EEE 232 Microelectronic Devices and Circuits Final Exam July 3, 2021

100 min

Last Name: First Name: Section: Student No:

Formulas that you might need:

$g_m = rac{I_{CQ}}{V_T}$	$r_{\pi} = \frac{\beta V_T}{I_{CQ}}$	$r_o = \frac{V_A}{I_{CQ}}$	$V_T = 26 mV$

**Q1**) (30 pts) The turn on voltage of each diode in the circuit below is  $V_{\gamma} = 0.7$  V. Determine I<sub>D1</sub>, I<sub>D2</sub>, I<sub>D3</sub>, Va and Vb.

Hint: Make an assumption about the states of each diodes and validate your assumptions.



Q2) (40 pts) In the given circuit below  $\beta$ =125, V<sub>A</sub>=200, V<sub>T</sub>=26 mV, V<sub>BE</sub>=0.7 V:



- a) Find *Icq* and *VcEq* and verify any assumption you have made.
- b) Plot the dc and ac load lines.
- c) Draw the AC small signal equivalent circuit.
- d) Calculate the small-signal voltage gain  $A_v = \frac{v_o}{v_c}$ .
- e) Determine the output resistances  $R_o$ .
- f) What is the functionality of  $C_E$ ?
- g) What is the role of  $C_{C1}$ ?

Q3) (30 pts) Consider the common base amplifier given below. All capacitors are assumed short at the frequencies interest. The transistor parameters for the circuit are  $\beta$ =120, V<sub>A</sub>= $\infty$ , V<sub>T</sub>=26 mV, V<sub>BE</sub>=0.7 V. The circuit parameters are V<sub>CC</sub>=V<sub>EE</sub>=3.3 V, R<sub>S</sub>=500 $\Omega$ , R<sub>L</sub>=6k $\Omega$ , R<sub>B</sub>=100k $\Omega$ , R<sub>E</sub>=12k $\Omega$ , and R<sub>C</sub>=12k $\Omega$ .

Please verify all your assumptions and calculations.



- a) Determine the small signal transistor parameters  $g_m,\,r_\pi\,\text{and}\,r_o$
- b) Determine the overall voltage gain  $A_v = \frac{v_o}{v_s}$
- c) Determine the input and output resistances  $R_{in}$ .