Midterm Exam: Electronics 323
November 24, 2010

Formula sheet provided. In all questions give at least some explanation of what you are doing to receive full value. Total 36 points. Individual values follow each question.

1. Why is an intrinsic semiconductor different from a normal metallic conductor? How do you make a semiconductor "p-type" and "n-type"? Suppose that p and n type semiconductors are in contact with each other. Make a sketch of the total carrier concentration across the junction. What is the central region called? (8)

2. Draw the $I - V$ curve for a diode that is assumed to have infinite conductivity when it reaches a turn-on voltage of 0.7 V but zero conductivity otherwise. Assuming the input is a sine wave of amplitude 3 V draw the voltage across R_L for the circuit in Fig. 1 assuming the diode has a turn-on voltage of 0.7 V. What kind of a circuit is this? How could you make the voltage
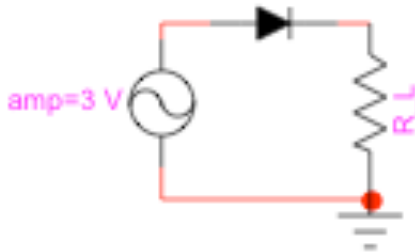

Figure 1: Circuit for Question 2

supplied to the load more constant with time? (8)

3. Consider the transistor amplifier circuit shown in Fig. 2. The h_{fe} of the transistor is 80. $h_{oe} = 100$ μS and $h_{ie} = 2$ kΩ at this Q-point. It is a germanium-based pnp transistor and you may assume that $-V_{BE} = 0.2$ V.

   (a) Stating your assumptions calculate the DC or quiescent current through the collector resistor and also calculate V_C. (4)

   (b) I assume one of the assumptions you used was that I_B was small compared to the current through the voltage divider. Verify this assumption. (2)

   (c) Construct the small signal h-parameter equivalent circuit neglecting h_{re}. All of the resistors should be included in your diagram. (4)

   (d) Calculate the small signal voltage gain with two key assumptions. (1) No current flows through the h_{oe}^{-1} resistor. (2) The current that flows through h_{ie} is much smaller than the current that flows through the emitter resistor. As a clue $v_{be} = v_i - v_e$ and you will need to eliminate v_{be} and v_e from your equations (the above equation plus two others) to leave only v_i and v_o. Answer should agree with equation 32 on the formula sheet. (3 points)

   (e) Use the formula above or from your formula sheet to give the small signal gain. Is this "loaded" or "unloaded"? (3)
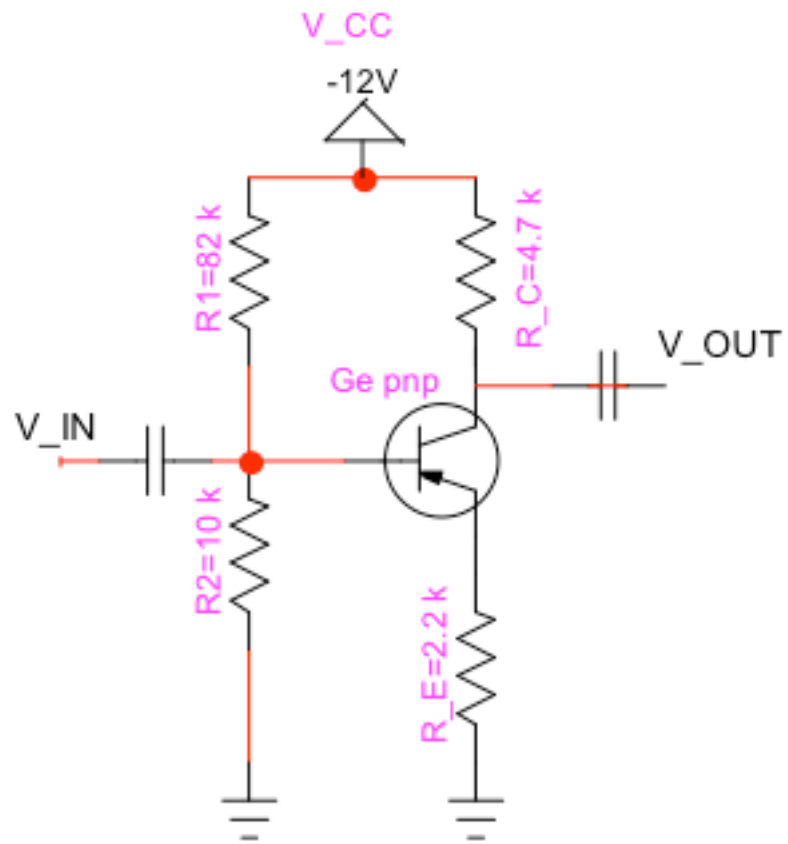
Figure 2: Circuit for Question 3

4. Very briefly, how does a BJT work i.e. explain transistor action or why there is such a quantity as h_{FE}. (4)