Analog Electronic Circuits (EC2.103) : Quiz-2

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Date : 2^{nd} April, 2024, Duration : 45 minutes, Max. Marks : 10

Instructions:

- Clearly write your valid assumptions (if any)
- You are only allowed to use own handwritten **single** A-4 sheet (both sides) as short notes
- Mobile phone, computers can not be used during the exam

1. (a) Fig. 1(a) shows a voltage amplifier. The transfer characteristic (V_{OUT} vs V_{IN}) of this amplifier is shown in Fig. 1(b). An ac input $v_{in} = sin(2\pi 1000t)mV$ is applied to the circuit. Find the amplitude of the output sinusoidal voltages for V_{DC} = $0.2V$ and $0.9V$, respectively. [2M]

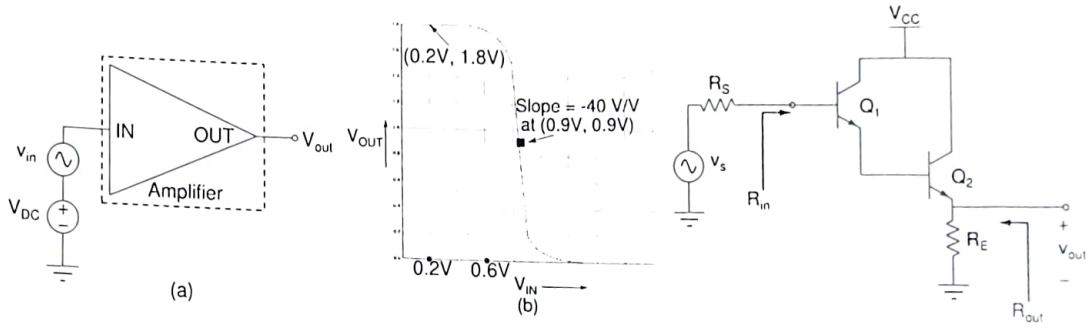

Figure 1: (a), (b) and (c), respectively

(b) As shown in figure 1(c), derive the expression for small signal input resistance R_{in}. Consider that both transistors (Q_1 & Q_2) are in active mode and symbols have their usual meanings. [2M]

2. Figure 2(a) shows an common source amplifier where transistor M_1 and M_2 are biased in saturation. It is given that the small signal drain resistance (r_{o1}) of M_1 is sufficiently larger than the load resistance $R_L = 500\ \Omega$ as shown in the figure, voltage gain $|\frac{v_{out}}{v_{in}}|$ = 5 and the DC voltage at the output node is 0.9V. Consider $\mu_n C_{ox} = 250\mu A/V^2$.

(a) What are the values of the required transconductance (g_m) and $\frac{W}{L}$ of M_1, respectively? [2M]

(b) Draw small signal equivalent and derive voltage gain ($A_v = \frac{v_{out}}{v_{in}}$). [2M]

(c) In Fig. 2(b), M_P and M_N are sized such that $V_B = 0.9$V. Find the region of operation of the two transistors considering $|V_{TN}| = |V_{TP}| = 0.45V$ (show the necessary steps). Draw small signal equivalent and derive the expression for voltage gain $\frac{v_b}{v_a}$. [2M]

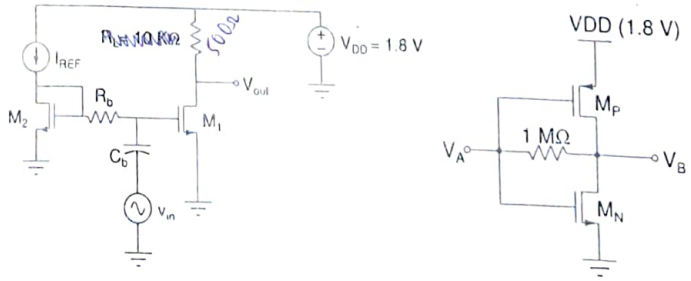

Figure 2: (a) and (b), respectively

Good luck !!