1. The BJT transistor in the circuit below has the following parameters: \( \beta_F = 160, I_S = 1.2 \times 10^{-16} \) A. Find the following:

   a. (2 pts.) In what “region” (forward active, saturation, cutoff, or reverse active) does the transistor operate for each case [1] – [4] shown in the table? Hint: Be careful to consider both \( V_{BE} \) and the biasing of each of the diodes in the transistor model.

   b. (1 pt.) Determine the emitter current \( (I_E) \) for the transistor in this circuit for case [4].

   ![Diagram of BJT transistor](image)

   - \( V_{CB} \)  
     - 0.7 V  
     - 0.6 V  
     - -2 V
   - \( V_{EB} \)  
     - 0.7 V  
     - [1]  
     - [2]  
     - [3]  
     - [4]

2. (4 pts.) The BJT in the figure below is in a circuit commonly used to determine the \( \beta_F \) and \( I_S \) parameters of the transistor. You can assume that the CVD across each of the ideal diodes shown is 0.7 V. Notice that the transistor will operate in FAR. If \( I_B = 62.8 \) \( \mu \)A and \( I_E = 9.29 \) mA are measured in this circuit, determine \( \beta_F \) and \( I_S \) for the device. (No, you DON’T have to know the values of \( V_S \) and \( R_S \) to solve this problem.)

   ![Diagram of BJT transistor circuit](image)

3. (3 pts.) The transistor below is designed into a 2-R bias circuit. Given that \( \beta_F = 80 \) and \( I_S = 5 \times 10^{-14} \) A for the transistor, find the values of \( R_B \) and \( R_C \) that are necessary to have the transistor operate at a Q-point = (5 V, 8 mA).
4. (4 pts.) Determine the dc Q-point \((V_{CE}, I_C)\) for the transistor in the following biasing circuit. The BJT has \(\beta_F = 120\) and \(V_{BE}\) is measured to be 0.63 V. How much total power \((P)\) is dissipated from the single voltage supply?

5. (2 pts.) Determine the currents \(I_1\) and \(I_2\) in the following circuit. Assume transistors \(Q_1\) and \(Q_2\) are a "matched pair" with the same \(\beta_{F0} = 75\) and Early Voltage \(V_A = 85\) V. You may assume that \(V_{BE} = 0.7\) V.
6. (4 pts.) An NPN transistor with $I_s = 2.00 \times 10^{-12}$ A and $\beta_F = 140$ is used in a 4-resistor biasing circuit with a single supply voltage, $V_{cc} = 6.00$ V. The desired Q-point for the transistor ($V_{ce}, I_c$) is (1 V, 50 mA). Use the design “rules of thumb” that $R_1 + R_2 = 5V_{cc}/I_c$ $\Omega$, and $I_cR_C = I_eR_E$. Find the closest 1% values of the four bias circuit resistors – $R_1$, $R_2$, $R_C$, and $R_E$ that are required to implement this design. (Refer to Appendix A in your text for the list of commercially available 1% resistors.)

**Bonus (5 points)**
Using the 1% resistor values, create a bias point simulation of your circuit from problem 6 in PSpice to verify its design. Operate the device at 17 °C. Show only the voltages and currents necessary to verify the Q-point. Print your schematic showing this data for your homework submission.