

# EE230: Lab-2

## Unregulated DC Power Supply Learning

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### **1 Overview of the experiment**

#### **1.1 Aim of the experiment**

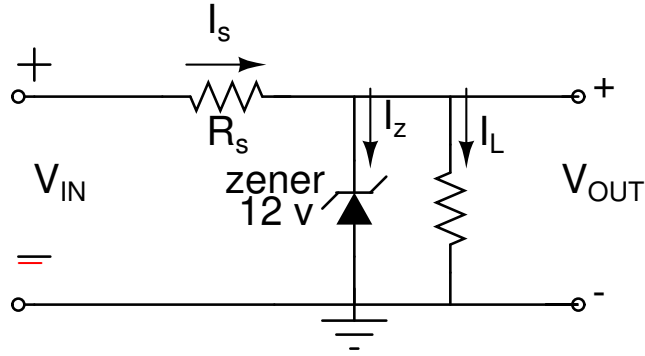
1. Understanding the limits of performance of a Zener regulator
2. Understanding a BJT based series voltage regulator to appreciate the basic blocks of an IC voltage regulator.

#### **1.2 Methods**

We start by analysing the circuits and then simulating in ngspice to check against theoretical expectations.

## 2 Design

### 2.1 Zener Regulator



In non conduction region :

$$I_z = 0$$

$$V_{out} < 12V$$

$$V_{out} = \frac{V_{in}}{R_s + R_l}$$

In conduction region : Using  $R_z = 125\Omega$  and  $V_z = 12V$

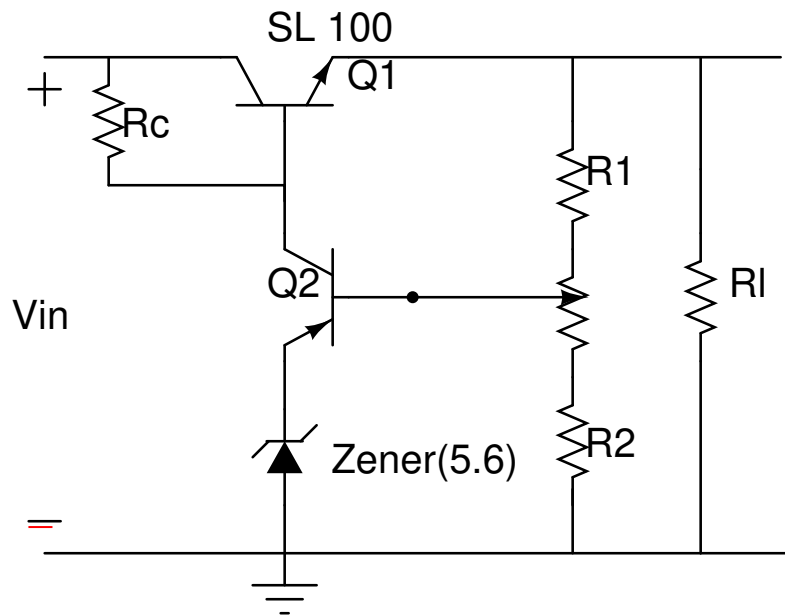
$$V_{out} \geq 12V$$

$$V_{out} = (V_{in}/R_s + 12/125)/(1/R_s + 1/R_z + 1/R_l)$$

$$I_s = (V_{in} - V_{out})/R_s$$

$$I_z = (V_{out} - 12)/125$$

## 2.2 BJT Series Regulator



## 3 Simulation results

### 3.1 Zener Regulator

#### 3.1.1 Code snippet

```
1 Zener Regulator Circuit
2
3 *Defining zener Subckt
4 .MODEL DF D ( IS=27.5p RS=0.620 N=1.10 CJO=78.3p VJ=1.00 M
   =0.330 TT=50.1n)
5 .MODEL DR D ( IS=5.49f RS=50 N=1.77 )
6 .SUBCKT ZENER_12 1 2
7 D1 1 2 DF
8 DZ 3 1 DR
9 VZ 2 3 10.8
10 .ENDS
11
12 *describe circuit
13 * <element-name> <nodes> <value/nodel>
14 Vin 1 0 dc 20
15
16 Vrs 2 3 dc 0
17 Rs 1 2 470
18
19 x3 4 3 ZENER_12
20 Viz 4 0 dc 0
21
22 RL 3 5 1k
23 Vil 5 0 dc 0
24
25 *analysis commandx
26
27 .op
28
29 .control
30 run
31
32 *display cmd
33 print v(3) i(Vrs) i(Vil) i(Viz)
34 *end control mode
35 .endc
36
37 *end netlist
38 .end
```

### 3.1.2 Simulation results

## 3.2 BJT Series Regulator

### 3.2.1 Code snippet

```
1 BJT Regulator Circuit
2
3 .include zener_B.txt
4 *Defining Models
5 .model bc547a NPN (IS=10f BF=200 ISE=10.3f IKF=50m NE=1.3
6 + BR=9.5 VAF=80 IKR=12m ISC=47p NC=2 VAR=10 RB=280 RE=1 RC=40
7 + tr=0.3u tf=0.5n cje=12p vje=0.48 mje=0.5 cjc=6p vjc=0.7 mjc
   =0.33 kf=2f)
8
9 .model SL100 NPN (IS=100f BF=80 ISE=10.3f IKF=50m NE=1.3
10 + BR=9.5 VAF=80 IKR=12m ISC=47p NC=2 VAR=10 RB=100 RE=1 RC=10
11 + tr=0.3u tf=0.5n cje=12p vje=0.48 mje=0.5 cjc=6p vjc=0.7 mjc
   =0.33 kf=2f)
12
13 *describe circuit
14 * <element-name> <nodes> <value/nodel>
15 Vin 1 0 dc 20
16 RC 1 3 1K
17 Q1 1 3 2 SL100
18 Q2 3 4 5 bc547a
19 xz 0 5 DI_1N4734A
20 R1 2 4 12.5K
21 R2 0 4 12.5K
22 RL 2 0 1k
23
24 *analysis commandx
25 .op
26
27 .control
28 run
29
30 *display cmd
31 print v(1) v(2) v(3) v(4) v(5)
32 *end control mode
33 .endc
34
35 *end netlist
36 .end
```

### 3.2.2 Simulation results

#### Zener Regulator

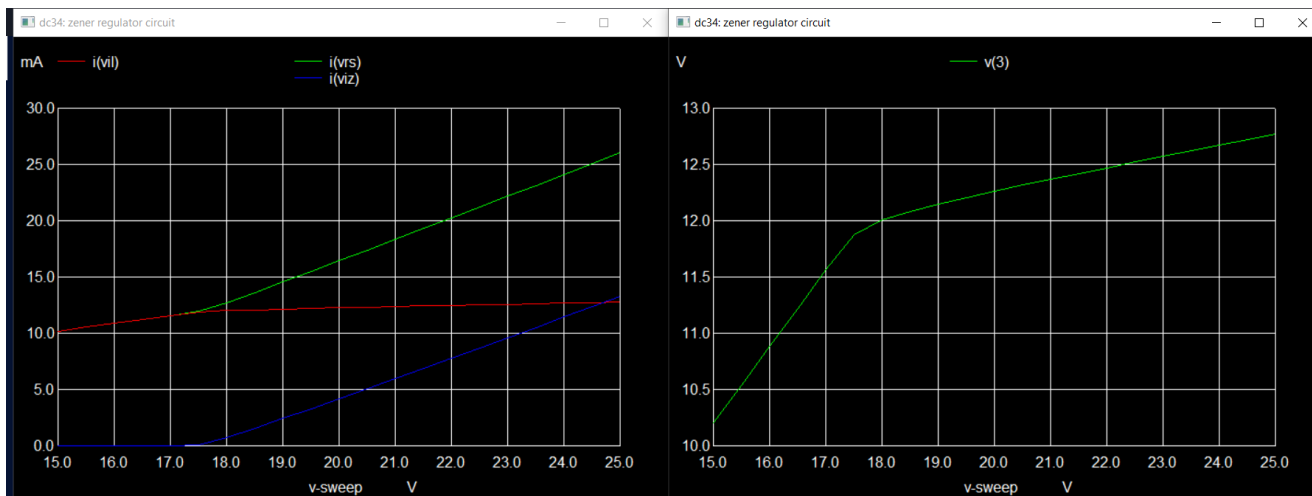
```
ngspice 36
o compatibility mode selected!

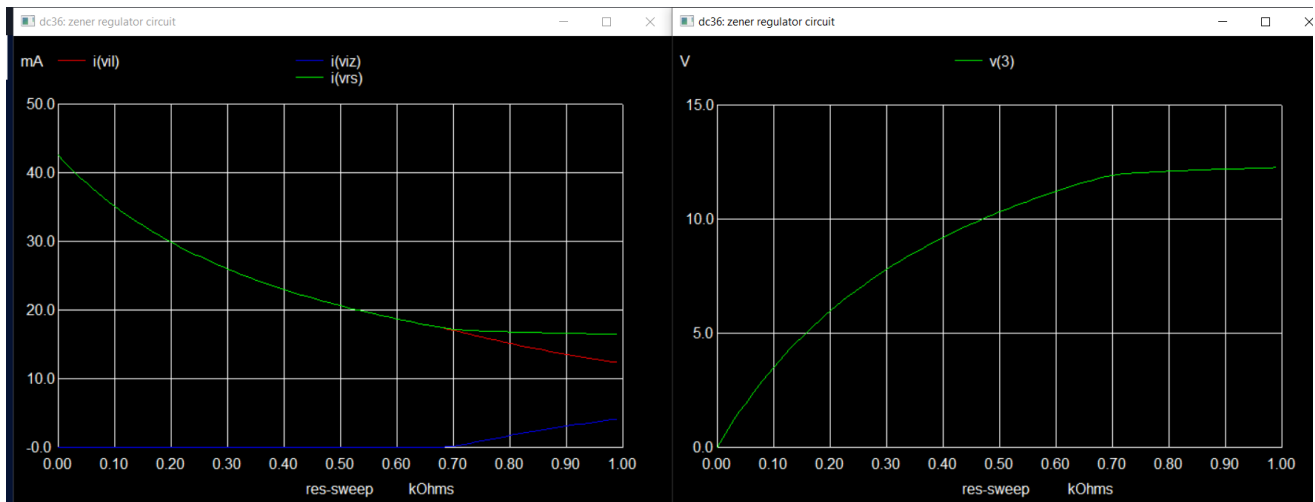
ircuit: zener regulator circuit

oing analysis at TEMP = 27.000000 and TNOM = 27.000000

o. of Data Rows : 1
(3) = 1.226269e+01
(vrs) = 1.646236e-02
(vil) = 1.226269e-02
(viz) = 4.199669e-03
gspice 39 ->
```

ener-Regulator-A.cir -- ready -- Quit





## BJT Series Regulator

```

ngspice 36
Circuit: bjt regulator circuit
Doing analysis at TEMP = 27.000000 and TNOM = 27.000000

No. of Data Rows : 1
v(1) = 2.000000e+01
v(2) = 1.304369e+01
v(3) = 1.374712e+01
v(4) = 6.235345e+00
v(5) = 5.512430e+00
ngspice 44 ->

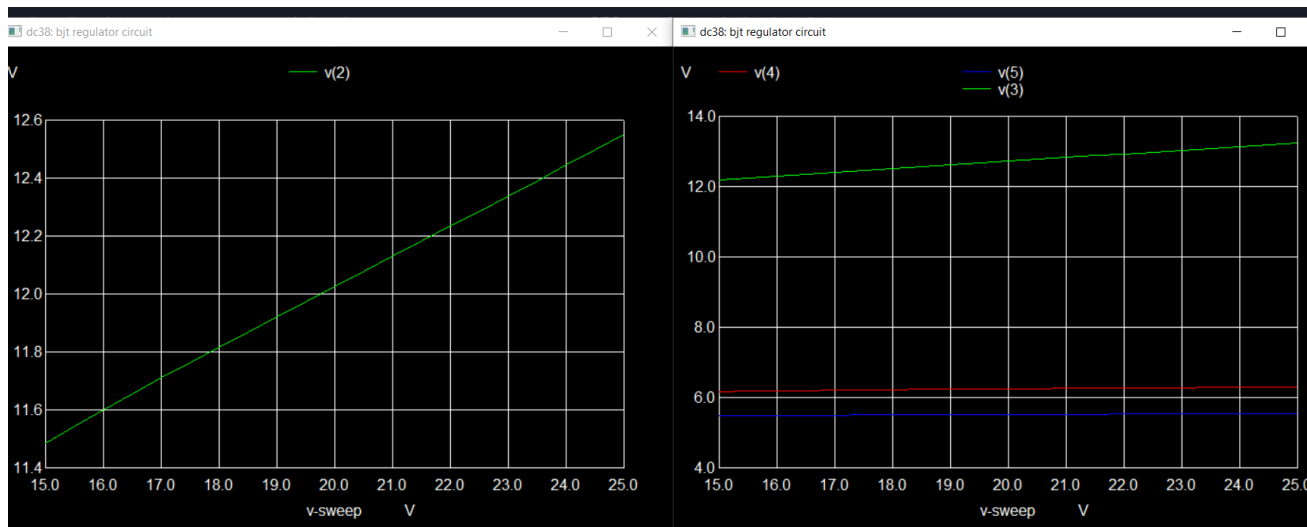
```

```
ngspice 36

Circuit: bjt regulator circuit
Doing analysis at TEMP = 27.000000 and TNOM = 27.000000

No. of Data Rows : 1
v(1) = 2.000000e+01
v(2) = 1.202664e+01
v(3) = 1.272388e+01
v(4) = 6.250379e+00
v(5) = 5.518861e+00
ngspice 45 ->
```

**BJT-Regulator-B.cir**      -- ready --      Quit



## 4 Experiment completion status

All the sections were completed