

### Homework 05

1. A bipolar junction transistor (BJT) is characterized by various quantities, for example the thermal voltage ( $V_T$ ), alpha ( $\alpha$ ), beta ( $\beta$ ), and the BE threshold voltage ( $V_{th}$ ).
  - (a) Describe the meaning of each of these quantities and give (approximate) associated numerical values.
  - (b) Which one of these quantities is best suited to help us understand the physical operation of a BJT? Explain your answer.
  - (c) Which one of these quantities is most relevant in the practice of BJTs? Explain your answer.
  - (d) Which of these quantities depends strongly on a geometrical dimension (thickness of the base layer) of the BJT? Explain your answer.
2. This problem relates to a bipolar junction transistor (BJT).
  - (a) Draw the  $I_E$ -versus- $I_B$  characteristic ( $I_E$  vertical axis (ordinate) and  $I_B$  horizontal axis (abscissa)) of a generic BJT. In the same diagram, draw the  $I_C$ -versus- $I_B$  characteristic of a BJT. Explain the characteristic.
  - (b) Draw the  $I_C$ -versus- $V_{BE}$  characteristic of a BJT. In the drawing, show the BJT's forward active region (ON region) and cutoff region (OFF region). Explain the characteristic.
  - (c) Draw the output characteristic  $I_C$ -versus- $V_{CE}$  of a BJT. In the drawing, show the BJT's forward active region (ON region), cutoff region (OFF region), and saturation region.
  - (d) Sketch the  $I_C$ -versus- $V_{CE}$  characteristic and indicate the saturation voltage. A typical value of the saturation voltage is 0.2 V. Can you give a quantitative justification of that typical value?
3. This problem relates to a bipolar junction transistor (BJT) having a current amplification  $\alpha$  in common-base (common-B) configuration.
  - (a) Draw a common-B BJT amplifier circuit of a pnp BJT (without sources and without resistors). Label all input and output quantities.
  - (b) Draw the large-signal equivalent circuit of the transistor circuit (for the forward active operating regime); the equivalent circuit should not use the transistor circuit symbol. Define all quantities used in the equivalent circuit.
  - (c) Draw the AC small-signal equivalent circuit (for the forward active operating regime). Define all quantities used in the circuit.
  - (d) Can you comment on the input resistance of the circuit? Do we generally prefer an amplifier having a small or large input resistance?