University of British Columbia
Electrical and Computer Engineering
ELEC 302
Electronic Circuits for Electromechanical Design
Instructor: Dr. Kenichi Takahata

Laboratory 1 – Power Supplies and Voltage Regulators

Introduction

In this laboratory, you will build power supply circuits using a step-down transformer, diode rectifiers, and capacitor filters. You will also build a voltage regulator using a Zener diode.

Before you start, make sure to read **Lab Instructions.pdf** posted on the course website. This laboratory also assumes that you have read **Oscilloscope operation & Part identification.pdf**.

Components Required for the Laboratory

- One center-tap-step-down transformer
- One oscilloscope
- Four diodes 1N4005
- One 5.1-V zener diode 1N5338B
- Capacitors and resistors

Pre-Laboratory Assignments

1) Read the description of Tasks 1-3 assigned in these sheets.
2) Review the lecture notes and the sections in Chapter 3 of the text for the following circuits: half wave rectifier, full wave rectifier using a center tap transformer, and full wave rectifier using a bridge circuit. Find the formula for each circuit to calculate the corresponding filter capacitor. Also review relevant supplementary materials referred to in class.
3) Find the data sheets for the rectifier diode and the zener diode listed above.
4) For Task 3, draw the circuit diagram of a 5.1-V Zener voltage regulator. Calculate the resistance coupled in series with the Zener diode so to have a standby (no load) current of 66.7 mA. Assume the input voltage to the regulator is around 15 V.

References

A.S. Sedra, K.C. Smith, "Microelectronic Circuits 5th Edition," Oxford University Press

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Task 1: Half-Wave Rectifier and Filter

1) Measure the output RMS voltage of the center-tap-step-down transformer available in the lab using an oscilloscope. Also connect one of the outputs of the transformer (using the center tap as reference) to the oscilloscope and sketch the resulting waveform on the time axis. There is a turn-on switch on the back of the transformer. Additionally, there are three banana plugs available on the front for easy access to the secondary terminals of the transformer.

2) Connect a half wave rectifier circuit to the step down transformer available in the lab (see figure below). Load the circuit with a 1-kΩ resistor. Measure the output V_o (load voltage) with the oscilloscope, and sketch the waveform on the time axis, clearly indicating the peak voltage. ***You must wear you safety glasses*** while the circuits are on.

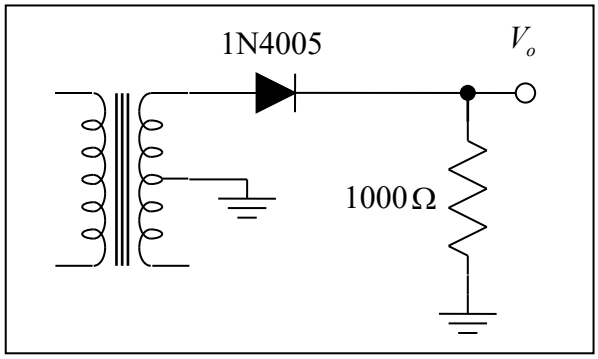

Figure 1.1: Half wave rectifier

Add a filter capacitor to the circuit above so that the output ripple voltage is less than 1.0 V_{pp}. ***You must be extremely careful with the polarity of the capacitor, as it may EXPLODE if connected incorrectly. (This happened numerous times in the past, seriously!).*** Measure the average DC output voltage with the oscilloscope and write it down. Additionally, setting the oscilloscope in AC mode, sketch and indicate the output ripple voltage. Explain the cause of the ripple.

Task 2: Full-Wave Rectifiers and Filters

1) Same as the previous task, but using a bridge rectifier instead. Note: the capacitance required is not necessarily the same as before. Compare the ripple with the previous result and discuss your observation.
2) Same as the previous task, but using a center-tap-transformer-based full wave rectifier.

Task 3: Voltage Regulator

Remove the 1-kΩ load resistor from the previous circuit (but leave the filter capacitor in place), and add the Zener regulator you prepared in the pre-lab. Measure the average DC output voltage with the oscilloscope and write it down. Additionally, setting the oscilloscope in AC mode, sketch and indicate the output ripple voltage. Compare the ripple measured in Task 2.2 and discuss your observation.

Report (due date & time – see "Laboratory" page on the course website)

An individual report is required for this experiment. Refer to "Lab instructions.pdf" and follow the report format and other instructions described. Please ensure to present all your data clearly (using diagrams, tables, and graphs as required) and include the following:

- Explanation of the tests that were undertaken and diagrams of their set-ups.
- Descriptions of the measurements you performed in the lab.
- Table(s) of measurements obtained where applicable.
- The pre-lab work at the beginning of your report.