Simon Fraser University

Mechatronic Systems Engineering

Midterm Exam for ENSC 226: Electronic Circuits

Instructor: Behraad Bahreyni

1 March 2011

Time: 110 minutes

Name: ________________________

Student number: ________________

Question	Mark
1	/ 30
2	/ 20
3	/ 20
4	/ 30
Total	/100

$V_{D,on} = 0.7V$ $|V_{BE,on}| = 0.7V$ $|V_{CE,sat}| = 0.2V$

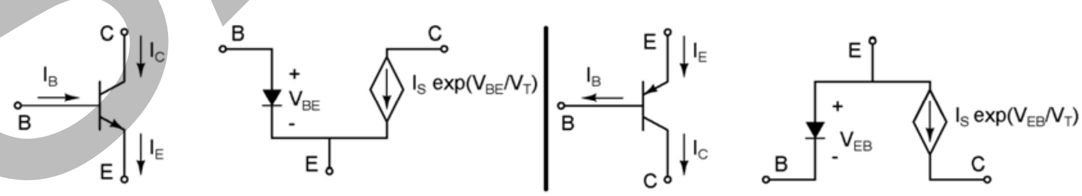
$\alpha = \dfrac{\beta}{\beta + 1}$ $r_d = \dfrac{V_T}{I_D}$ $V_T = 25mV$

$g_m = \dfrac{1}{r_m} = \dfrac{I_C}{V_T}$ $r_\pi = \beta\, r_m = \dfrac{\beta}{g_m}$ $r_o = \dfrac{V_A}{I_C}$

Physical model of a diode: $I_D = I_s\left(e^{\frac{V_{BE}}{V_T}} - 1\right)$

Ripple voltage in half wave rectifiers: $V_r = \frac{V_P - V_{D,on}}{f\,R_L C_L}$

	Active	**Saturation**	**Cut-off**
	BE forward biased BC reverse biased	BE forward biased BC forward biased	BE reverse biased BC reverse biased
npn	$V_{BE} \approx 0.7V$ $V_{BC} < 0$ $I_C = \beta\, I_B = \alpha\, I_E$ $I_C = I_S\, e^{\frac{V_{BE}}{V_T}}\left(1 + \frac{V_{CE}}{V_A}\right)$	$V_{BE} \approx 0.7V$ $V_{BC} \approx 0.5V$ $I_B > \frac{I_C}{\beta}$ $V_{CE} \approx 0.2V$	$V_{BE} < 0.7$ $V_{BC} < 0.7$ $I_B \approx I_C \approx I_E \approx 0$
pnp	$V_{EB} \approx 0.7V$ $V_{CB} < 0$ $I_C = \beta\, I_B = \alpha\, I_E$ $I_C = I_S\, e^{\frac{V_{EB}}{V_T}}\left(1 + \frac{V_{EC}}{V_A}\right)$	$V_{EB} \approx 0.7V$ $V_{CB} \approx 0.5V$ $I_B > \frac{I_C}{\beta}$ $V_{EC} \approx 0.2V$	$V_{EB} < 0.7$ $V_{CB} < 0.7$ $I_B \approx I_C \approx I_E \approx 0$



Question 1. [30 marks]

Circle the correct answer for each of the following problems.

1.a. [5 marks] During lab 1, you learned that the basic equation for the physical model of diodes needed to be modified. What was the additional parameter that was introduced? How was the equation for the current/voltage relationship of the diode modified?

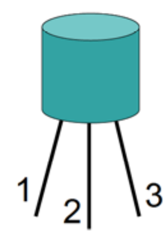
Additional parameter: ________

I_D = ____________________

1.b. [5 marks] Assume that you are given a working BJT whose model number has been erased from its package. We want to use a multimeter similar to the one you used in the lab to determine the type (npn or pnp) and pins (base, collector, and emitter) of the transistor. Using the diode more on the multimeter, the following data is obtained:

Between pins 1&2: *0.5V*	Between pins 2&1: *OPEN*
Between pins 1&3: *0.7V*	Between pins 3&1: *OPEN*
Between pins 2&3: *OPEN*	Between pins 3&2: *OPEN*

Where, for example, the measurement between pins 1&2 is taken by connecting the positive lead of the multimeter to pin 1 and its negative lead to pin 2. What are the transistor type and pin arrangement of this transistor?



(a) npn; pin 1: Base, pin 2: Emitter, pin3: Collector

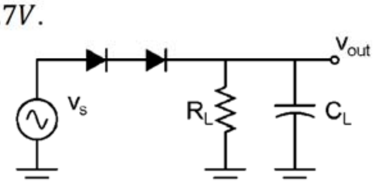
(b) npn; pin 1: Base, pin 2: Collector, pin3: Emitter

(c) pnp; pin 1: Base, pin 2: Emitter, pin3: Collector

(d) pnp; pin 1: Base, pin 2: Collector, pin3: Emitter

(e) None of the above

1.c. [5 marks] What is the output ripple voltage of the circuit shown below? Assume $R_L = 1k\Omega$, $C_L = 100\mu F$, $v_{in} = 5\sin 2\pi\, 100t$ and $V_{D,on} = 0.7V$.

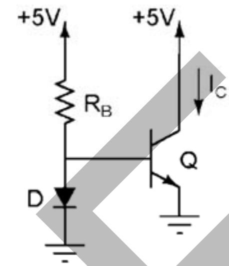


(a) 0.5V (b) 0.3V

(c) 0.36V (d) 0.43V

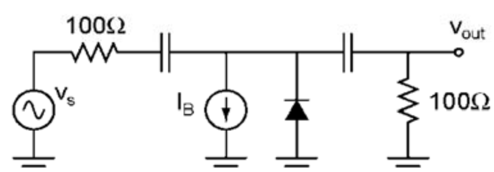
(e) None of the above

1.d. [10 marks] Assume $I_{SD} = 1fA$, $I_{SQ} = 10fA$, $\beta = \infty$, and $V_A = \infty$. What is the collector current, I_C, if $R_B = 1k\Omega$?



I_C = _______________ mA

1.e. [5 marks] Assume $I_B = 0.1mA$ and that the capacitors are short circuits for small signal operation. What is the small signal output voltage, v_{out}?



$v_{out} = v_s \times$ _____________

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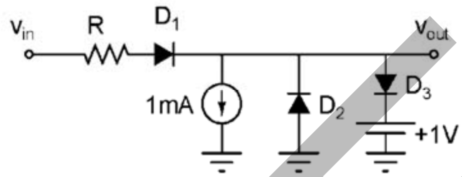
Question 2. [20 marks]

Using the constant voltage drop model for the diodes, draw the input output characteristic curve for $-5V < v_{in} < +5V$ for the circuit shown. Label all important information on your graph.

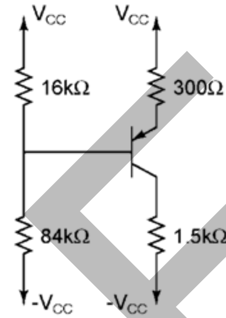


R=1kOhm

Question 3. [20 marks]

What are I_C and V_{EC}? Assume $V_{CC} = +6V$, $\beta = 100$, and $V_A = \infty$. Justify any assumption you make.

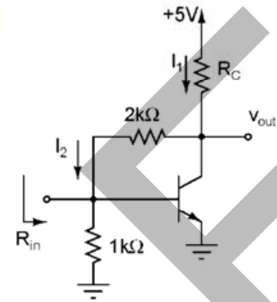
I_C = ____________ mA V_{EC} = ____________ V



You may use this space to answer any of the questions with proper reference to the question.

Question 4. [30 marks]

The transistor shown in the circuit to the right is operating in its active region. Assume $R_C = 1k\Omega$, $\beta = 100$, and $V_A = \infty$.



4.a. Ignoring I_B, what is the collector voltage of the transistor?

$V_C = v_{out} =$ ______________ V

4.b. What is the collector current of the transistor?

$I_C =$ ______________ mA

4.c. Calculate the small signal parameters g_m and r_π.

$g_m =$ ____________ mS $r_\pi =$ ______________ Ω

4.d. Draw the small signal equivalent of the circuit.

4.e. What is the input resistance of the circuit (R_{in} on the graph)?

R_{in} = ______________ Ω

<u>You may use this space to answer any of the questions with proper reference to the question.</u>