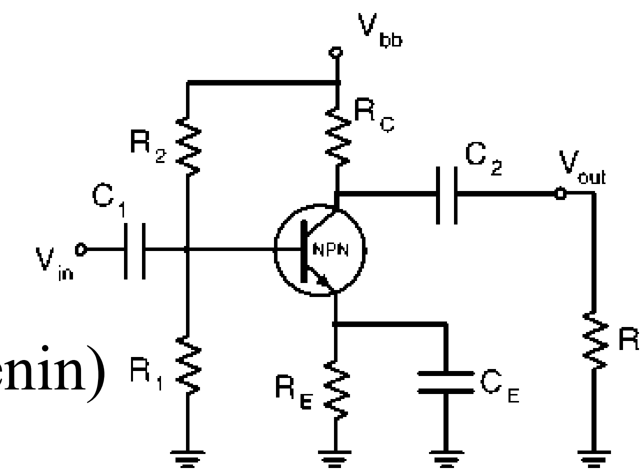
- There are two loops!
- Use Kirchoff twice



- In the Base loop
  $2v = 1600 * I_b + 0.7 + 100 * (I_b + I_c)$ or
  $1.3v = 1700 * I_b + 100 * I_c$
- In the Collector loop
  $10v = 1000 * I_c + 0.2 + 100 * (I_b + I_c)$ or
  $9.8v = 100 * I_b + 1100 * I_c$

Two Equations in Two Unknowns

- Our Equations:
  $1.3v = 1700 * I_b + 100 * I_c$
  $9.8v = 100 * I_b + 1100 * I_c$
- Several ways to find a solution
  - Solve one for Ib and substitute into the other to get Ic
  - I used a tool called MatLab
- $I_c = 8.89$ mA and $I_b = 0.24$ mA
- Vc = 10 – 8.89 = 1.1 v
- Ve = 0.091*100 = 0.9 v and
- Vb = 2 – 0.00024*1600 (using Thevenin)
  = 2 – 0.384 = 1.62v
- $\beta = I_c / I_b = 8.89 / 0.24 = 37$ It has dropped in saturation



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