

Due date: Monday, 1st June 2026 (online submission to XMUT204 website at VUW)

Section A: BJT Characteristics

1. A BC546A transistor is used in the BJT amplifier circuit as shown in Figure 1 below and selected sections of its datasheet are provided in the Appendix.

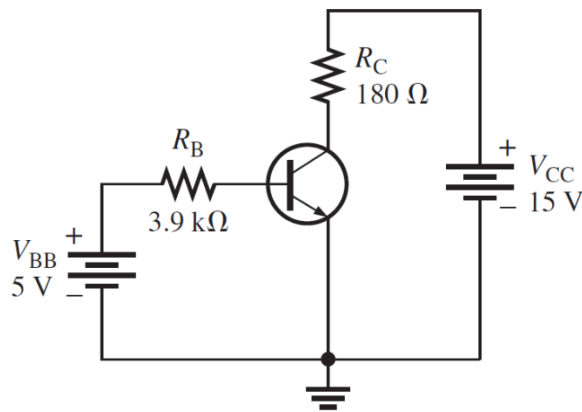


Figure 1: BJT amplifier circuit

- a. Determine the device parameters of the transistor (i.e. DC gain, base-emitter junction voltage, and saturated collector-emitter voltage). [5 marks]
- b. Describe whether the BJT is in saturation or not. [5 marks]
- c. Calculate the power dissipation of the transistor with the circuit condition as specified in part (b). Comment on the result. [5 marks]

Section B: BJT Biasing Circuits

2. Calculate I_B , I_C , I_E , V_{BE} and V_{CE} in the BJT amplifier circuit in Figure 2 below, given that transistor DC gain $\beta_{DC} = 100$, $V_{CC} = 10\text{ V}$, $R_C = 2\text{ k}\Omega$, $R_B = 220\text{ k}\Omega$, and input voltage $V_{BB} = 4\text{ V}$. [15 marks]

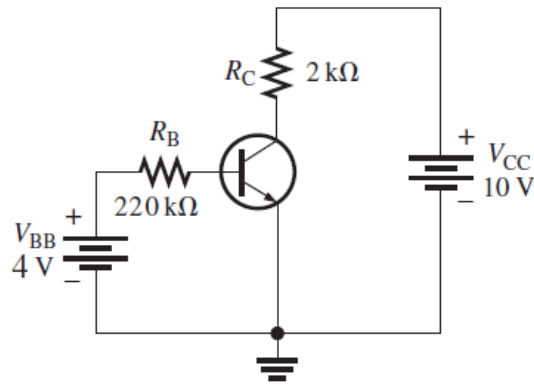


Figure 2: BJT amplifier circuit

3. For the biasing circuit for the BJT amplifier with feedback emitter resistor given in the Figure 3 below, $V_{CC} = 12\text{ V}$, $V_{BB} = 6\text{ V}$, $R_B = 25\text{ k}\Omega$, $R_C = 0.4\text{ k}\Omega$, and $R_E = 0.6\text{ k}\Omega$.

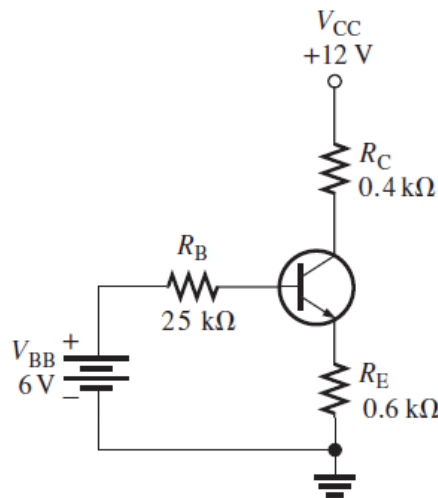


Figure 3: BJT amplifier circuit with feedback emitter resistor

- a. Calculate all characteristic currents and voltages in the circuit if the BJT transistor's DC gain, $\beta_{DC} = 75$. [15 marks]
 - b. Draw a load line to indicate the Q-point. [10 marks]
4. Calculate V_B , V_E , V_C , V_{CE} , I_B , I_E and I_C for the BJT amplifier circuit given in the Figure 4 below. Assume the BJT transistor is 2N3904 and it has a DC gain, $\beta_{DC} = 200$, $R_1 = 22\text{ k}\Omega$, $R_2 = 10\text{ k}\Omega$, $R_C = 1\text{ k}\Omega$ and $R_E = 1\text{ k}\Omega$, and $V_{CC} = +30\text{ V}$. [15 marks]

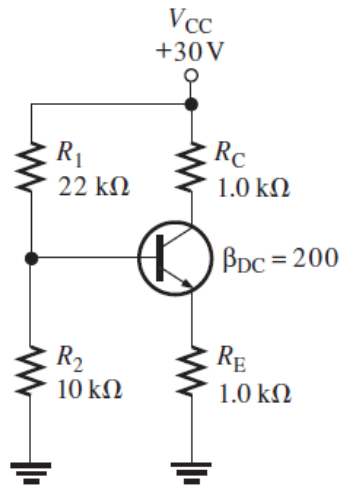


Figure 4: BJT amplifier circuit with voltage divider biasing circuit

C. BJT Switching Applications

5. For the BJT transistor circuit given in the Figure 5 below, $V_{CC} = +10\text{ V}$ and the transistor's AC current gain, $h_{FE} = 250$.

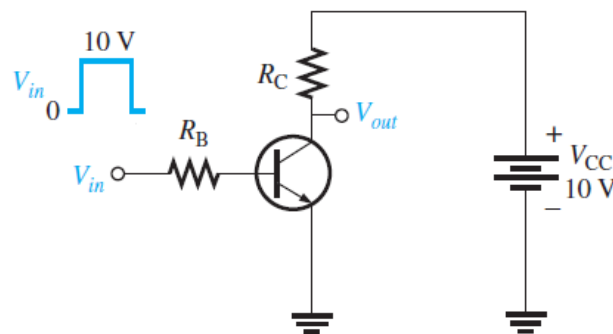


Figure 5: BJT switching circuit

- Calculate the values of R_B and R_C that will ensure that the transistor operates efficiently as a switch for the input waveform V_{in} as shown above (use E12 resistor value). Sketch the output waveform that will result from the given input waveform. Use transistor DC gain, $\beta_{DC} = 250$. [20 marks]
- Calculate the Q-point if a constant value of input voltage, $V_{in} = 3\text{ V}$ is applied at the input. Determine if this design is feasible and, if it is not, suggest a solution to fix it? [10 marks]

Appendix - (Selected) BC546 Transistor Datasheet

Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. Values are at $T_A = 25^\circ\text{C}$ unless otherwise noted.

Symbol	Parameter	Value	Unit
V_{CBO}	Collector-Base Voltage	BC546	80
		BC547 / BC550	50
		BC548 / BC549	30
V_{CEO}	Collector-Emitter Voltage	BC546	65
		BC547 / BC550	45
		BC548 / BC549	30
V_{EBO}	Emitter-Base Voltage	BC546 / BC547	6
		BC548 / BC549 / BC550	5
I_C	Collector Current (DC)	100	mA
P_C	Collector Power Dissipation	500	mW
T_J	Junction Temperature	150	$^\circ\text{C}$
T_{STG}	Storage Temperature Range	-65 to +150	$^\circ\text{C}$

Electrical Characteristics

Values are at $T_A = 25^\circ\text{C}$ unless otherwise noted.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector Cut-Off Current	$V_{CB} = 30\text{ V}, I_E = 0$			15	nA
h_{FE}	DC Current Gain	$V_{CE} = 5\text{ V}, I_C = 2\text{ mA}$	110		800	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10\text{ mA}, I_B = 0.5\text{ mA}$		90	250	mV
		$I_C = 100\text{ mA}, I_B = 5\text{ mA}$		250	600	
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 10\text{ mA}, I_B = 0.5\text{ mA}$		700		mV
		$I_C = 100\text{ mA}, I_B = 5\text{ mA}$		900		
$V_{BE(on)}$	Base-Emitter On Voltage	$V_{CE} = 5\text{ V}, I_C = 2\text{ mA}$	580	660	700	mV
		$V_{CE} = 5\text{ V}, I_C = 10\text{ mA}$			720	
f_T	Current Gain Bandwidth Product	$V_{CE} = 5\text{ V}, I_C = 10\text{ mA}, f = 100\text{ MHz}$		300		MHz
C_{ob}	Output Capacitance	$V_{CB} = 10\text{ V}, I_E = 0, f = 1\text{ MHz}$		3.5	6.0	pF
C_{ib}	Input Capacitance	$V_{EB} = 0.5\text{ V}, I_C = 0, f = 1\text{ MHz}$		9		pF
NF	Noise Figure	BC546 / BC547 / BC548	$V_{CE} = 5\text{ V}, I_C = 200\text{ }\mu\text{A}, f = 1\text{ kHz}, R_G = 2\text{ k}\Omega$	2.0	10.0	dB
		BC549 / BC550		1.2	4.0	
		BC549	$V_{CE} = 5\text{ V}, I_C = 200\text{ }\mu\text{A}, R_G = 2\text{ k}\Omega, f = 30\text{ to }15000\text{ MHz}$	1.4	4.0	
		BC550		1.4	3.0	

h_{FE} Classification

Classification	A	B	C
h_{FE}	110 – 220	200 – 450	420 – 800

Marking Schedule

Student ID : _____

Student Name : _____

No	Description	Mark	Your Mark	Remarks
A	BJT Transistor Structures			
1a	Device parameters of the BJT.	5		
1b	Whether the BJT is saturated or not.	5		
1c	Power dissipation of the BJT with its condition as specified in part (b).	5		
B	BJT Biasing Circuits			
2	Values of I_B , I_C , I_E , V_{BE} and V_{CE} .	15		
3a	Characteristic currents and voltages in the circuit.	15		
3b	Load line to indicate the Q point.	10		
4	Values of V_B , V_E , V_C , V_{CE} , I_B , I_E and I_C .	15		
C	BJT Switching Applications			
5a	Values of R_B and R_C and sketch the output waveform.	20		
5b	Values of Q-point and whether solution is feasible and if it is not, the solution to fix it.	10		
	Total	100		

Comment: