

Name: _____

Massachusetts Institute of Technology
Department of Nuclear Science and Engineering
Department of Electrical Engineering and Computer Science

22.071/6.071 – Introduction to Electronics, Signals and Measurement
Spring 2006

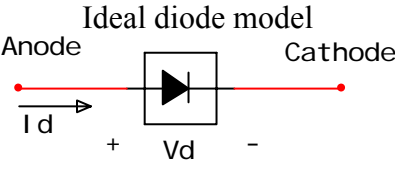
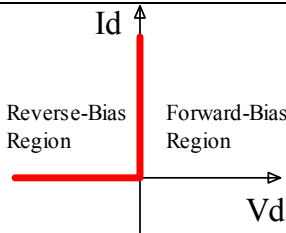
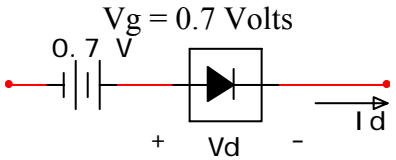
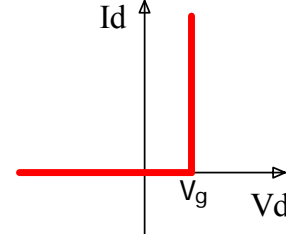
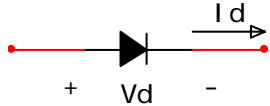
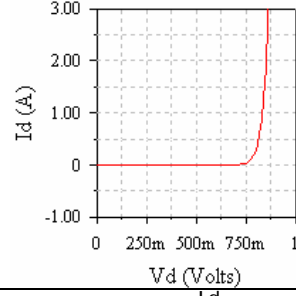
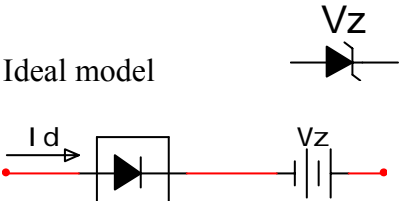
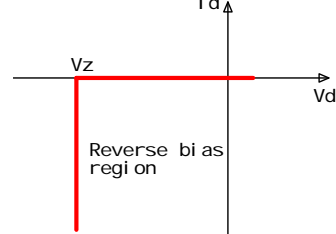
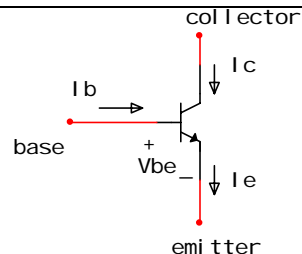
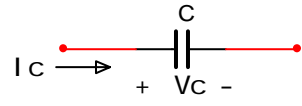
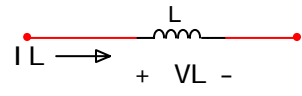
Quiz 3

- Please write your name on each page of the exam in the space provided
- Please verify that there are 12 pages in your exam.
- To the extent possible, do your work for each question within the boundaries of the question or on the back side of the page preceding the question. Extra pages are also provided for computation.
- Note that the total number of points is 100.
- Closed book. No Calculators
- Partial credit adds up so make sure that you show your work.

Name: _____

General Useful Information

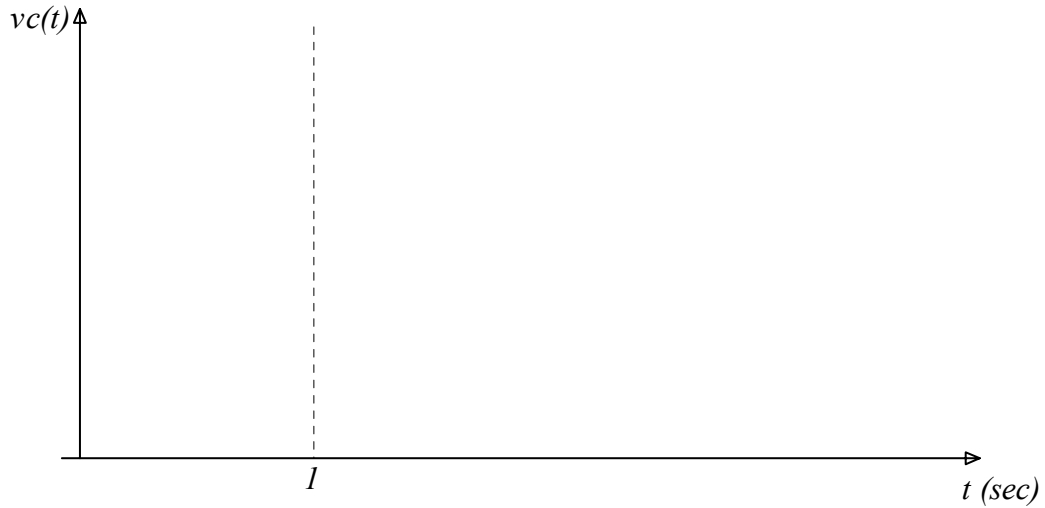
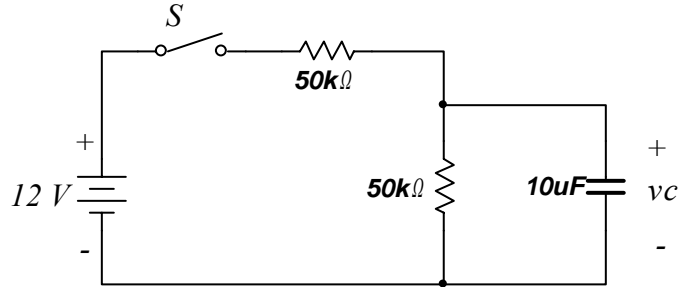
Diodes:

<p style="text-align: center;">Ideal diode model</p> 	
<p style="text-align: center;">0.7 Volt offset model</p> 	
<p style="text-align: center;">Full diode model $I_d = I_s \left[\exp\left(\frac{V_d}{V_T}\right) - 1 \right]$</p> 	
<p style="text-align: center;">Zener Diode</p> <p style="text-align: center;">Ideal model</p> 	
<p style="text-align: center;">BJTs</p> <p style="text-align: center;">$I_e = I_c + I_b$</p> <p style="text-align: center;">For operation in the active region</p> <p style="text-align: center;">$I_c = \beta I_b$</p> <p style="text-align: center;">$V_{be} = 0.7 \text{ V}$</p>	
<p style="text-align: center;">Reactives</p> <p style="text-align: center;">Capacitor</p> <p style="text-align: center;">$I_c = C \frac{dV_c}{dt}$</p>	
<p style="text-align: center;">Inductor</p> <p style="text-align: center;">$V_L = L \frac{dI_L}{dt}$</p>	

Name: _____

Problem 1 - (15 points)

For the following circuit the switch S has been open for a long time. At time $t=0$ the switch is closed and it is opened again at time $t=1$ sec. Sketch $v_C(t)$ for all t . Indicate all relevant values in your sketch. (This is the homework problem. One of the element values has been changed for easier algebraic operations)

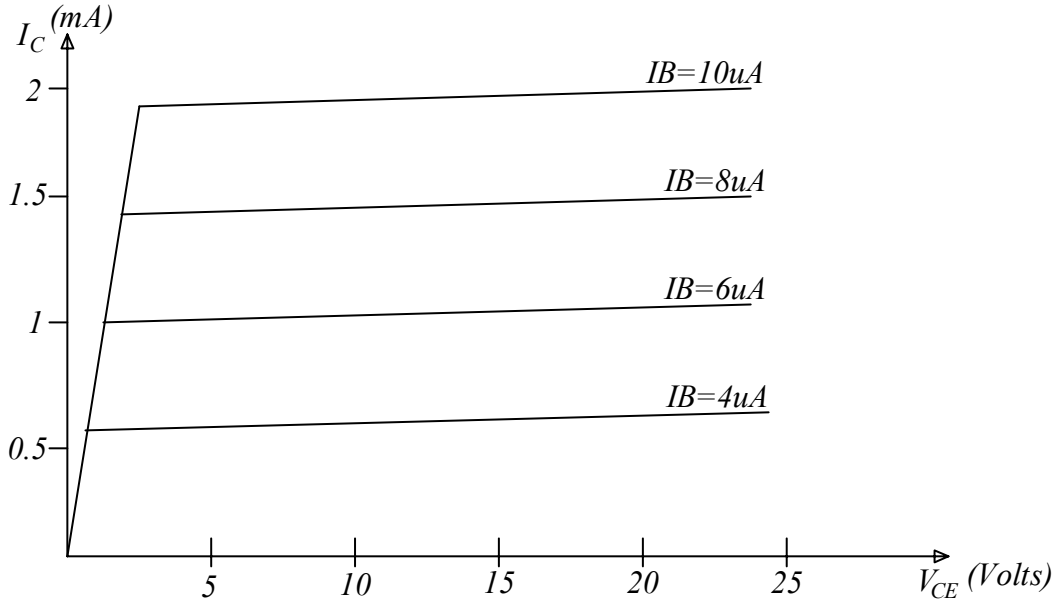
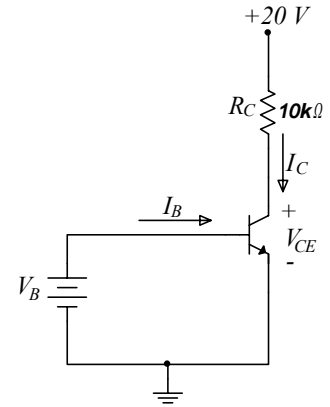


Name: _____

Problem 2 - (15 points)

The transistor used in this circuit has the characteristics shown on the graph below.

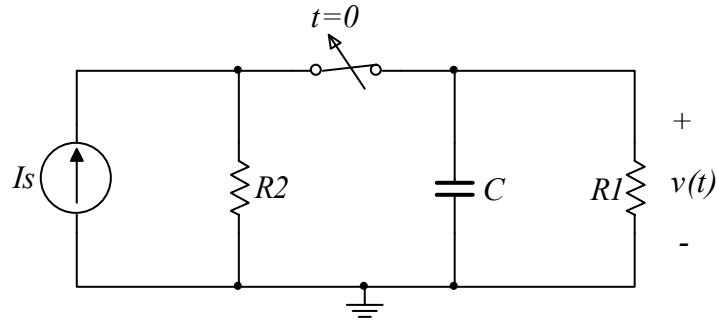
A) Calculate the load line, draw it on the graph and locate the Q-point for $I_B = 6\mu A$ ($6 \times 10^{-6} A$)



B) Estimate the value of the transistor β .

Name: _____

Problem 3 - (15 points)



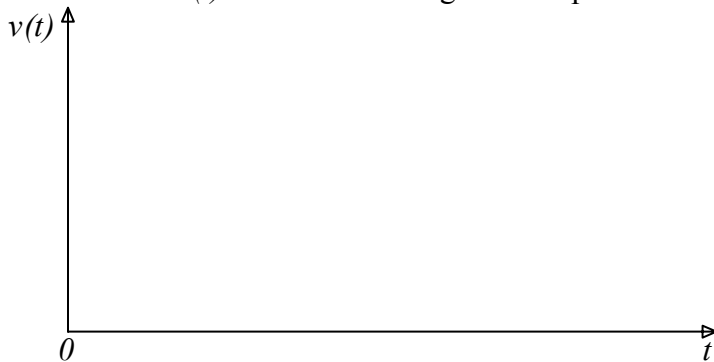
In this circuit, the switch is closed for a long time and opens at time $t=0$.

- A. What is the voltage v just before opening the switch $v(t=0^-)$?

- B. What is the voltage v just after opening the switch $v(t=0^+)$?

- C. What is the value of the time constant τ governing the evolution of v for $t > 0$?

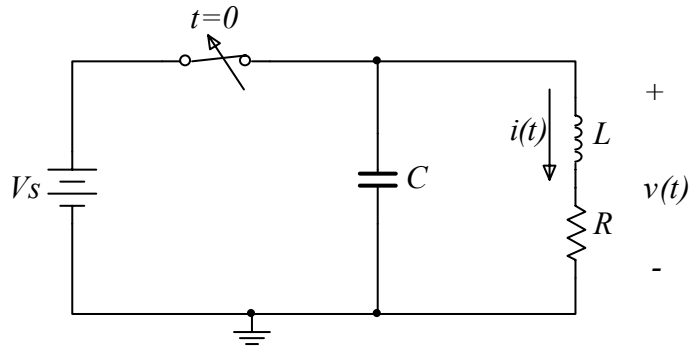
- D. Draw $v(t)$ versus time and give an expression for $v(t)$.



Name: _____

Problem 4 - (10 points)

For the following circuit, the switch is closed for a long time then opens at time $t=0$.

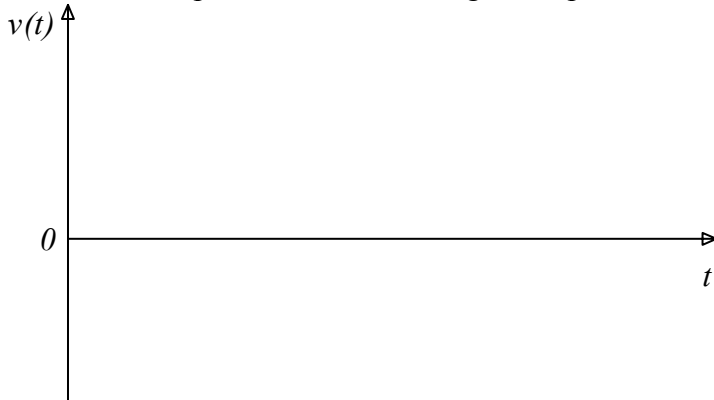


A. What is the voltage v and current i just before opening the switch $v(t=0^-)$, $i(t=0^-)$?

B. Obtain the differential equation for the subsequent ($t>0$) evolution of voltage $v(t)$.

C. Obtain two initial conditions to apply at $t=0^+$

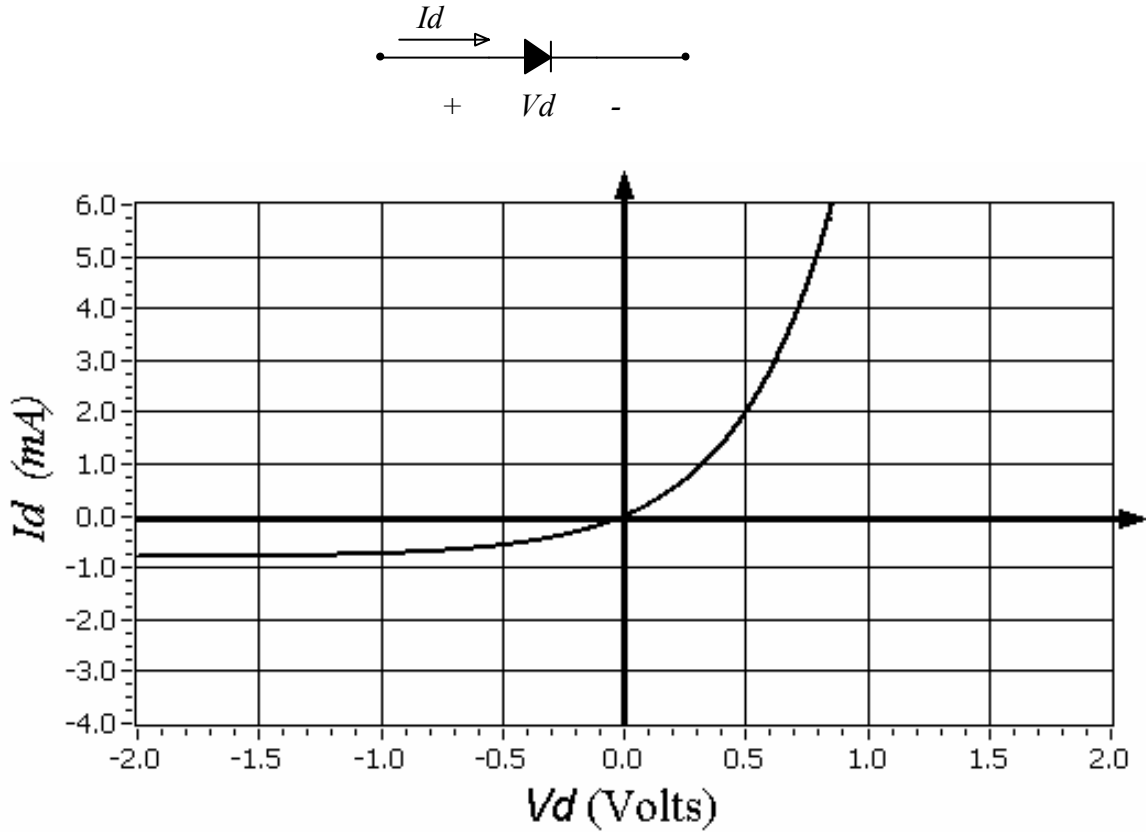
D. In the space below draw the general possible forms of the voltage $v(t)$



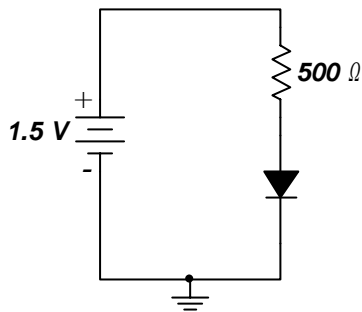
Name: _____

Problem 5 - (15 points)

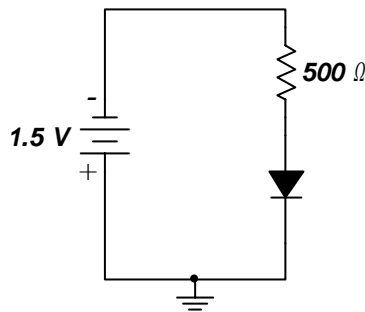
The graph below shows the i - v characteristic curve of a certain diode.



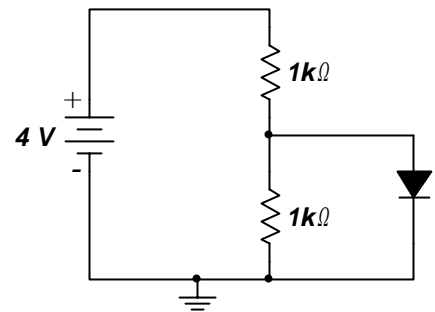
The diode is used in the following circuits. Draw on the above plot and label, the load-line you would use for each circuit in order to obtain the diode voltage and current.



(A)



(B)

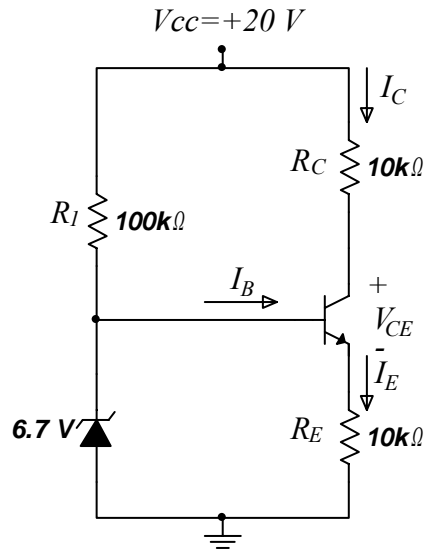


(C) 5 pt Extra credit

Problem 6 - (15 points)

Name: _____

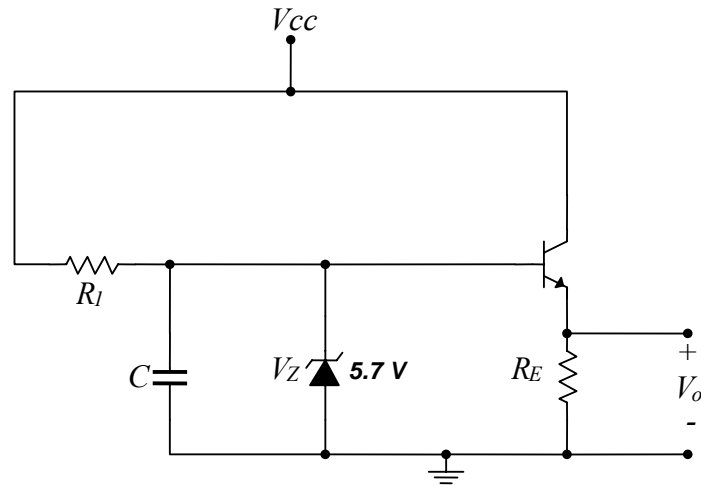
The **Zener** diode used in this circuit has a $V_z = 6.7$ Volts and it is used for biasing the npn transistor which has $\beta=100$.



Determine the Q-point (I_{CQ} and V_{CEQ}) of the transistor

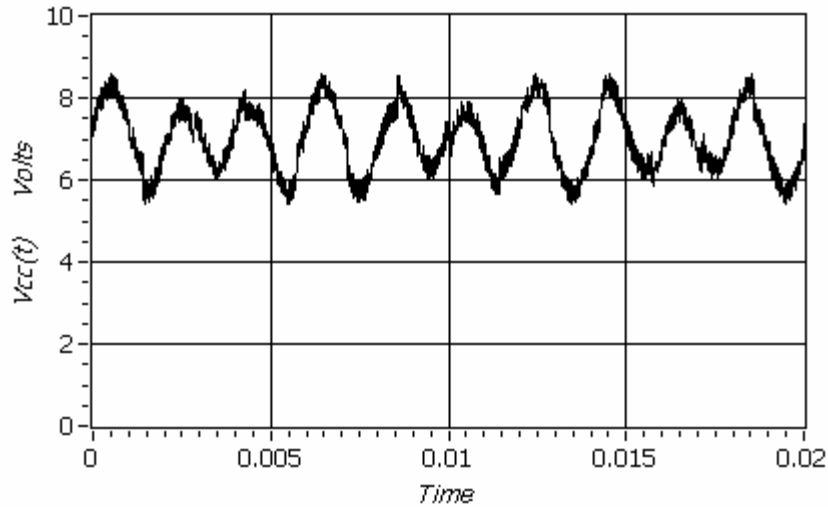
Name: _____

Problem 7 - (15 points)



Voltage V_{CC} applied to the above circuit has the form shown below. It has a DC offset of about 7 Volts with considerable fluctuations about that value. The **Zener** diode used in the circuit has $V_Z = 5.7$ Volts. The output is taken across the emitter resistor R_E as indicated in the schematic.

A. Draw the form of the output voltage V_o on the same graph.



B. What is the role of resistor R_I and capacitor C ?

Name: _____

Blank page: For computation

Name: _____

Blank page: For computation

Name: _____

Problem	Points
1	
2	
3	
4	
5	
6	
7	
Total	