Sheel Shah, 19D070052, Expt3

Q1.

Analysis:
Req = 2.2 || 10 = 1.8k. Veq = 12*2.2/12.2 = 2.16V.
Veq = ib x Req + 0.7 + (beta +1)*ib*Re => ib = 7.2 uA.
Ic = beta*ib => ic = 1.44 mA
Vo = 12 – ic*rc = 10.272V
Ve = (beta+1)*ib *re = 1.45V
Vb = Ve + 0.7 = 2.15V

Simulation:

```
v(1)  =  1.474208e+00
v(2)  =  2.143645e+00
v(3)  =  1.024445e+01
i(v2)  =  1.125117e-05
i(v3)  =  1.462957e-03
```

(refer to the code below to see what node number is what node)

Code:

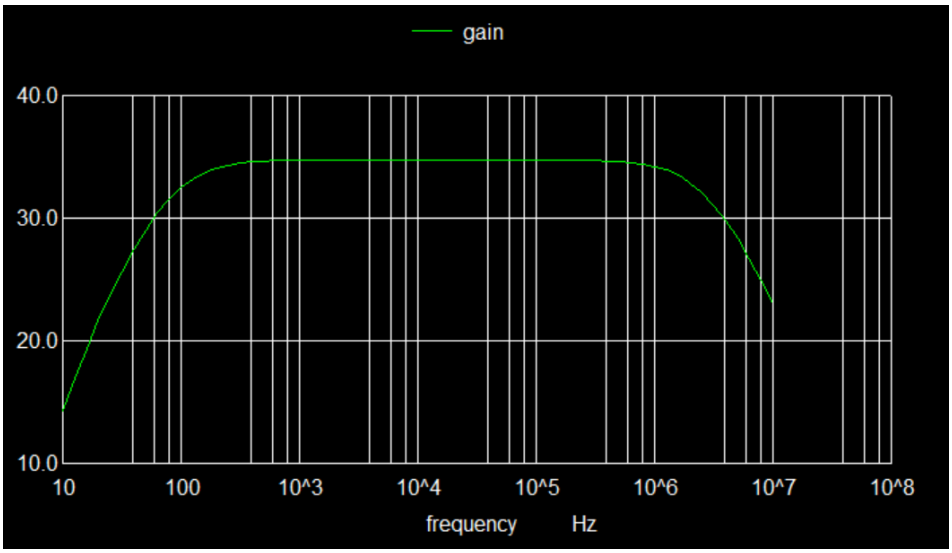
```
19D070052 Sheel Shah Expt3 CE Amp Biasing
.model bc547a NPN IS=10f BF=200 ISE=10.3f IKF=50m NE=1.3
+ BR=9.5 VAF=80 IKR=12m ISC=47p NC=2 VAR=10 RB=280 RE=1 RC=40
+ tr=0.3u tf=0.5n cje=12p vje=0.48 mje=0.5 cjc=6p vjc=0.7 mjc=
0.33 kf=2f
** nodes:
**   1 emitter, 2 base, 3 collector/output
**   4 Vcc
q0 3 2 1 bc547a
re 1 0 1k
r2 20 0 2.2k
r1 20 4 10k
v2 20 2 0
** to measure Ib
rc 4 30 1.2k
v3 30 3 0
** to measure Ic
vcc 4 0 12
.op
.control
run
print v(1)
print v(2)
print v(3)
print i(v2)
print i(v3)
.endc
.end
```

Learnings:

1. Not all the assumptions we make are accurate/correct.
2. Simulations and analysis can be slightly different, but shouldn't be too off.

Q2.

```
19D070052 Sheel Shah Expt3 CE Amp
.model bc547a NPN IS=10f BF=200 ISE=10.3f IKF=50m NE=1.3
+ BR=9.5 VAF=80 IKR=12m ISC=47p NC=2 VAR=10 RB=280 RE=1 RC=40
+ tr=0.3u tf=0.5n cje=12p vje=0.48 mje=0.5 cjc=6p vjc=0.7 mjc=
0.33 kf=2f
** nodes:
**   1 emitter, 2 base, 3 collector
**   4 Vcc
**   5 Vin
**   6 Vout
q0 3 2 1 bc547a
vcc 4 0 12
vin 5 0 dc 0 ac 10m
c1 5 2 10u
re 1 0 1k
ce 1 0 100u
r2 2 0 2.2k
r1 2 4 10k
rc 4 3 1.2k
c2 3 6 10u
rl 6 0 100k
.ac dec 10 10 0.01g
.control
run
let gain = vdb(6) - vdb(5)
meas ac peak MAX gain
let f3db = peak/sqrt(2)
meas ac fl WHEN gain=f3db RISE=1
meas ac fh WHEN gain=f3db FALL=1
plot gain
.endc
.end
```




```
peak                    =   3.474902e+01 at=   1.584893e+04
fl                      =   2.803502e+01
fh                      =   8.382100e+06
fh - fl = 8.382072e+06
```

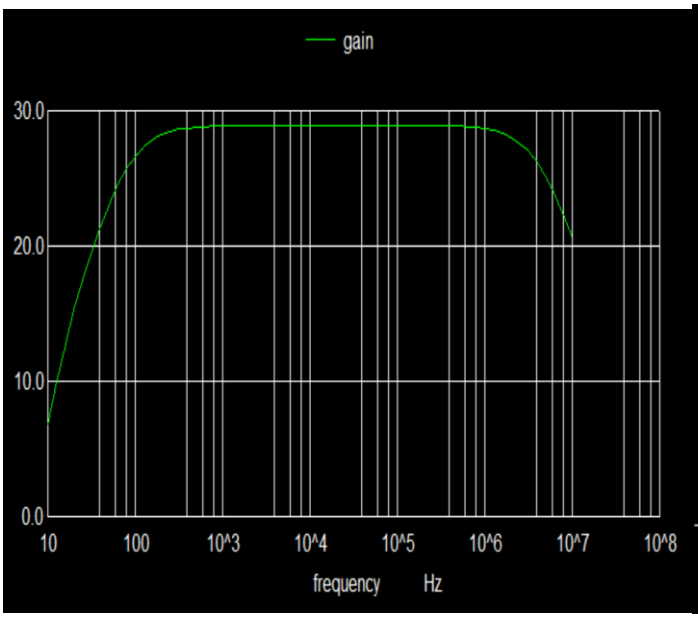
Learnings:

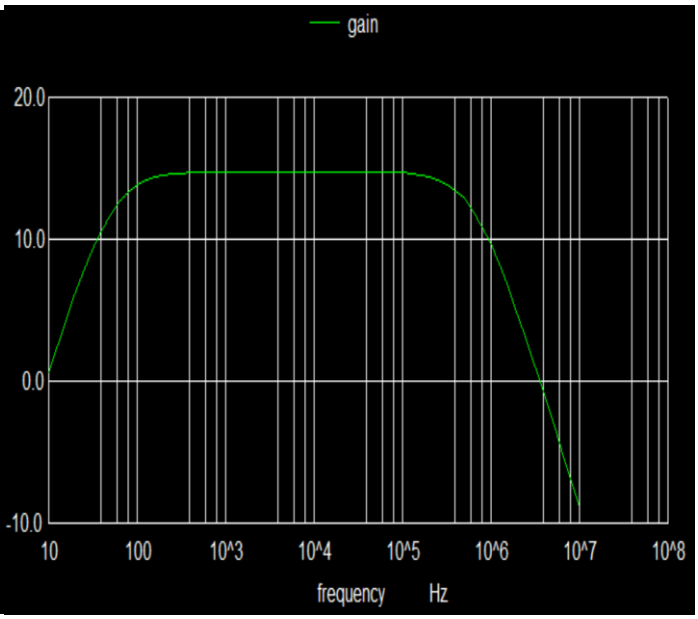
The CE amp has good gain, and a decent bandwidth. However, we know that Rin and Rout values are not appropriate.

Q3.

```
19D070052 Sheel Shah Expt3 CE Amp Biasing
.model bc547a NPN IS=10f BF=200 ISE=10.3f IKF=50m NE=1.3
+ BR=9.5 VAF=80 IKR=12m ISC=47p NC=2 VAR=10 RB=280 RE=1 RC=40
+ tr=0.3u tf=0.5n cje=12p vje=0.48 mje=0.5 cjc=6p vjc=0.7 mjc=0.33 kf=2f
** nodes:
**   1 emitter, 2 base, 3 collector
**   4 Vcc
**   5 Vin
**   6 Vout
q0 3 2 1 bc547a
vcc 4 0 12
vin 5 0 dc 0 ac 10m
rs 5 50 0
** rs is changed
c1 50 2 10u
re 1 0 1k
ce 1 0 100u
r2 2 0 2.2k
r1 2 4 10k
rc 4 3 1.2k
c2 3 6 10u
rl 6 0 100k
** rl is changed
.ac dec 10 10 0.01g
.control
run
let gain = vdb(6) - vdb(5)
meas ac peak MAX gain
let f3db = peak/sqrt(2)
meas ac fl WHEN gain=f3db RISE=1
meas ac fh WHEN gain=f3db FALL=1
plot gain
.endc
.end
```

When Rl is 12k, gain is 34.038 dB. When Rl is 1.2k, gain is 28.917 dB.
When Rs is 2.2k, gain is 25.283 dB. When Rs is 10k, gain is 14.774 dB.





Learning:

Gain is directly proportional to Rc||Rl and hence decreases with Rl.
As Rs increases, gain decreases.

Q4.

```
19D070052 Sheel Shah Expt3 CE Amp Biasing
.model bc547a NPN IS=10f BF=400 ISE=10.3f IKF=50m NE=1.3
+ BR=9.5 VAF=80 IKR=12m ISC=47p NC=2 VAR=10 RB=280 RE=1 RC=40
+ tr=0.3u tf=0.5n cje=12p vje=0.48 mje=0.5 cjc=6p vjc=0.7 mjc=0.33 kf=2f
** nodes:
**   1 Vin, 2 Rs-C1, 3 base1
**   4 emitter1
**   5 collector1, 6 base2
**   7 emitter2, 8 Re2
**   9 vcc/collector2
**   10 vout
vin 1 0 dc 0 ac 10m
vcc 9 0 12

rs 1 2 0
c1 2 3 10u

q1 5 3 4 bc547a
r2 3 0 2.2k
r1 3 9 10k
re 4 0 1k
ce 4 0 100u
rc 5 9 1.2k

vib2 5 6 0
vie2 7 8 0

q2 9 6 7 bc547a
re2 8 0 10k
c2 7 10 10u
rl 10 0 10k

.op
.control
run
print i(vib2) i(vie2)
.endc
.end
```

```
i(vib2) = 5.550494e-06
i(vie2) = 9.566787e-04
```

Learnings:

The CC amp buffer helps increase Rin, as well as decrease Rout, making the overall amplifier much better.