PURPOSE:

The purpose of this experiment is to design, build and test a variable-voltage operational amplifier regulated DC power supply with internal current limit.

PRELIMINARY WORK:

Suggested circuit diagram of the voltage-regulator/current-limiter section of the power supply you are required to design is given in the attached page. (You may opt for a different circuit as long as it satisfies the requirements/specifications of the design). A list of the components available in the C.I.E. laboratory for this experiment is given below.

Transformer: 120VRMS primary to 12V-0-12V 0.45A secondary
Capacitors: 4700 uF maximum, electrolytic
Transistors: TIP39A NPN Power (β=60) 5W with heat sink
2N2222A NPN (β=100)
Zener Diode: 1N4735 6.2V 500mW I_zmin < 1 mA
Potentiometer: 10 K linear taper
Rectifier Diodes: 1N4001 1 A max DC current  R_F = 1 ohm

Within the limitations of the components given above, design a variable DC power supply which will deliver,

\[ V_{Load} = V_{Set} = \text{Constant} \]

as long as \( I_{Load} < I_{Limit} = 0.25 \text{ Amp} \)

where \( V_{Set} \) is a voltage value set by the potentiometer in the circuit. Design the regulator so that \( V_{Set} \) reaches an absolute maximum output voltage the regulator can deliver (\( V_{Max} \)) at about 80% position of the potentiometer. Note that \( V_{Max} \) is determined by the unregulated supply voltage, the op.amp.’s maximum output voltage or current and the transistor voltage drops.
Calculate $V_{\text{Max}}$ and the worst case values of (i.e. when $I_{\text{Load}} = I_{\text{Limit}} = 0.25$ Amp) the unregulated supply voltage $V_{\text{CC}}$, the peak-to-peak ripple voltages on $V_{\text{CC}}$, across the Zener diode and across the load when $V_{\text{Set}}$ is 5VDC.

**EXPERIMENT:**

A. **DC Voltage Regulator Test:**

A.1 Hook up the DC voltage regulator part of your design and check its operation. Use your bench power supply to power it at $\pm 12$VDC. With a 220 $\Omega$ resistor connected as its load check if its Zener is delivering 6.2VDC and if the potentiometer is controlling its output.

A.2 Load-test the regulator at $V_{\text{Set}} = 5$VDC. Use $R_L = 1$ K$\Omega$, 100 $\Omega$, 50 $\Omega$, 33 $\Omega$, 20 $\Omega$, 10 $\Omega$, 1$\Omega$ and short circuit to measure and plot $V_{\text{Load}}$ vs. $I_{\text{Load}}$ characteristics. From the curves determine the "Percent Load Regulation" and the Thevenin equivalent source resistance between 0 and 0.25 A.

A.3 Vary the bench supply's voltage between $\pm 12$VDC and $\pm 10$VDC to determine the regulator's "Line Regulation" in units of $\%$.

B. **Power Supply Test:**

B.1 Hook up the rest of your circuit and repeat A.2 and A.3. At each point in the measurements record the RMS and the peak-to-peak ripple voltages at the rectifier output, across the Zener diode and across the load. Plot peak-to-peak ripple voltages as a function of the load current.

For "Line Regulation" tests use a "Variac".

**SAFETY WARNING !** The secondary of the variac is not isolated from the line. Make sure you do not touch any terminals of the variac and use a portable meter with no connection to ground to measure its voltage. The oscilloscope and the other C.I.E. bench equipment can be damaged if they are used to measure the output of such a variac.

**CONCLUSIONS/DISCUSSIONS:**

1. Compare the test results with your design calculations and explain the differences.

2. Prepare a spec. sheet of the"Variable Voltage DC Power Supply" you have designed and tested.

3. Based on your experience, what modifications do you think you would have to make to bring the voltage output to 0 - 20VDC and the current level to 0.5A, guaranteed?

Give a list of the parts needed and estimate the cost of such a power supply using prices from catalogs such as Allied Electronics or Newark Electronics.
6.2V

V+supply

V-supply

+ -

Vout

10K Pot

1N4735

R1

LM741

2N2222

TIP29A

R2

R3

R4

LOAD

10K Pot

MGG/OpAmp2-04Regulator-L14