الاسم : احمد علاء الدين ابو الفتوح

Sec: 1 B.n:5

Problem (7.54)

7.54 In the circuit shown in Fig. P7.54, the transistor has a β of 200. What is the dc voltage at the collector? Replacing the BJT with one of the hybrid-π models (neglecting r_o), draw the equivalent circuit of the amplifier. Find the input resistances R_{ib} and R_{in} and the overall voltage gain (v_o/v_{sig}). For an output signal of ±0.4 V, what values of v_{sig} and v_b are required?

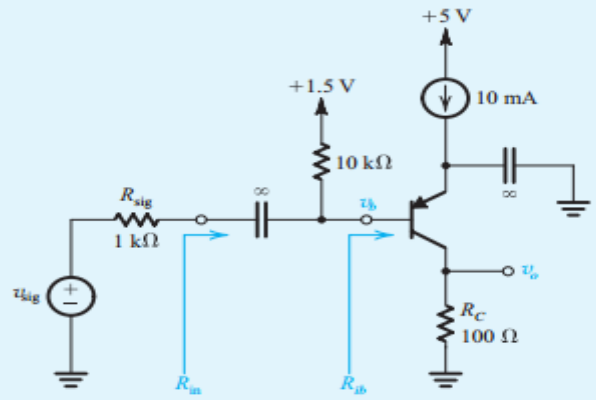
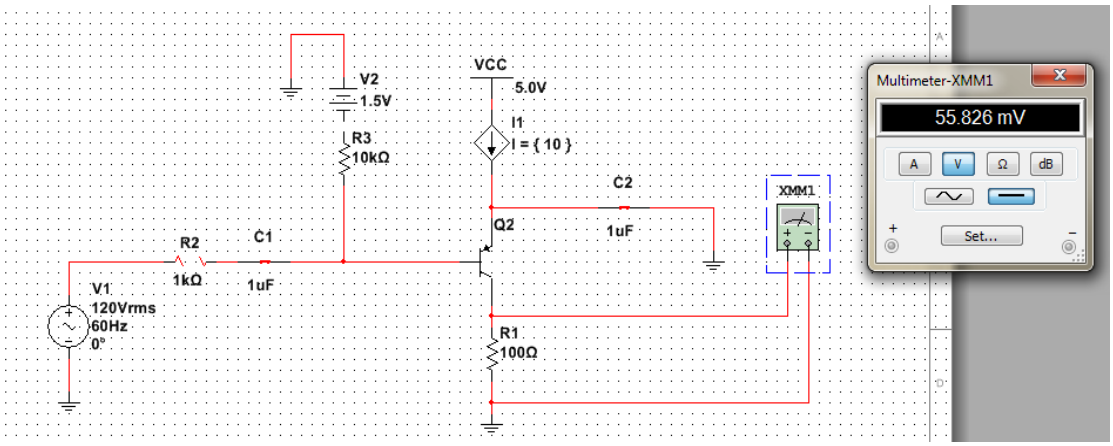
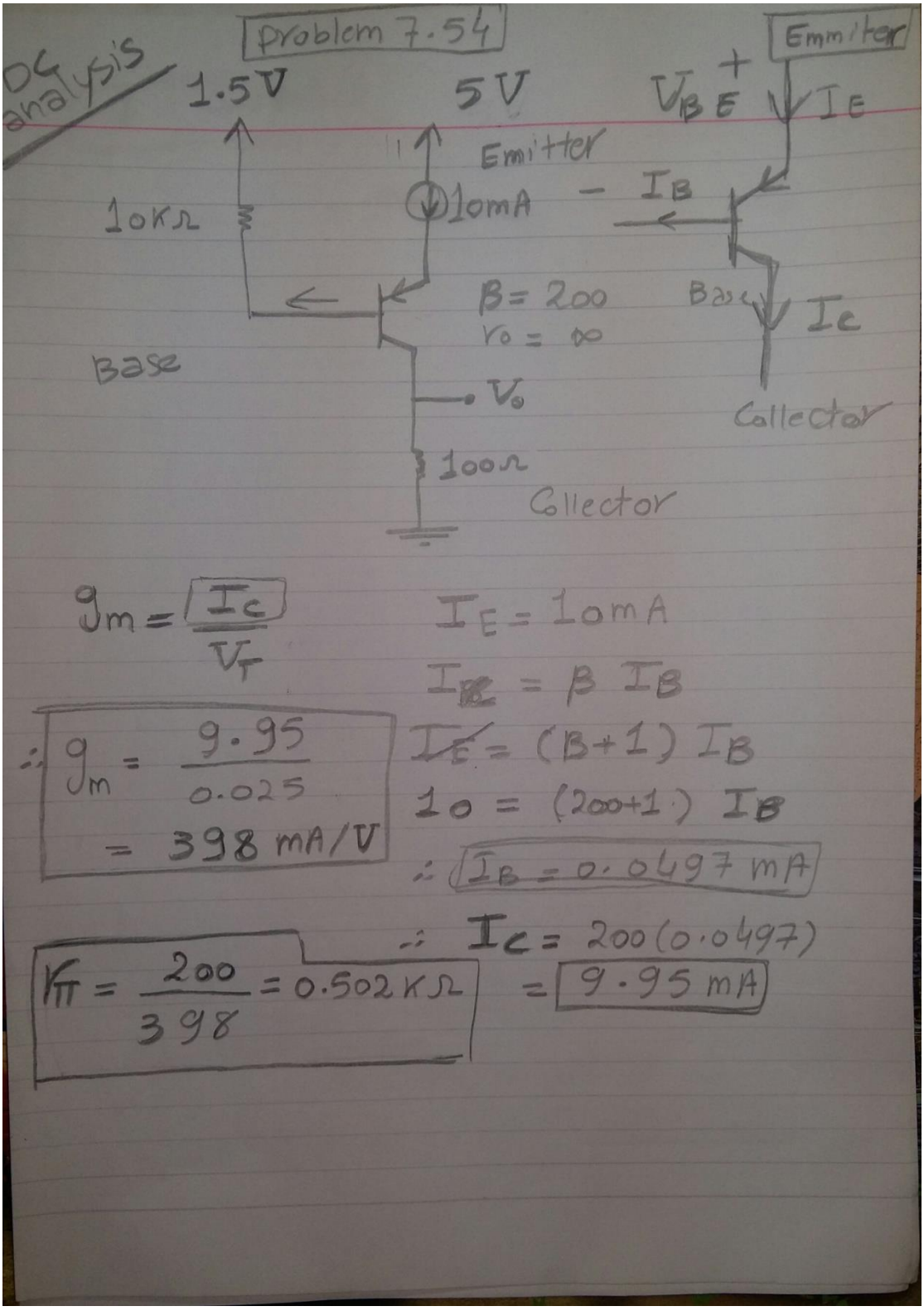


Figure P7.54

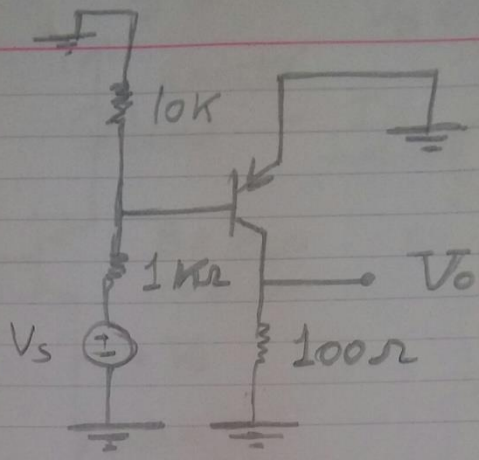
Simulation



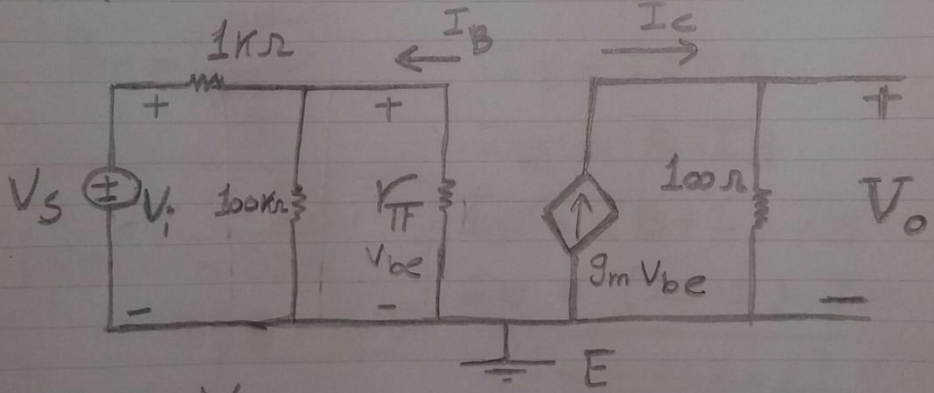
Solution


Problem 7.54
DC analysis
1.5 V
5 V
Emitter
10mA
10kΩ
Base
β = 200
$r_o = \infty$
V_o
100Ω
Collector
V_{BE}
+
−
I_E
I_B
I_C
Collector
$g_m = \frac{I_C}{V_T}$
$I_E = 10mA$
$I_B = \beta I_B$
$I_E = (\beta+1) I_B$
$10 = (200+1) I_B$
$\therefore I_B = 0.0497 mA$
$\therefore I_C = 200(0.0497)$
$= 9.95 mA$
$\therefore g_m = \frac{9.95}{0.025}$
$= 398 mA/V$
$r_\pi = \frac{200}{398} = 0.502 k\Omega$

AC analysis



Hybrid-π model



$$A_V = \frac{V_o}{V_i} \qquad V_{be} = \frac{V_i * \left(\frac{100 * 0.502}{100 + 0.502}\right)}{1 + \left(\frac{100 * 0.502}{100 + 0.502}\right)}$$

$$\therefore \boxed{V_{be} = 0.333\, V_i}$$

$$V_o = g_m V_{be} * 0.1$$

$$= (398)(0.333 V_i)(0.1) = 13.25\, V_i$$

$$\therefore V_o = 13.25\, V_i$$

$$\therefore \boxed{A_V = \frac{V_o}{V_i} = 13.25}$$

Excel

L	K	J	I	H	G	F	E	D	C	B	A	
				constants			→		vt	vee(mv)	vdd(mv)	1
									0.025	1.5	5	2
Av	vbe	rpi(kohm)	gm(ma/v)	IC(ma)	IB(ma)		R2(kohm	rsig(kohm	R1(KOHM	IE(ma)	B	3
13.26678	0.333328	0.5025	398.01	9.950249	0.049751		0.1	1	100	10	200	4
7.967969	0.201191	0.2525	396.0396	9.90099	0.09901		0.1	1	100	10	100	5
9.925312	0.498747	1.005	199.005	4.975124	0.024876		0.1	2	100	5	200	6
66.11352	0.33222	0.5025	398.01	9.950249	0.049751		0.5	1	50	10	200	7
												8
		Out put parameters						Input varied parameters				9
												10