Fall-2020 UM-SJTU JI Ve311 Homework #3

Instructor: Dr. Chang-Ching Tu

Due: 11:59 am, October 16, 2020 (Friday)

Note:

(1) Please use A4 size papers.

(2) The homework should be submitted online.

(2) Please use the SPICE model below for simulation.

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.model Qbreakn NPN IS=1e-16 BF=100 VAF=100
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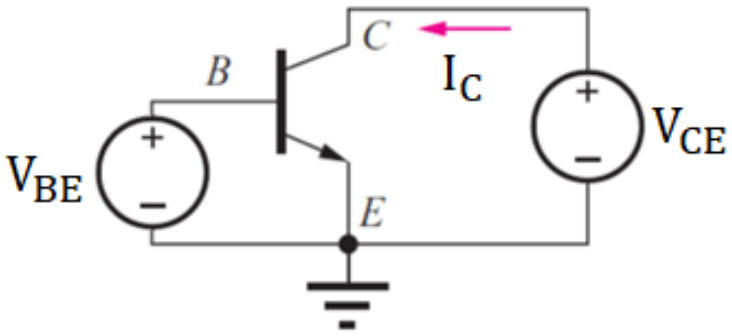
1. [BJT Forward-Active I-V Characteristics] For a npn BJT circuit as below:
   (a) [20%] When $V_{BE} = 0.5\,V$ and $V_{CE} = 1\,V$, use proper equations provided in the course slides and the spice model above to calculate the gm and r_o.
   (b) [10%] In Pspice, when $V_{CE} = 1\,V$, plot I_C versus V_{BE} (from 0 to 1 V). Find out the slope at $V_{BE} = 0.5\,V$ and compare it with the gm value calculated in (a).
   (c) [10%] In Pspice, when $V_{BE} = 0.5\,V$, plot I_C versus V_{CE} (from 0 to 2 V). Find out the inverse of the slope at $V_{CE} = 1\,V$ 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 $V_{IN} = 0.5\,V$, use proper equations provided in the course slides and the spice model above to calculate the small-signal voltage gain ($A_\upsilon = \frac{\upsilon_{out}}{\upsilon_{in}}$). 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 $V_{IN} = 0.5\,V$ and compare it with the voltage gain calculated in (a).
   (c) [15%, Transient Analysis] In Pspice, when $V_{in} = 0.5 + 0.001 \cdot \sin(2\pi 100 \cdot \text{time})\,V$, plot V_{out} and V_{in} versus time (from 0 to 0.1 second). Find out $|A_\upsilon| = \left|\frac{\upsilon_{out}}{\upsilon_{in}}\right|$ and compare it with the voltage gain calculated in (a).