

Fall-2021 UM-SJTU JI Ve311 Homework #3

Instructor: Dr. Chang-Ching Tu

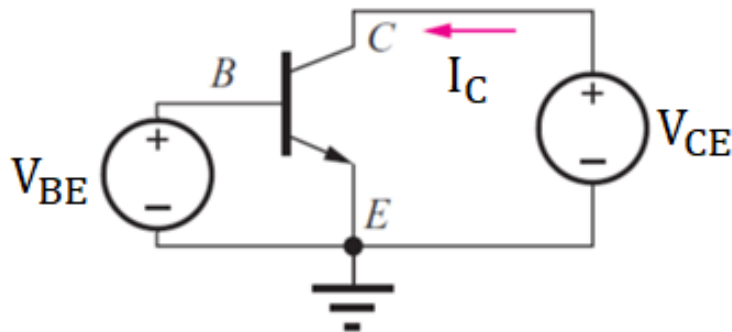
Due: 10:40 am, October 20, 2021 (Wednesday), online submission

Note:

- (1) Please use A4 size papers.
- (2) Please use the SPICE model below for simulation.

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.model Qbreakn NPN IS=4e-16 BF=100 VAF=50
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1. [BJT Forward-Active I-V Characteristics] For a npn BJT circuit as below:
 - (a) [20%] When $V_{BE} = 0.7 \text{ V}$ and $V_{CE} = 2 \text{ V}$, use proper equations provided in the course slides and the spice model above to calculate the g_m and r_o .
 - (b) [10%] In Pspice, when $V_{CE} = 2 \text{ V}$, plot I_C versus V_{BE} (increasing from 0 to 1 V). Find out the slope at $V_{BE} = 0.7 \text{ V}$ and compare it with the g_m value calculated in (a).
 - (c) [10%] In Pspice, when $V_{BE} = 0.7 \text{ V}$, plot I_C versus V_{CE} (increasing from 1 to 3 V). Find out the inverse of the slope at $V_{CE} = 2 \text{ V}$ and compare it with the r_o value calculated in (a).



2. [BJT Common-Emitter Amplifier] For a npn BJT circuit as below:
- (a) [30%] When $V_{IN} = 0.7 \text{ V}$, use proper equations provided in the course slides and the spice model above to calculate the small-signal voltage gain ($A_v = \frac{v_{out}}{v_{in}}$). Hint: take Early Effect into consideration.
 - (b) [15%, DC Sweep] In Pspice, plot V_{OUT} versus V_{IN} (increasing from 0 to 1 V). Find out the slope at $V_{IN} = 0.7 \text{ V}$ and compare it with the voltage gain calculated in (a).
 - (c) [15%, Transient Analysis] In Pspice, when $V_{in} = 0.7 + 0.001 \cdot \sin(2\pi 100 \cdot \text{time}) \text{ V}$, plot V_{out} and V_{in} versus time (from 0 to 0.1 second). Find out $|A_v| = \left| \frac{v_{out}}{v_{in}} \right|$ and compare it with the voltage gain calculated in (a).

