University of Michigan
EECS 311: Electronic Circuits
Fall 2008

PROBLEM SET 5

Issued 10/15/2008
Due in Lecture 10/22/2008

J&B refers to the course text: "Microelectronic Circuit Design (3rd Edition)," by Richard Jaeger and Travis Blalock.

P5.0 Fill out the anonymous, midterm evaluation online by following these steps below. This is completely anonymous (even though you've logged in through CTools), and very valuable to me for making changes to the class *while you're still taking it*.

a) Go to https://ctools.umich.edu/portal

b) Enter your username and password and click on "Login" button.

c) Click on "Teaching Questionnaires" in the left navigation menu under My Workspace.

d) Click on a link under "Current evaluations to take".

P5.1 For the circuit shown in Figure 1, derive expressions for I_C and I_E in terms of β_F, and find the value of V_{BE} given $I_B = 10\mu A$ and the reverse saturation current of the B-E junction diode is $I_S = 10^{-17}$. Ignore base-width modulation.

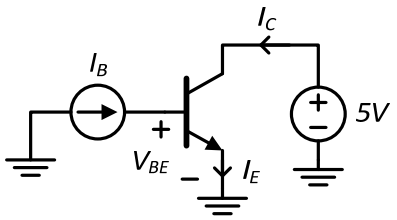

Figure 1.

P5.2 The current gain of a BJT from the emitter to the collector is given by $I_C/I_E \equiv \alpha_F$ when in the forward-active region, where $\alpha_F = \beta_F/(1+\beta_F)$. Use this to answer the following parts. Ignore base-width modulation.

a) Derive the above expression for α_F. Use the circuit shown in Figure 1.

b) Derive an expression for I_B/I_E in terms of only α_F.

c) We often approximate that $I_E \approx I_C$. Given that up to a 5% error is acceptable, we can use the approximation of $I_E \approx I_C$ by placing the following condition on α_F: $\alpha_F > 0.95$. What is the minimum value of β_F allowed that satisfies this condition? What is the minimum value of β_F if only a 1% error is acceptable?

P5.3 J&B Problem 5.2. Ignore base-width modulation. You are asked to find I_S in this problem. In J&B, I_S is defined for collector current as follows: $I_C = I_S e^{V_{BE}/V_T}$. Base current is therefore $I_B = (I_S/\beta_F) \cdot e^{V_{BE}/V_T}$.

P5.4 Find the values of base and collector currents I_B and I_C for the circuit shown in Figure 2, given that $\alpha_F = 0.995$. Ignore base-width modulation.

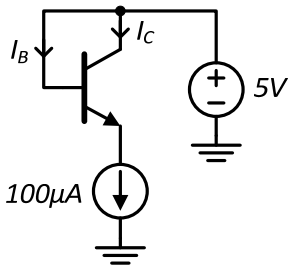

Figure 2.

P5.5 J&B Problem 5.72.

P5.6 J&B Problem 5.82. In J&B, "Q-point" refers to the quiescent, or DC bias point. Assume $\beta_R = 1$. Ignore base-width modulation.

P5.7 J&B Problem 5.85. In J&B, "Q-point" refers to the quiescent, or DC bias point. Assume $V_{BE,on} = 0.7V$. Ignore base-width modulation.

P5.8 J&B Problem 5.87, part (a) only. Assume $V_{BE,on} = 0.7V$. Ignore base-width modulation.