PROJECT ABSTRACT

Adjustable DC Bench Power Supply with Digital Voltage Display

The most-used instrument on any electronics workbench, built by the student: a 0–30 V / 3 A linear bench supply with adjustable current limit, digital voltmeter/ammeter, CC/CV indicators and short-circuit protection — series-pass regulation, op-amp feedback loops and full thermal design, documented stage by stage.

Project type: Hardware prototype

Availability: Built to order

Price: Request a quotation

Suitable branches: Electronics / E&TC, Electrical

Technologies: Linear series-pass regulation, op-amp feedback loops, 2N3055 pass transistor, digital panel meters, CC/CV logic

Prepared by Projectech · projectech.in — for academic project reference.

1. Introduction / Background

Every electronics lab runs on its bench power supplies, yet most students only ever turn the knobs — they never learn why a linear supply is heavy, why it gets hot at low voltage and high current, or what the current-limit knob actually does to the control loop. Building one answers all of it. This project is the canonical student linear supply: a mains transformer and bridge rectifier feed unregulated DC to a series-pass power transistor driven by an op-amp error amplifier, which holds the output at the knob-set voltage against load changes. A second loop watches the output current and folds the voltage back when the set limit is reached — the CC/CV behavior that makes the supply inherently short-circuit proof. Digital panel meters show volts and amps, and the enclosure, binding posts and calculated heatsink make it a genuinely usable bench instrument.

2. Problem Statement

Power-supply theory (rectification, feedback regulation, current limiting, thermal design) is taught as separate chapters, and students never see them interact. The project addresses this with a single build where every stage is sized, calculated and measured by the student: the heatsink math, the loop behavior at the CC/CV boundary, and the ripple on the output are all their own work.

3. Objectives

- Build a 0–30 V / 0–3 A adjustable linear supply with independent current limit.
- Implement op-amp voltage-regulation and current-limit feedback loops with CC/CV indication.
- Size the heatsink by thermal calculation for worst-case dissipation.
- Provide digital voltage/current metering and standard binding-post outputs.
- Make the design short-circuit proof through the current-limit loop.
- Deliver stage-by-stage documentation plus the full student kit.

4. Proposed Methodology

The supply is built stage by stage. (1) Power: a 230 V to ~24 V mains transformer, bridge rectifier and reservoir capacitor produce unregulated DC. (2) Regulation: a 2N3055-class series-pass transistor driven by an op-amp error amplifier compares a divided output sample against the voltage-knob reference; a second op-amp loop senses current across a shunt and takes over at the current-knob limit. (3) Instrumentation and packaging: 3-digit voltmeter/ammeter modules, CC/CV LEDs, multi-turn setting pots and 4 mm binding posts on a labeled front panel, all in a ventilated metal enclosure with mains fuse and switch. The heatsink is selected from the worst-case dissipation calculation included in the report.

5. System Architecture / Working

The transformer, rectifier and reservoir capacitor deliver unregulated DC to the series-pass transistor. The voltage loop's error amplifier drives the pass transistor to hold the knob-set output against load and line changes. The current loop monitors the shunt: at the set limit it pulls the output voltage down to hold current constant, lighting the red CC LED while the green CV LED shows normal voltage regulation. Panel meters display volts and amps continuously. Under a short circuit the current loop clamps the output at the set current while the calculated heatsink absorbs the pass transistor's dissipation.

6. Hardware / Software Requirements

- 230 V to ~24 V mains transformer
- Bridge rectifier + reservoir capacitor
- 2N3055-class series-pass transistor on calculated heatsink
- Op-amp error amplifier (voltage loop) + op-amp current-limit loop with shunt
- 3-digit LED voltmeter + ammeter panel modules

- Multi-turn potentiometers for voltage/current setting
- 4 mm binding posts + chassis ground, metal enclosure, mains fuse + switch
- Heatsink thermal-sizing calculation sheet

7. Expected Outcomes

- A working 0–30 V / 3 A bench supply with smooth CC/CV behavior.
- A verified heatsink thermal design the student calculated themselves.
- Measured ripple and regulation figures from the student's own test procedure.
- A complete report, PPT and viva Q&A; on linear regulation and thermal design.

8. Applications

- Everyday bench power for electronics labs, hobby benches and project work.
- Teaching rectification, feedback control and thermal design by construction.
- Safe current-limited power for testing student prototypes.

9. Future Scope

- Dual/tracking second output for op-amp circuit work.
- Digital (microcontroller) voltage/current setting with display.
- Switch-mode pre-regulator for higher efficiency (hybrid topology).
- USB logging of voltage/current profiles.