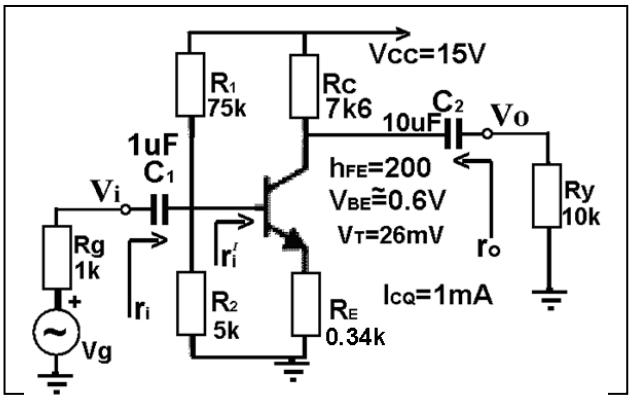
Anlg.Electr.Circ.-summer-MT1 Name:	No:

P1- For the transistor in the figure, I_{CQ}=1mA, $\beta_F=h_{FE}$=200, $V_{BE}\cong$0.6V, $V_T\cong$26mV, C_{cb}=10pF and F_T=100MHz are given.

Signature:

a) Find the cut-off frequencies for the low and high frequency regions.



b) Vg is a sinusoidal signal the amplitude of which is 5mV and the frequency of which is the cut-off frequency at the high frequency region. Draw vg(t) and vo(t) for the same time-axis.

c) Calculate the tilt and the rising-time of the circuit for a square-wave source of 10kHz. Draw the output signal Vo(t) (the amplitude of the square-wave source is 10mV).

A-1-

a) $r_i' = r_b = \beta_F \left(\frac{1}{g_m} + R_E \right)$

$= 200 \ (26 + 340)$

$\cong 73k$

$r_i = R_2 // R_1 // r_i' \cong 4,4k$

Low frequency Region

$C_1 \rightarrow Z_1 = C_1 . (r_i + R_g) = 1\mu F . 5,4k$

$= 5,4 mSn$

$f_{L1} = \frac{1}{2\pi Z_1} = 29,5Hz.$

$C_2 \rightarrow Z_2 = C_2 (R_c + R_y) = 10\mu F . 17,6k$

$= 176 mSn$

$f_{L2} = \frac{1}{2\pi Z_2} \cong 1Hz$

$f_{LC} \cong f_{L1} \cong 30Hz$

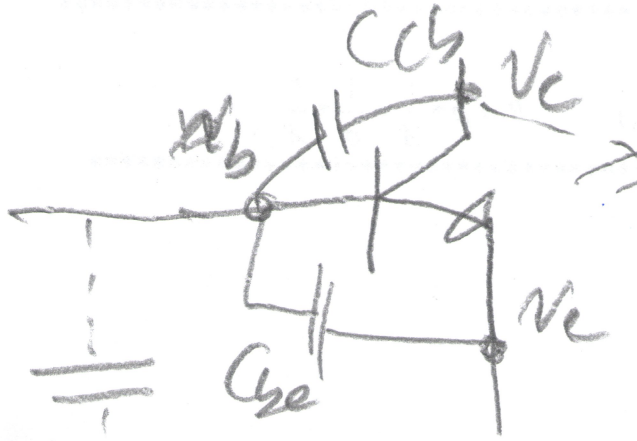
a) High frequency

$$\frac{V_c}{V_s} = \frac{-g_m (R_c // R_y)}{1 + g_m R_E} \cong -12$$

$$F_T = \frac{g_m}{2\pi (C_{be} + C_b)} \rightarrow C_{be} = \frac{g_m}{2\pi F_T} - C_{cb}$$

$$\cong 61,2p - 10p$$

$$\downarrow \cong 51,2pF$$



$$C_{eq2} = C_{cb}(1 - (-12)) + C_{be}\left(1 - \frac{V_e}{V_s}\right)$$

$$\frac{V_e}{V_s} = \frac{R_E // R_y}{\frac{1}{g_m} + R_E // R_y} \downarrow \cong 0,93$$

$$= 130pF + 3,6pF$$

$$\downarrow \cong 134pF$$

$$C_{eq} \cong C_{cb} = 10pF$$

$$f_{HL} = \frac{1}{2\pi C_{eq2} (R' // R_1 // R_2 // R_3)} \cong 1,5MHz$$

$$(R' // R_1 // R_2 // R_3) \sim 0,8k$$

$$f_H \cong 1MHz$$

$$f_{HL} = \frac{1}{2\pi C_{eq2} (R_c // R_y)} = \downarrow 7MHz$$

b) $A_V = \frac{v_c}{v_b} \cdot \frac{v_b}{v_i}$

$$\frac{v_c}{v_b} = \frac{-g_m \cdot (R_C // R_y)}{1 + g_m R_E} \simeq \frac{-\frac{1}{26} \cdot 4{,}3k}{1 + g_m \cdot 0{,}34k}$$

$$\simeq -12$$

$$\frac{v_b}{v_i} = \frac{r_i}{r_i + R_y} = \frac{4{,}4}{5{,}4}$$

$$A_V = \frac{4{,}4}{5{,}4} \cdot (-12) \simeq -10$$

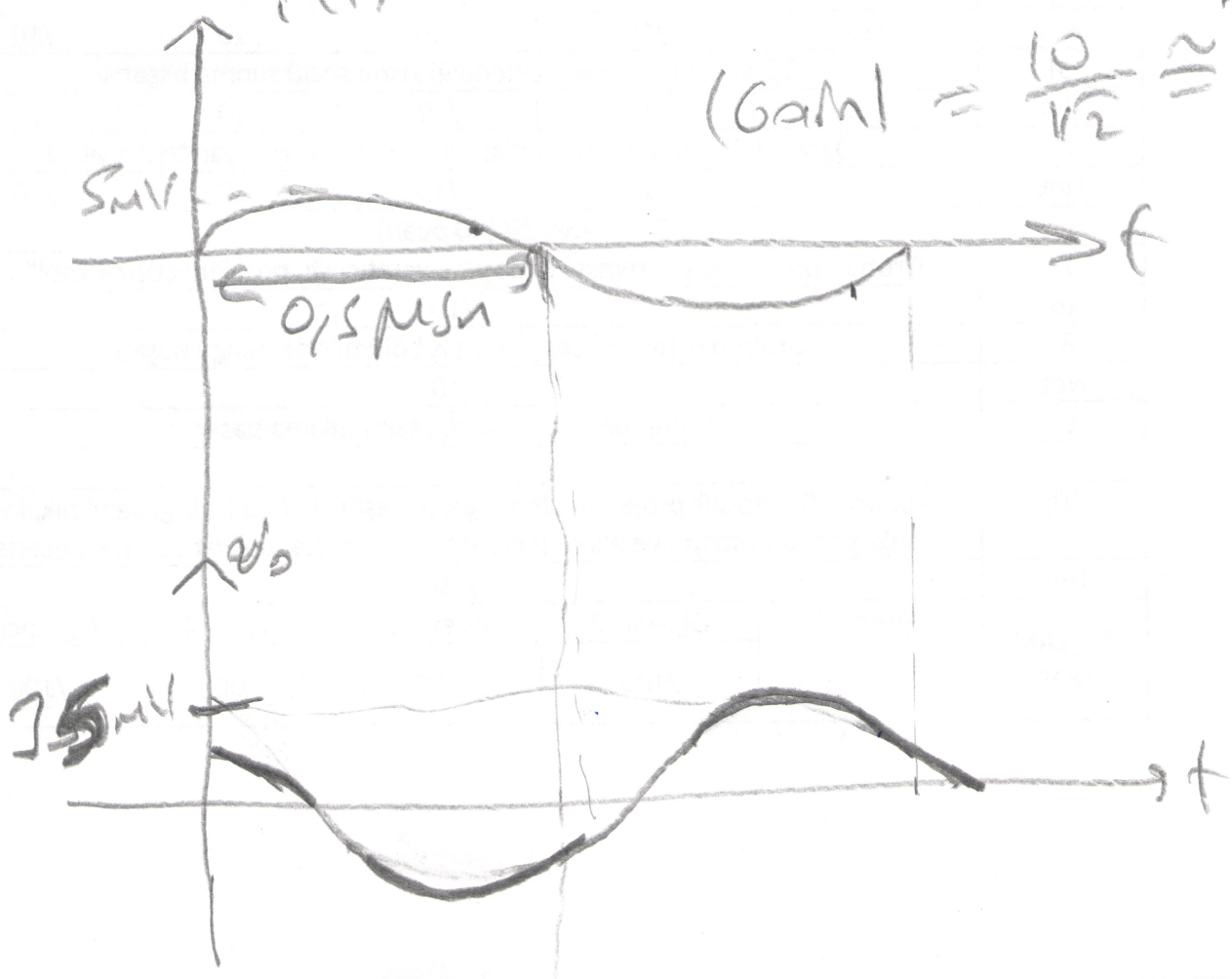
$f_{HC} \simeq 1\,MHz$

$v_i(t)$

Phase difference $= 180 - 45$

$= 135°$

$|G_0 A_0| = \frac{10}{\sqrt{2}} \simeq 7$



c) $t_r = \frac{0,35}{f_{HC}} = \frac{0,35}{1MHz} = 0,35\mu s$

$t_H/t = \frac{T_D}{2} = \frac{50\mu}{5,6m} \cong \frac{1}{100}$