Analog Electronic Circuits (EC2.103) : Midsem exam
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Date : 29th Feb, 2024, Duration : 1 Hour 30 minutes, Max. Marks : 15

Instructions:
- Clearly write your assumptions (if any)
- You can use one A4 sheet of own handwritten short notes in the exam hall
- Use of mobile phone and computers are not allowed during this exam

1. True/False with reason

(a) For BJT based voltage amplifiers, it is preferred to have EB junction reverse biased and CB junction forward biased. **(T/F, give reason)** [1 Mark]

(b) Collector current a pnp BJT biased in forward active mode depends on the base-collector junction voltage. **(T/F, give reason)** [1 Mark]

2. Consider the full wave rectifiers shown in Fig. 1(a) and Fig. 1(b). All diodes have same cut-in voltage (v_γ) and negligible on resistance.

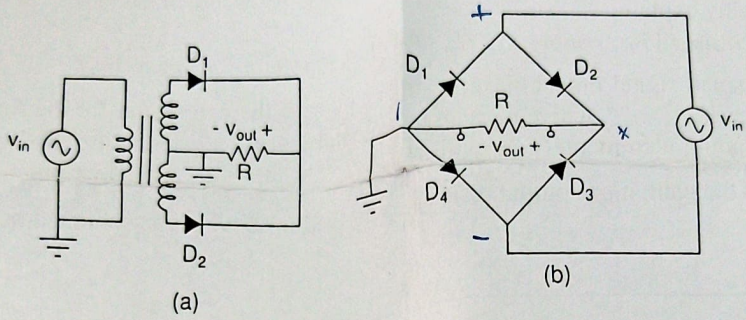

Figure 1

(a) Plot v_{out} vs v_{in} for Fig. 1(a) and find peak inverse voltage in the circuit. [2 Mark]

(b) Plot v_{out} vs v_{in} for Fig. 1(b) and find peak inverse voltage in the circuit. [2 Mark]

3. In the AC equivalents shown in Fig. 2, BJTs Q_1 and Q_2 are biased in the forward active mode having transconductance g_{m1} and g_{m2}, respectively. Also consider Q_1 and Q_2 have finite output impedances r_{o1} and r_{o2}, respectively due to the Early effect.

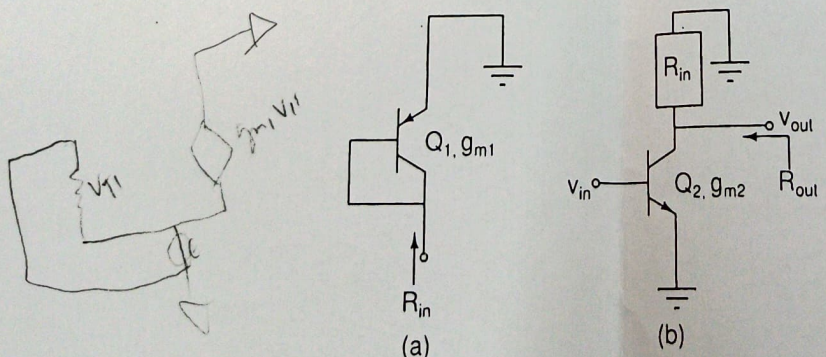

Figure 2

(a) Draw the small signal equivalent of the circuit in Fig. 2(a) and find the small signal equivalent resistance R_{in}. Is it high or low impedance, comment. [2 Mark]

(b) Draw the small signal equivalent and find the small signal voltage gain ($\frac{v_{out}}{v_{in}}$) for Fig. 2(b) if R_{in} from Fig. 2(a) is used. Also derive the expression for small signal output resistance R_{out} as shown in the figure. Is it high or low impedance, comment. [3 Mark]

4. For the circuit shown in Fig. 3, assume that BJT is in forward active mode.

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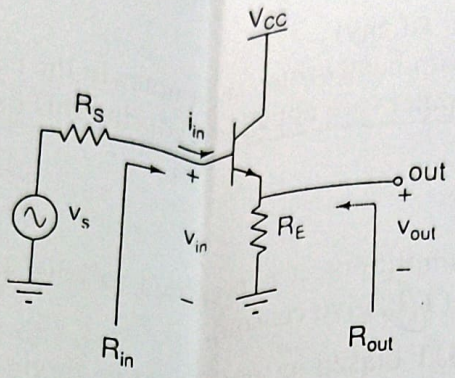

Figure 3

(a) Draw the small signal model and derive expression for the voltage gain $A_v = \frac{v_{out}}{v_s}$. [1 Mark]

(b) Derive the expression for the small signal input resistance defined as $R_{in} = \frac{v_{in}}{i_{in}}$. Is it high or low, briefly explain. [1 Mark]
(Hint: Ground V_{CC}, remove v_s, R_s, apply test source v_{in}, measure i_{in}.)

(c) In your small signal model make $v_s = 0$ and derive the expression for the small signal output resistance $R_{out} = \frac{v_x}{i_x}$, where v_x is an incremental voltage applied at the 'out' node and i_x is the corresponding incremental current drawn. Is R_{out} high or low, briefly explain. [1 Mark]

(d) Based on the gain, input-output resistances derived in above parts, comment on the utility of this circuit. [1 Mark]

Good luck !!

$$\frac{\left(\frac{R_s}{\beta+1} \,\|\, R_{EQ} + \frac{1}{g_m}\right) \| R_{EQ}}{R_{EQ} + \frac{1}{g_m} + \frac{R_s}{\beta+1}}$$