Analog Electronic Circuits (EC2.103) : Midsem exam

Date : 18^{th} May, 2022, Duration : 1 Hour 30 minutes, Max. Marks : 15

Instructions:

- Clearly write your assumptions (if any)
- Numerical answers must be correct upto **two places** of decimal to get any credit
- Refrain from copying
- You can use your lecture notebooks and own handwritten short notes in the exam hall
- Use of mobile phone and computers are not allowed during this exam

1. True/False, fill in the blanks, short answer

   (a) For BJT based voltage amplifiers, EB junction should be forward biased and CB junction should also be forward biased. **(T/F)** [1 Mark]

   (b) Current gain in an npn BJT can be defined as the ratio of lifetime of majority carrier in base to transition time of minority carriers in base. **(T/F)** [1 Mark]

   (c) I-V characteristic of a diode is shown in Fig. 1. At points A and B, conductance of the diode are approximately —— and ——, respectively. **(Fill in the blanks with proper units)** [1 Mark]

   (d) Draw Bode magnitude and phase plots for the transfer function $H(s) = \frac{(s-1)}{s(s+10)(s+20)}$. [1 Mark]

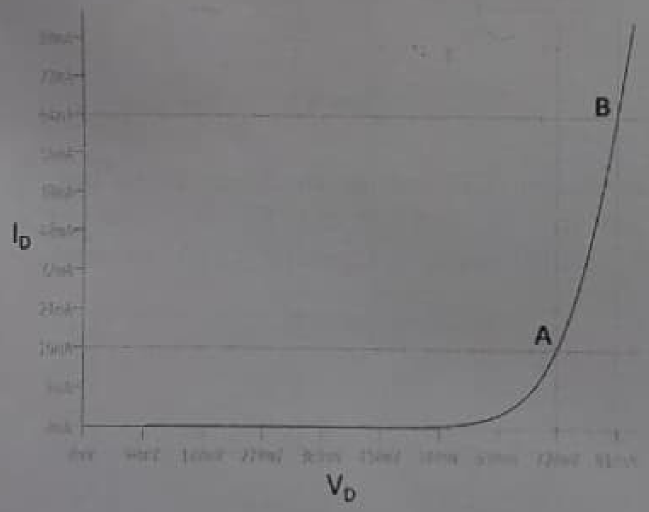

Figure 1

2. For the circuit shown in Fig. 2, assume that BJT is in forward active mode.

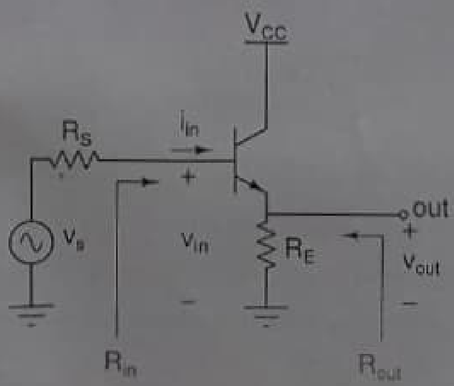

Figure 2

(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]

3. For the circuit shown in Fig. 3, identify the amplifier configuration (CE/CB/CC). Draw small signal equivalent and derive small signal voltage gain ($A_v = \frac{v_{out}}{v_s}$) considering that coupling capacitances (C_1, C_2) have negligibly small impedance at the frequency of interest. [3 Mark]

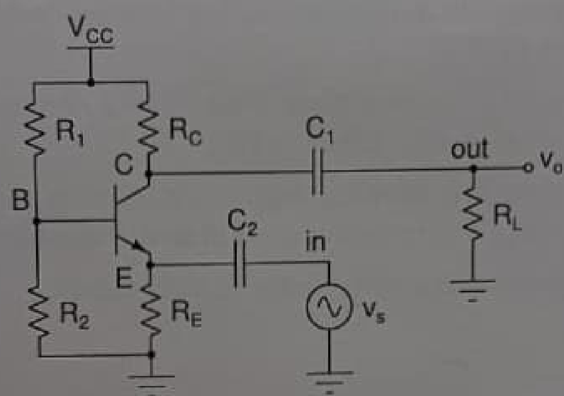

Figure 3

4. Fig. 4 shows a common emitter (CE) voltage amplifier. Given that $V_{CC} = 12\ V$, $C_B = 10\ \mu F$, $C_C = 10\ \mu F$, $C_E = 100\ \mu F$, $R_1 = 18.46\ k\Omega$, $R_2 = 2.24\ k\Omega$, $R_E = 2\ k\Omega$, $R_C = 30.3\ k\Omega$, $R_L = 1\ k\Omega$, $\beta = 300$, $R_S = 50\ \Omega$ and $v_s = V_m sin(2\pi f_0 t)$ V, where $f_0 = 1\ kHz$.

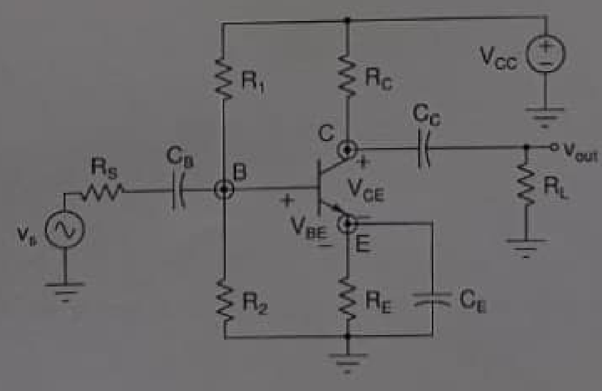

Figure 4

(a) Find transconductance (g_m) of the amplifier. [1 Mark]

(b) Draw small signal model of the voltage amplifier. [1 Mark]

(c) Calculate the value of small signal input resistance (r_π) at the base of the transistor. [1 Mark]

(d) Find the expression and value of the mid-band gain ($A_v = \frac{v_{out}}{v_s}$) of the amplifier in dB. [1 Mark]

Good luck !!