ECE 113B Midterm #2

February 22, 2002
(Professor Kleinfelder)

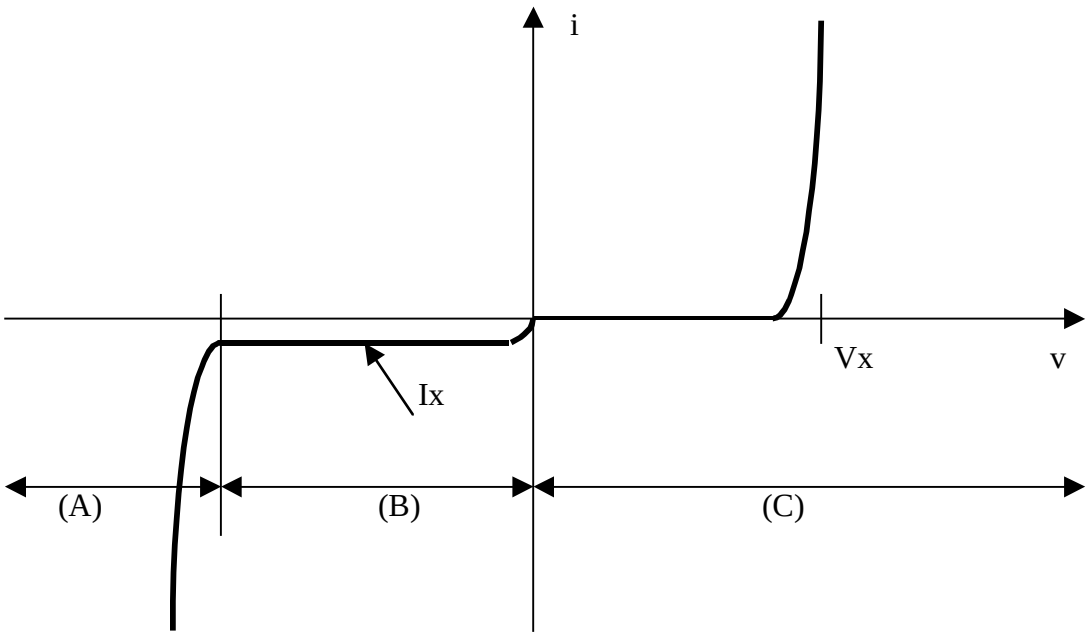
CLOSED BOOK AND NOTES

To receive credit, please show all work and place your answers where requested.

NAME:_____ID:_____

Signature:_____Seat/Row:_____

Problem 1 (15 points): The following curve shows the i-v characteristics of a typical silicon junction diode. The scale is not uniform. Name the regions (A), (B), (C) below.



(Region A, 2pts) _____

(Region B, 2pts) _____

(Region C, 2pts) _____

Assume Ix (not its normal symbol) is approximately constant. What is its symbol and what is this current called?

(2pts) _____

What is the value of voltage Vx (not it's normal symbol) commonly assumed to be in quick calculations under typical conditions (e.g., room temperature, i_C=1ma)?

(2pts) _____

Write the equation for the i-v relationship in region (C):

(2pts) _____

Write the equation for V_T:

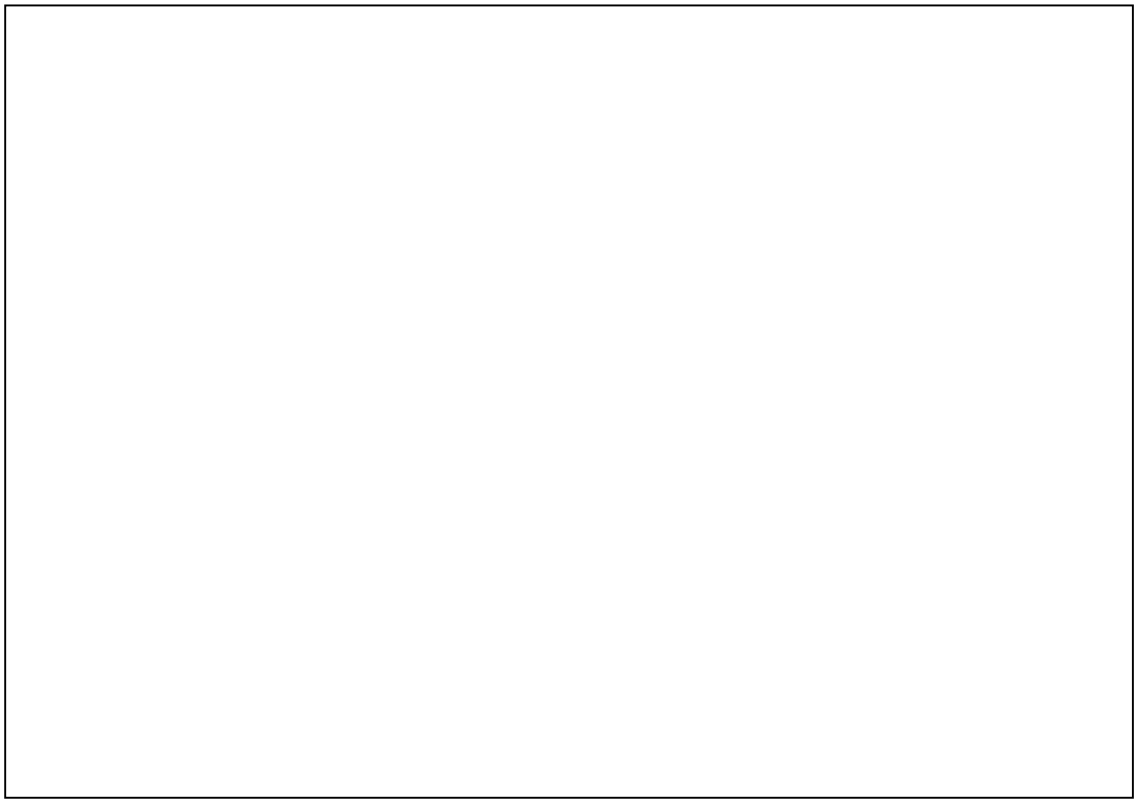
(2pts) _____

What is V_T's approximate value at room temperature?

(1pts) _____

Problem 2 (10 pts).

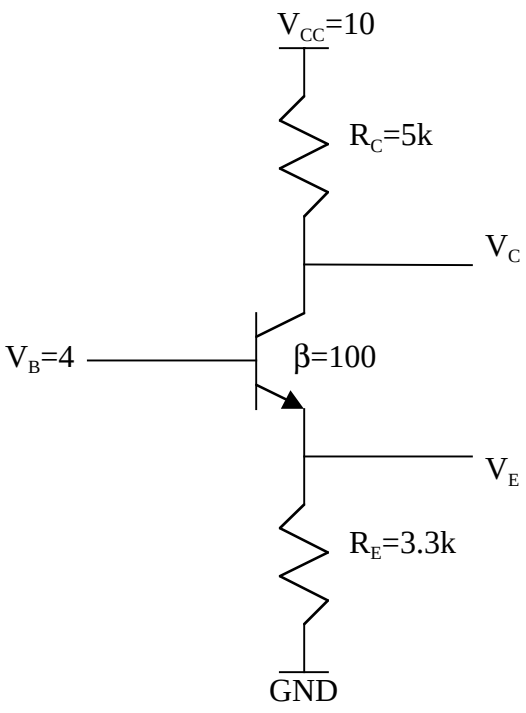
(A) Draw and label (with doping type and junctions) a simple cross-section of an NPN transistor as it would be made in a planar silicon process (4 pts).



(B) In a NPN transistor, there are two junctions, the emitter-base junction (EBJ), and the collector base junction (CBJ). Label the modes of operation of the NPN transistor as a function of the EBJ and CBJ bias conditions (2 pts each):

EBJ	CBJ	Mode (put your answers below)
Reverse (2pts)	Reverse	_____
Forward (2pts)	Reverse	_____
Forward (2pts)	Forward	_____

Problem 3 (24 pts): Assume that the transistor in the following circuit is in the active mode and that β=100. Slight approximations in math (to ~3 significant digits) are o.k.



Showing your work, find alpha:

(4 pts) _____

Showing your work, find an approximate value for V_E:

(4 pts) _____

Showing your work, find the emitter current I_E:

(4 pts) _____

Showing your work, find the voltage I_C:

(4 pts) _____

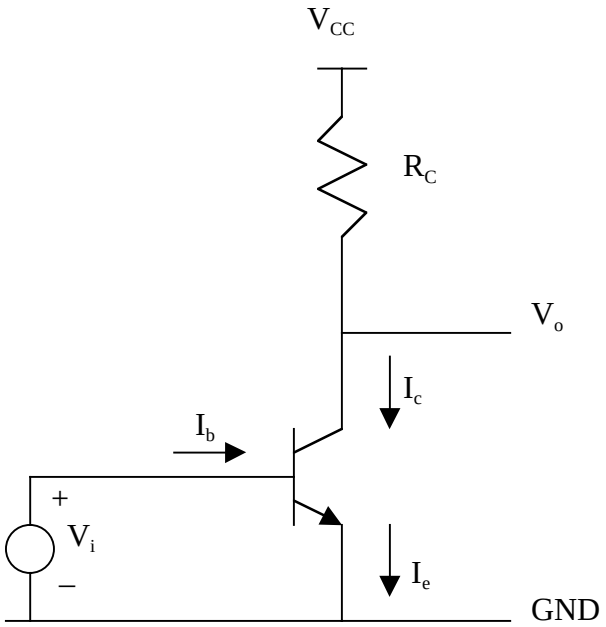
Showing your work, find the voltage V_C:

(4 pts) _____

Showing your work, find the current I_B:

(4 pts) _____

Problem 3 (46 pts): The following is a resistively-loaded common-emitter amplifier with highly simplified biasing. Assume the transistor is in the forward-active region. Do not discount r_o.



(6 pts) Draw and completely annotate a **large** signal equivalent circuit model for this amplifier. Do not draw the small signal model here!

Showing your work, what is the base current I_b in terms of V_i and beta?

(4 pts) _____

Showing your work, write an equation for the output voltage V_o in terms of V_i:

(4 pts) _____

(6 pts) Draw and completely annotate a small-signal equivalent model for this amplifier:

What is the input resistance of this amplifier?

(2 pts) _____

What general procedure is used to measure output resistance?

(2 pts) _____

What is the output resistance of this amplifier?

(2 pts) _____

Showing your work, what is the voltage gain of this amplifier?

(5 pts) _____

If the amplifier output is connected to a second identical amplifier input, what does the (first) amplifiers voltage gain become?

(5 pts) _____

Showing your work, what is the maximum voltage gain of this amplifier?

(5 pts) _____

Showing your work, if the output is shorted to ground, what is the current gain of the amplifier?

(5 pts) _____

What is “emitter degeneration” in the context of this kind of amplifier?

(1 pts) _____

Name an advantage of emitter degeneration:

(1 pts) _____

Name a second advantage of emitter degeneration

(1 pts) _____

Name a third advantage of emitter degeneration

(1 pts) _____

Name one disadvantage of emitter degeneration.

(1 pts) _____

*** Extra Credit Problem ***
(10 extra points)

Using a simple biasing scheme, draw a circuit diagram for an emitter follower (common-collector) amplifier, its small signal model, and find its voltage gain. (Partial credit will be awarded).

Answer: _____