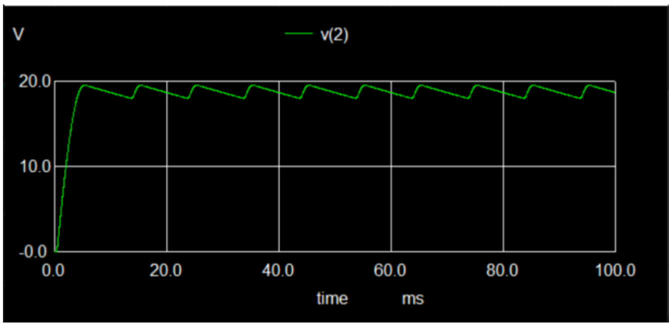
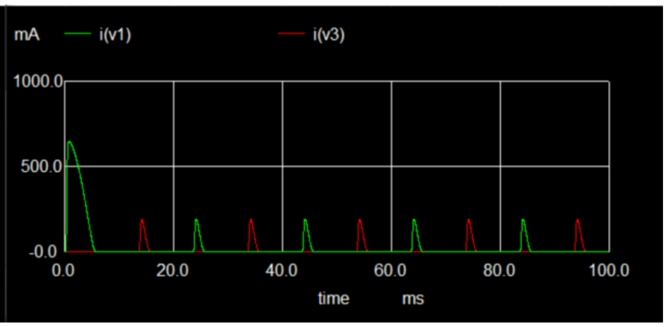
19D070052, Sheel Shah, Expt2 Report

Q1.

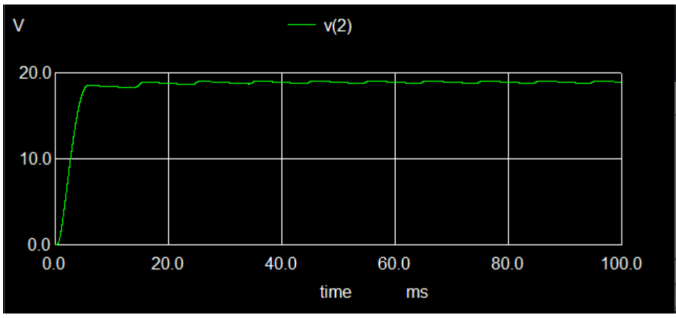
```
19D070052 Sheel Shah Expt2 Bridge Rectifier
.include all_model_files/Diode_1N914.txt
v0 1 3 sin(0 21.213 50 0 0)
d1 11 2 1N914
v1 1 11
** to measure current across d1
d2 0 1 1N914
d3 31 2 1N914
v3 3 31
** to measure currentb across d3
d4 0 3 1N914
r0 2 0 0.5k
c0 2 0 1000u
** Vout at node 2
.tran 10u 100m
.control
run
plot v(2)
plot i(v1), i(v3)
.endc
.end
```

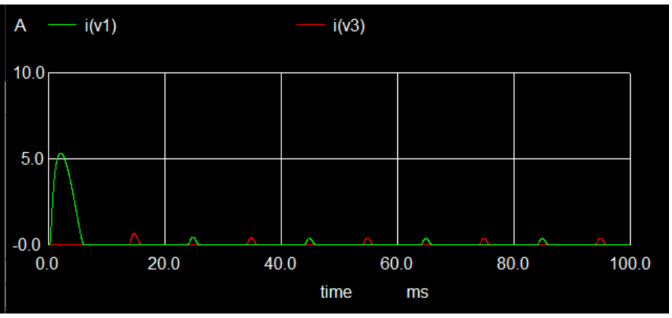
Rl = 1k, C = 100u





Rl = 0.5k, C = 1000u





Learnings:

Capacitors are good at making the output almost DC, but if too large a capacitance is used, it leads to excess currents in the diode causing them to burn. The large currents are due to the charge required by the capacitor to charge. Hence a medium capacitor along with some other mechanism to stabilize the DC output should be used.

Q2.

```
19D070052 Sheel Shah Expt2 Zener Diode
.include all_model_files/Diode_1N914.txt
v0 1 0 20
rs 12 2 470
v1 1 12
.SUBCKT ZENER_12 2 3
** between 2 and 3, with 23 as the centre dummy node
D1 2 3 DF
DZ 23 2 DR
VZ 3 23 10.8
.MODEL DF D ( IS=27.5p RS=0.620 N=1.10 CJO=78.3p VJ=1.00 M=0.330
TT=50.1n )
.MODEL DR D ( IS=5.49f RS=50 N=1.77 )
.ENDS
x1 21 22 ZENER_12
rz 0 21 125
v2 2 22
** to measure current Iz
rl 2 32 1k
** vary in part c
v3 32 0
** to measure Il
.op
** .dc v0 15 25 1
** used in part b
.control
run
print v(2), i(v1), i(v2), i(v3)
.endc
.end
```

Part A:

```
v(2) = 1.259358e+01
i(v1) = 1.575833e-02
i(v2) = 3.164745e-03
i(v3) = 1.259358e-02
```

Part B:

Index	v-sweep	v(2)	i(v1)	i(v2)	i(v3)
0	1.500000e+01	1.020408e+01	1.020408e-02	3.710267e-11	1.020408e-02
1	1.600000e+01	1.088435e+01	1.088435e-02	3.846324e-11	1.088435e-02
2	1.700000e+01	1.156459e+01	1.156469e-02	9.835770e-08	1.156459e-02
3	1.800000e+01	1.206175e+01	1.263458e-02	5.728260e-04	1.206175e-02
4	1.900000e+01	1.233694e+01	1.417673e-02	1.839795e-03	1.233694e-02
5	2.000000e+01	1.259393e+01	1.575760e-02	3.163669e-03	1.259393e-02
6	2.100000e+01	1.284528e+01	1.735046e-02	4.505178e-03	1.284528e-02
7	2.200000e+01	1.309327e+01	1.895049e-02	5.857216e-03	1.309327e-02
8	2.300000e+01	1.333989e+01	2.055342e-02	7.213532e-03	1.333989e-02
9	2.400000e+01	1.358561e+01	2.215827e-02	8.572659e-03	1.358561e-02
10	2.500000e+01	1.383060e+01	2.376468e-02	9.934078e-03	1.383060e-02

For V_in <= 17V, V_out drops rapidly below 12V, as the Zener diode is not active for V_in less than 17.64V (from theory)

Part C:

Via trial and error, the minimum R_l was found to be 720 ohms, which is close to the theoretic value 705 ohms (ignoring Zener resistance)

Learnings:

The Zener diode method does well for a good amount of change in V_in. It won’t work for applications where R_l/V_in is likely to vary a lot.

Q3.

```
19D070052 Sheel Shah Expt2 BJT
.include all_model_files/Zener_B.txt
.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
.model SL100 NPN IS=100f BF=80 ISE=10.3f IKF=50m NE=1.3
+ BR=9.5 VAF=80 IKR=12m ISC=47p NC=2 VAR=10 RB=100 RE=1 RC=10
+ 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 = collector of q1
** 2 = base of q1 / collector q2
** 3 = emitter of q1 / Vout
** 4 = base of q2 / Vb
** 5 = emitter of q2 / zener cathode
v0 1 0 20
q1 1 2 3 SL100
r0 1 2 1k
q2 2 4 5 bc547a
x1 0 5 DI_1N4734A
r1 3 4 11.27k
r2 4 0 13.73k
** both are 12.5k in part a
rl 3 0 1k
** .op
** for part a/b
.dc v0 15 25 0.5
.control
run
print v(1), v(2), v(3), v(4), v(5)
.endc
.end
```

Part A:

```
v(1) = 2.000000e+01
v(2) = 1.374712e+01
v(3) = 1.304369e+01
v(4) = 6.235345e+00
v(5) = 5.512430e+00
```

Part B:

Resistor values are in the code above

Part C: (refer to comments in the code to see what each node is)

Index	v-sweep	v(1)	v(2)	v(3)	v(4)	v(5)
0	1.500000e+01	1.500000e+01	1.216051e+01	1.146358e+01	6.169627e+00	5.479771e+00
1	1.550000e+01	1.550000e+01	1.222032e+01	1.152334e+01	6.182034e+00	5.486292e+00
2	1.600000e+01	1.600000e+01	1.227586e+01	1.157886e+01	6.191674e+00	5.491149e+00
3	1.650000e+01	1.650000e+01	1.233105e+01	1.163402e+01	6.200982e+00	5.495800e+00
4	1.700000e+01	1.700000e+01	1.238527e+01	1.168823e+01	6.209564e+00	5.500013e+00
5	1.750000e+01	1.750000e+01	1.243873e+01	1.174167e+01	6.217503e+00	5.503836e+00
6	1.800000e+01	1.800000e+01	1.249162e+01	1.179455e+01	6.224913e+00	5.507339e+00
7	1.850000e+01	1.850000e+01	1.254411e+01	1.184703e+01	6.231879e+00	5.510570e+00
8	1.900000e+01	1.900000e+01	1.259630e+01	1.189922e+01	6.238467e+00	5.513571e+00
9	1.950000e+01	1.950000e+01	1.264831e+01	1.195122e+01	6.244730e+00	5.516372e+00
10	2.000000e+01	2.000000e+01	1.270021e+01	1.200311e+01	6.250710e+00	5.518999e+00
11	2.050000e+01	2.050000e+01	1.275206e+01	1.205495e+01	6.256442e+00	5.521472e+00
12	2.100000e+01	2.100000e+01	1.280391e+01	1.210680e+01	6.261955e+00	5.523810e+00
13	2.150000e+01	2.150000e+01	1.285582e+01	1.215869e+01	6.267273e+00	5.526027e+00
14	2.200000e+01	2.200000e+01	1.290781e+01	1.221067e+01	6.272418e+00	5.528134e+00
15	2.250000e+01	2.250000e+01	1.295991e+01	1.226277e+01	6.277406e+00	5.530144e+00
16	2.300000e+01	2.300000e+01	1.301216e+01	1.231501e+01	6.282253e+00	5.532064e+00
17	2.350000e+01	2.350000e+01	1.306458e+01	1.236741e+01	6.286972e+00	5.533903e+00
18	2.400000e+01	2.400000e+01	1.311718e+01	1.241999e+01	6.291574e+00	5.535668e+00
19	2.450000e+01	2.450000e+01	1.316998e+01	1.247278e+01	6.296070e+00	5.537364e+00
20	2.500000e+01	2.500000e+01	1.322301e+01	1.252578e+01	6.300469e+00	5.538997e+00

Learnings:

This does much better than the Zener diode method, and the output is within +- 0.6V of 12V which is really good as V_in varies over +- 5V of 20V