24-4-2021

BILKENT UNIVERSITY Department of Electrical and Electronics Engineering

EEE313 Electronic Circuit Design MidTerm Exam #2

3 questions 120 minutes

Part-2 Two questions 80 minutes

- **Instructions:**
- Calculators without extensive memory are allowed
- Clearly explain all your answers in order to receive credit
- Put a box around your final answer
- Cheat sheets are not allowed
- Indicate the units for your final answers
- Write your name and student ID on the bottom of every page
- Mail your pdf solutions to eee313exam@bilkent.edu.tr with your student ID number as subject
- Also upload your pdf solutions to Moodle

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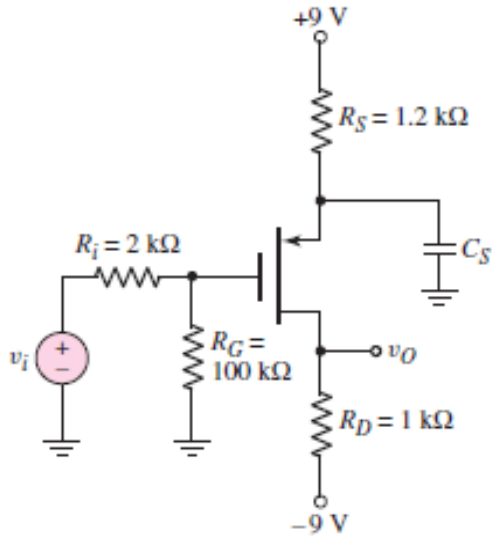
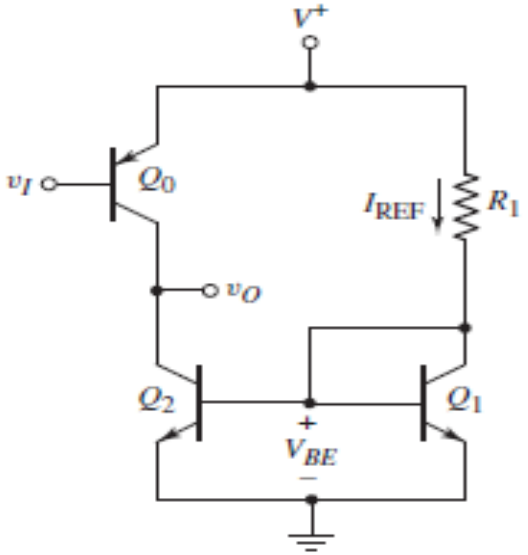
#2 24-4-2021





PART 2

80 minutes

Q2. (35 points)

The parameters of the common-source amplifier shown above are K_p=2mA/V^2, V_{TP}= -2V, λ=0.01V^{-1}, C_{gs}=10pF, C_{gd}=1pF, and $C_s \rightarrow \infty$.

a) Derive and numerically determine the Q-point values of I_D and V_{SD}. Neglect the contribution of λ in this part. Verify the state of the transistor.

b) Derive and numerically determine the midband small-signal ac gain v_o/v_i.

c) Derive and numerically determine the -3dB upper cut-off frequency f_H.

Q3. (30 points)

The amplifier show above uses a pnp driver and an npn active load circuit. The transistor parameters are: I_{S0}=5 x 10^{-13}A, I_{S1}=I_{S2}=10^{-12}A, V_{AN}=120V, and V_{AP}=80V. Let V^+=5V, V_T=0.026V, and neglect base currents. v_I=V_I+v_i where V_I is a fixed voltage and v_i is a small-signal variable contribution to the input.

a) Find the value of V_{BE} that will produce I_{REF}= 0.5mA. Neglect the contribution of V_{AN} in this part.

b) Determine the value of R_1

c) What value of V_I will produce V_{EC0}=V_{CE2}?

d) Derive and numerically determine the open-circuit small-signal voltage gain v_i/v_o.

Note: Collector current is given by the formulae i_C=$I_S e^{(VBE/VT)}(1+V_{CE}/V_{AN})$ and i_C=$I_S e^{(VEB/VT)}(1+V_{EC}/V_{AP})$ for npn and pnp BJTs, respectively.