LAB REPORT -3

BJT Common Emitter Amplifier Characteristics

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Q2. Net list for the circuit :

BJT Common Emitter Amplifier Characteristics
Vcc 4 0 12

R1 4 5 36k
R2 5 0 10k
Rc 4 7 5k
Re 3 8 1.99k

vdc 7 1 dc=0
vde 8 0 dc=0
vdb 5 2 dc=0
Q1 1 2 3 Q2N2222A

.model Q2N2222A NPN(IS=8.11E-14 BF=205 VAF=113 IKF=0.5 ISE=1.06E-11 NE=2 BR=4 VAR=24 IKR=0.225 RB=1.37 RE=0.343 RC=0.137 CJE=2.95E-11 TF=3.97E-10 CJC=1.52E-11 TR=8.5E-8 XTB=1.5)

Q3. Values of V_{CE}, I_C, I_E, I_B, V_E obtained are:

```
No. of Data Rows : 2
                  bjt common emitter amplifier characteristics
                  DC transfer characteristic  Thu Dec 30 11:49:09  2021
--------------------------------------------------------------------------------
Index   v-sweep         v(1,3)          v(3)
--------------------------------------------------------------------------------
0       0.000000e+00    -9.50284e-25    9.560875e-25
1       1.200000e+01    5.137738e+00    1.962002e+00
                  bjt common emitter amplifier characteristics
                  DC transfer characteristic  Thu Dec 30 11:49:09  2021
--------------------------------------------------------------------------------
Index   v-sweep         i(vdc)          i(vdb)          i(vde)
--------------------------------------------------------------------------------
0       0.000000e+00    -1.16064e-30    4.816066e-28    4.804460e-28
1       1.200000e+01    9.800520e-04    5.878563e-06    9.859306e-04
ngspice 6 ->
```

- ➔ V_{CE} = 5.13 V
- ➔ V_E = 1.96 V
- ➔ I_C = 0.98 mA
- ➔ I_E = 5.87 µA
- ➔ I_B = 0.985 Ma

Q4. Values of C_B, C_c, C_E for the signal frequency of 2 kHz to be in the mid-band region are:

C_B = 2.03 µF
C_C = 3.1u µF
C_E = 7.99 µF

Frequency response will look like:

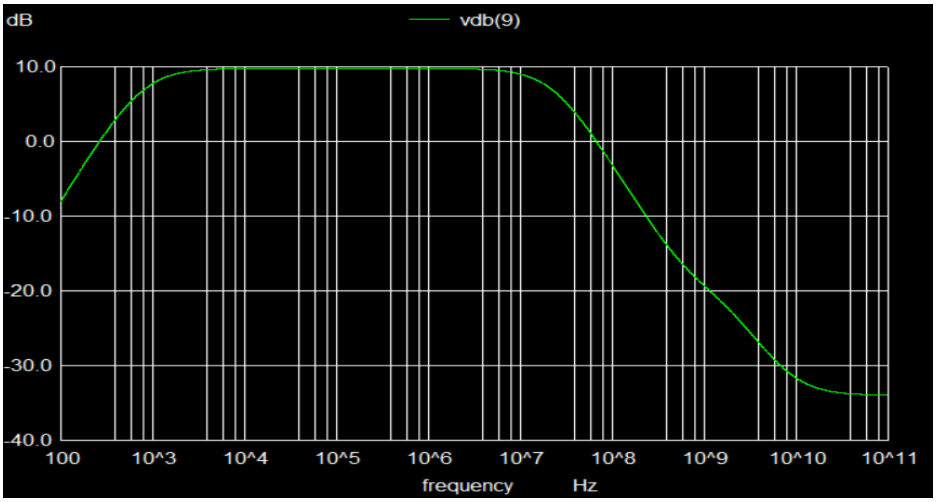
BJT Common Emitter Amplifier Characteristics
vin 8 0 dc=0 ac=100m
vcc 1 0 dc=12
vdc 6 3
vde 7 8
vdb 2 4

r1 1 2 36.08k
r2 2 0 10k
rc 1 6 5k
re 5 7 1.99k
rl 9 0 1k

q1 3 4 5 Q2N2222A

cb 2 8 2.03u
cc 6 9 3.1u
ce 5 0 7.99u

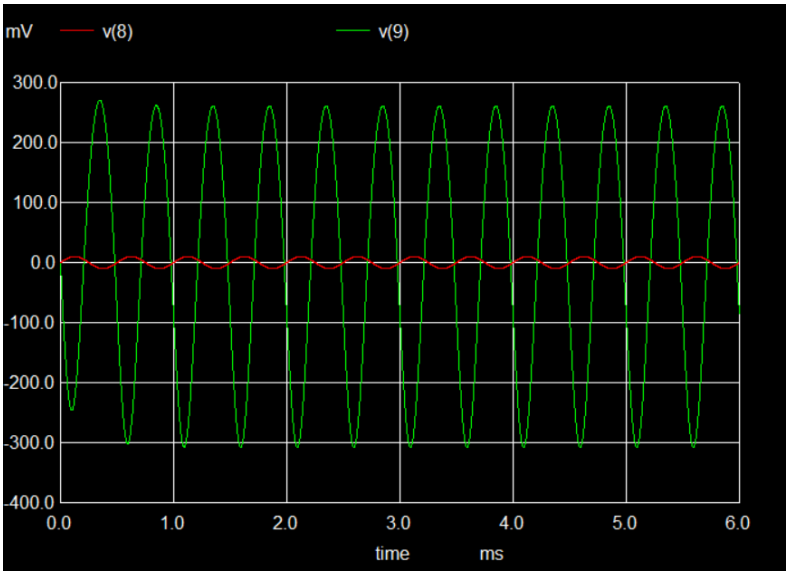
.model Q2N2222A NPN(IS=8.11E-14 BF=205 VAF=113 IKF=0.5 ISE=1.06E-11 NE=2 BR=4 VAR=24 IKR=0.225 RB=1.37 RE=0.343 RC=0.137 CJE=2.95E-11 TF=3.97E-10 CJC=1.52E-11 TR=8.5E-8 XTB=1.5)
.ac dec 1000 100 100G
***Control Statements**
.control
run
plot vdb(9) xlog
.endc
.end



Q5. Output voltage waveform and input voltage waveform

BJT Common Emitter Amplifier Characteristics

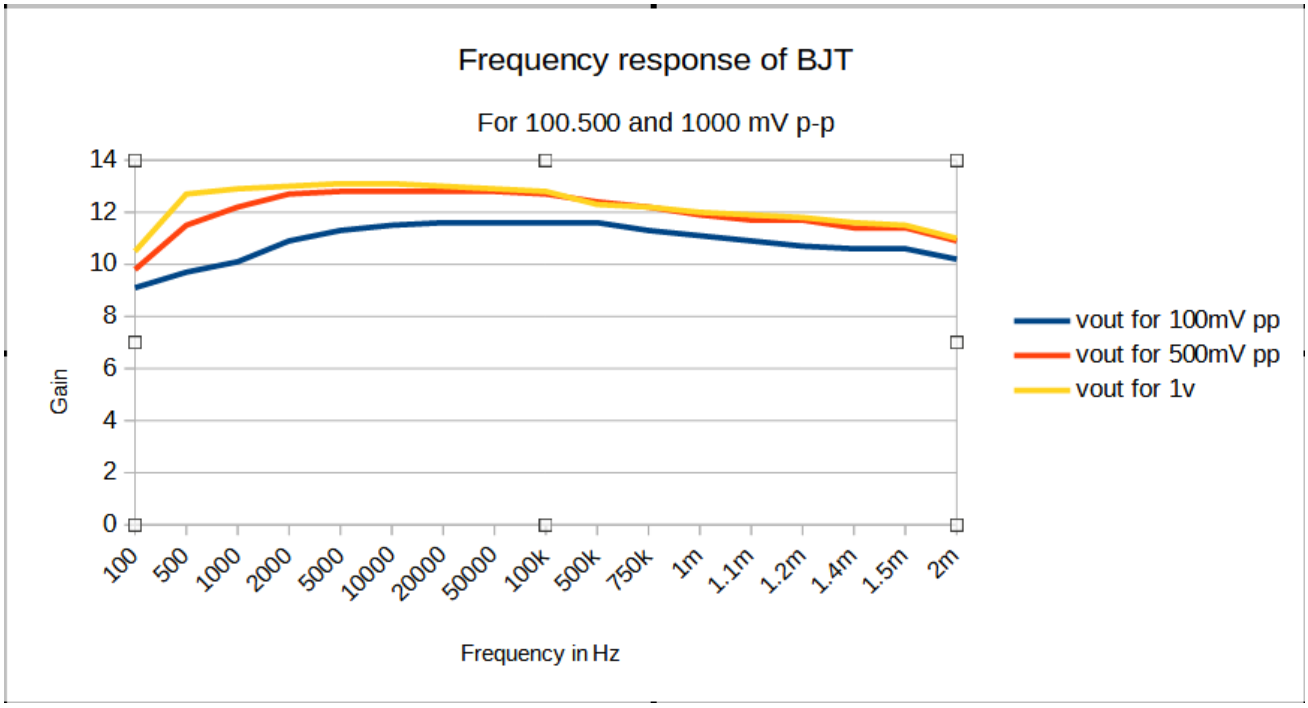
```
vin 8 0 sin(0 0.01 2000)
vcc 1 0 dc=12
vdc 6 3
vde 7 8
vdb 2 4

r1 1 2 36.08k
r2 2 0 10k
rc 1 6 5k
re 5 7 1.99k
rl 9 0 1k

q1 3 4 5 Q2N2222A

cb 2 8 2.03u
cc 6 9 3.1u
ce 5 0 7.99u

.model Q2N2222A NPN(IS=8.11E-14 BF=205 VAF=113 IKF=0.5 ISE=1.06E-11 NE=2 BR=4
VAR=24 IKR=0.225 RB=1.37 RE=0.343 RC=0.137 CJE=2.95E-11 TF=3.97E-10 CJC=1.52E-
11 TR=8.5E-8 XTB=1.5)
.tran 0.002ms 6ms
*Control Statements
.control
run
plot v(9) v(8)
.endc
.end
```



Hardware Exercise

Amplitude of the sinusoidal input = 200 mVp-p
Varying the frequency from 100 Hz to 1.5 MHz gives us:

Frequency(in Hz)	V_{out} for 100mV pp	V_{out} for 500mV pp	V_{out} for 1v
100	9.1	9.8	10.5
500	9.7	11.5	12.7
1000	10.1	12.2	12.9
2000	10.9	12.7	13
5000	11.3	12.8	13.1
10000	11.5	12.8	13.1
20000	11.6	12.8	13
50000	11.6	12.8	12.9
100k	11.6	12.7	12.8
500k	11.6	12.4	12.3
750k	11.3	12.2	12.2
1m	11.1	11.9	12
1.1m	10.9	11.7	11.9
1.2m	10.7	11.7	11.8
1.4m	10.6	11.4	11.6
1.5m	10.6	11.4	11.5
2m	10.2	10.9	11

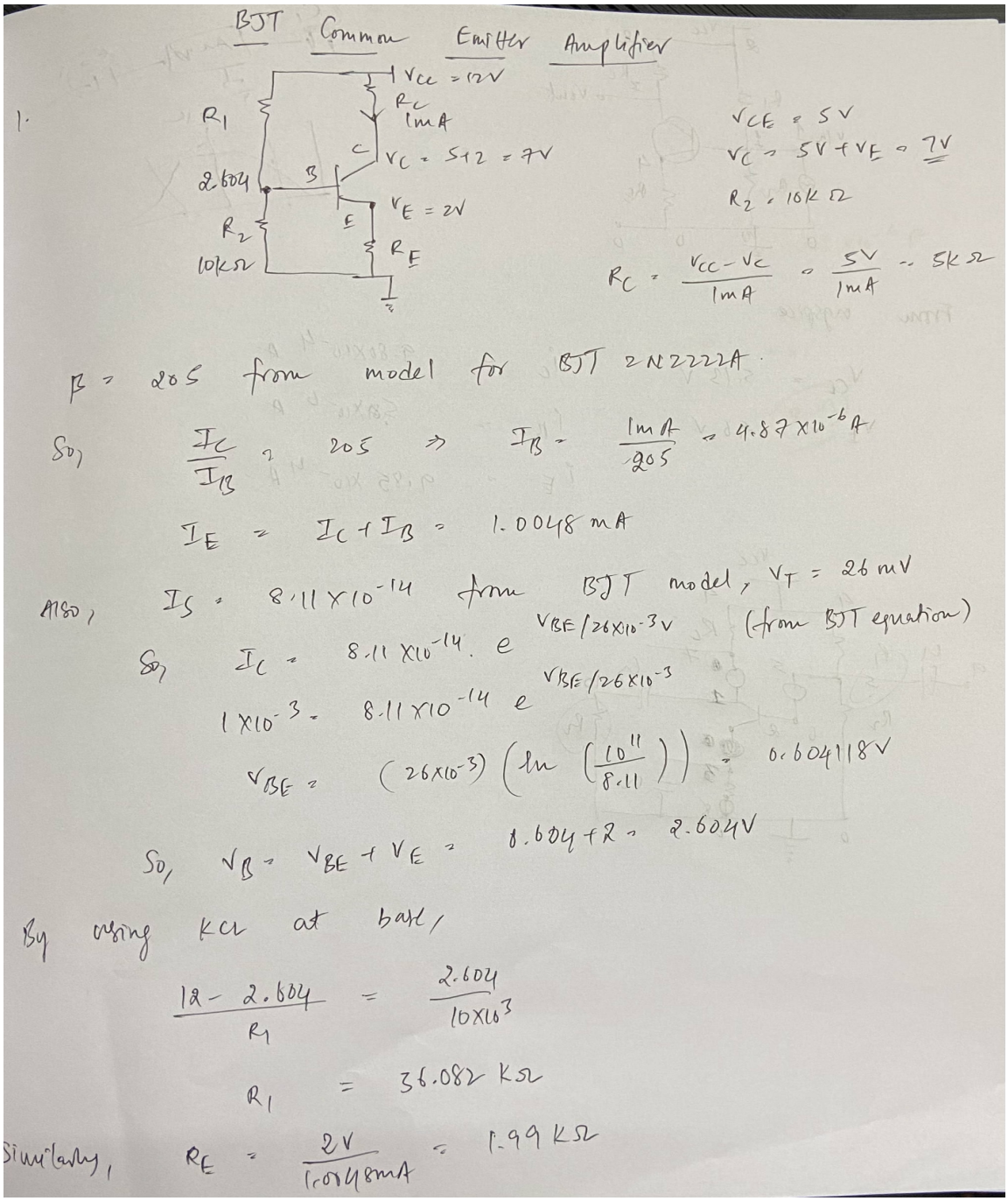


The gain is constant over a range of frequencies and increases and decreases before and after the range of frequencies.

After increasing the input amplitude to 500 mVp-p and 1Vp-p the output signal is clipped and clipping is prominently observed at higher voltages.

Discussion:

1. I understood how to implement a BJT circuit into a common emitter mode amplifier and found out the required resistances that need to be implemented in the circuit for the BJT to work as an amplifier.



2. Understood the frequency dependent amplification nature of the BJT CE amplifier and also adjusting the mid band range of frequencies by varying the capacitance values at emitter, base and collector regions of the BJT.
3. Operation of Arbitrary Function Generator (AFG) and Digital Oscilloscope for generation and analysis of Periodic signals at different frequencies.