Name: ID#:

ECE 340

Online Midterm Exam (1 hour 30 minutes)

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February 25, 2021 (Winter 2021)

Answer all questions in the space provided (Open book exam)

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Make reasonable assumptions as necessary.

Calculators are allowed.

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30 minutes extra provided for online submission to the Learn dropbox. Exams submitted after the 2 hour mark penalized at the rate of 1 mark per minute late.

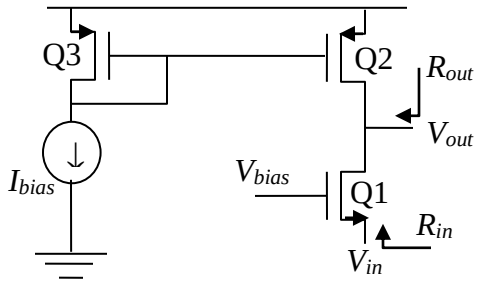
NAME:

ID #:

Q1	**/20**
Q2	**/20**
Q3	**/20**
Total Mark:	**/60**

1. Active Load Amplifier (20 marks)

For the circuit below, calculate the small signal R_{in}, R_{out} and gain V_{out}/V_{in}. **(5 marks each for total of 15 marks) Do not neglect r_o.** Identify at least two benefits the active load can provide? Based on the expressions derived for R_{in} and R_{out}, discuss at least three benefits/disadvantages that may arise from using the active load for the circuit shown below. **(5 marks)**



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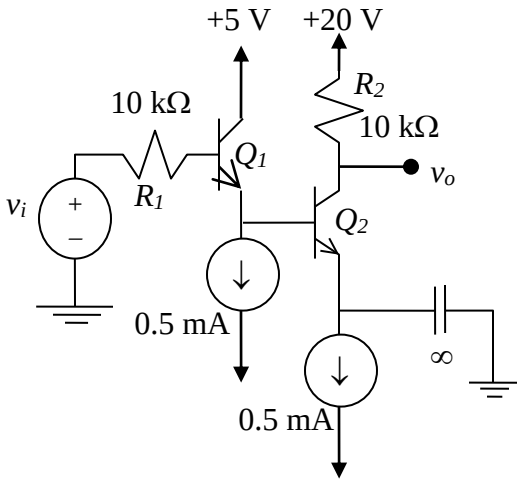
2. Two-stage amplifiers and frequency response (20 marks)



For the circuit shown above, let $\beta = 190$, $C_\mu = 2$ pF, $f_T = 40$ MHz.

(a) Calculate the mid-band gain. **(10 marks)**

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(b) Calculate the upper 3-dB frequency. **(10 marks)**

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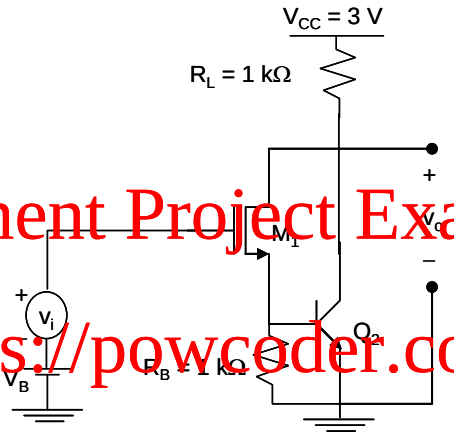
3. Two-stage BiCMOS amplifier (20 marks)

A BiCMOS Darlington is shown in the figure below. The bias voltage V_B is adjusted for a dc output of 2 V. **Calculate** the bias currents in both devices **(5 marks each for a total of 10 marks)** and then **calculate** the small signal voltage gain v_o/v_i of the circuit. **(10 marks)**

For the MOS transistor, assume W = 10 μm, L = 1 μm, $\mu_n C_{OX}$ = 200 μA/V^2, V_t = 0.6 V, γ = 0.25 V$^{1/2}$, ϕ_f = 0.3V and λ = 0.

For the BJT, assume $I_S = 10^{-16}$ A, β_F = 100, r_b = 0, and $V_A \rightarrow \infty$.



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