Analog Electronics I
Laboratory
Exercise 1
DC Power Supply Circuits

Aim of the exercise

The aim of this laboratory exercise is to become familiar with rectifying circuits and voltage stabilization techniques used in common applications. The students learn to read electronic circuit schematics, build simple circuits and verify their operation.

Equipment

- Oscilloscope;
- Measurement set: function generator, digital multimeter, frequency meter, power supply;
- Soldering toolbox;
- Measurement toolbox;
- Soldering station;
- Transformer;
- Prototype board.

Before the exercise please check the contents of the toolbox with the checklist on the box. If anything is missing report it to your teacher.

Measurement Toolbox Checklist:

No	Accessory	Qty
1	Digital Multimeter	2
2	BNC-BNC Connector	1
3	BNC-T Connector	1
4	BNC-CINCH Connector	1
5	BNC-BNC Cable	2
6	Banana-Banana Cable (single pole)	2
7	Banana-Crocodile Cable (single pole)	3
8	Oscilloscope Probe	2

Soldering Toolbox Checklist

No	Accessory	Qty
1	PC board holder	1
2	Side cutter	1
3	Flat nose pliers	1
4	Screwdriver	1
5	Spanner	1
6	Thin pliers	1
7	Soldering tin	1
8	Soldering paste	1
9	Desoldering tool	1

Warning! Soldering iron is heated to the temperature above 300ºC. Please use it carefully in order to prevent getting burn.

All measurements in this exercise should be done by means of the oscilloscope. Since you will measure DC voltages, the oscilloscope inputs should be set in DC mode.

Tasks

1. Half-wave rectifier circuit

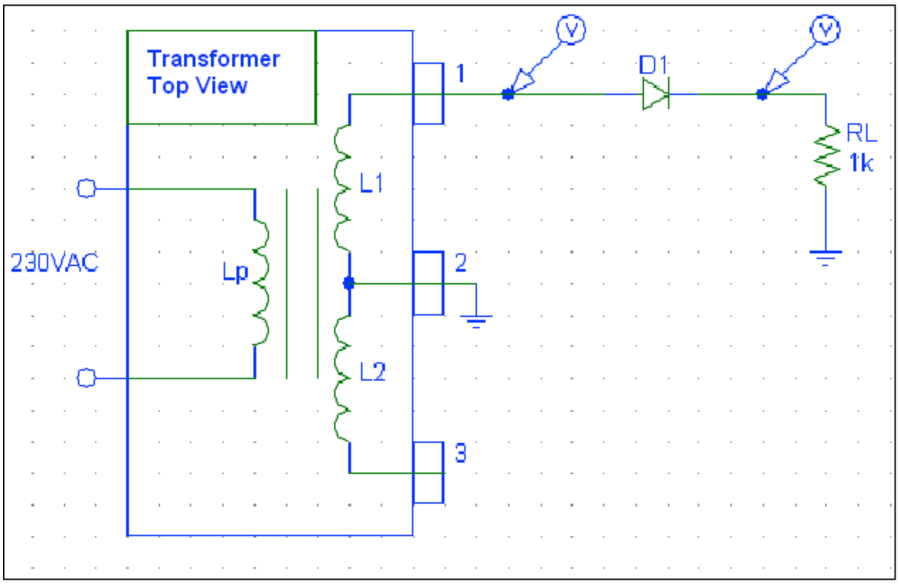

Fig. 1 Half-wave rectifier circuit

1. Solder the circuit illustrated in fig. 1. Note that the transformer is an external device. Connect it using banana cables.
2. Connect the oscilloscope probes to the test points indicated by voltage markers (fig.1). Connect the ground leads of the oscilloscope probes to the circuit ground.
3. Observe the voltages on the transformer output, load and diode. In case of a diode use two oscilloscope channels and set the differential mode. Set equal gains for both channels.
4. Measure:
   - voltage amplitudes on transformer output and load;
   - voltage drop on conducting diode;
   - maximum voltage on the diode in reverse bias.
5. Draw observed plots on the given grids. Write the parameters: time base, gains of oscilloscope inputs, mark zero offset.

Warning! Do not connect the ground leads of the oscilloscope probes to the other points that board ground. Those leads are connected inside the oscilloscope and improper connection causes short circuit.

2. Centre-tapped transformer full-wave rectifier

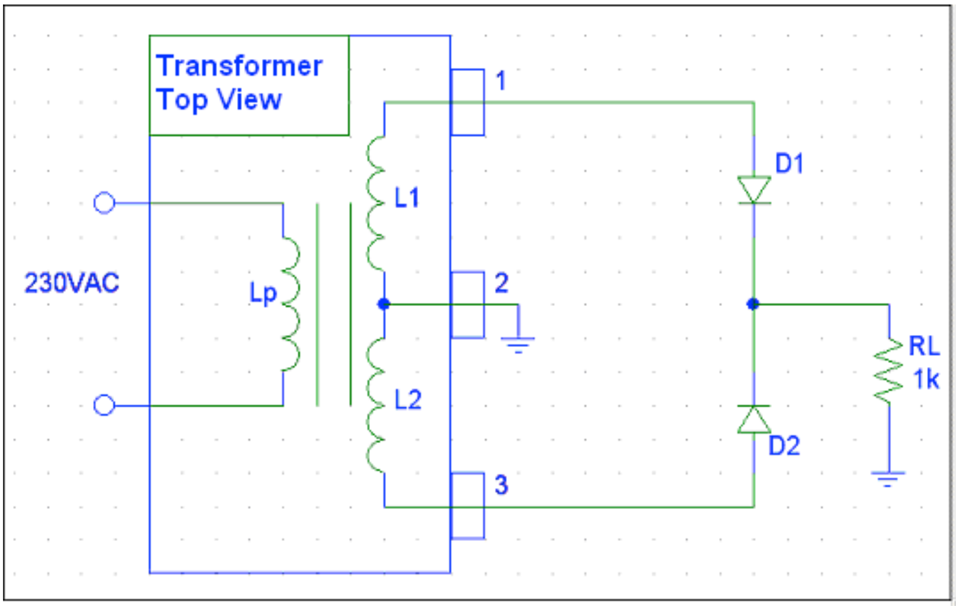

Fig. 2 Centre-tapped transformer full-wave rectifier.

1. Solder the circuit illustrated in fig. 2.
2. Observe voltages on the transformer output, load and both diodes.
3. Measure:
   - voltage amplitudes on transformer output ($V_{1\text{-}2}$, $V_{3\text{-}2}$, $V_{1\text{-}3}$) and load;
   - voltage drop on one of the conducting diodes;
   - maximum voltage drop on this diode in reverse bias.
4. Draw observed plots on the given grids. Write the parameters: time base, gains of oscilloscope inputs, mark zero offset.

3. Diode-bridge full-wave rectifier

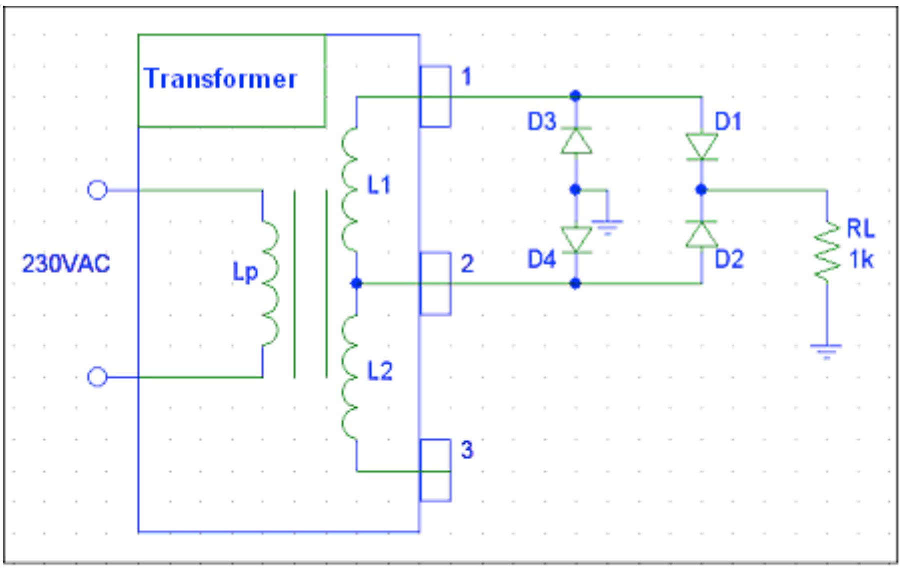

Fig. 3 Diode-bridge full-wave rectifier.

1. Solder the circuit illustrated in fig. 3.

Warning! In this circuit there is no connection between the board ground and the transformer!

2. Observe voltages on the transformer output, load and the diodes.
3. Measure:
   - voltage amplitudes on transformer output and load;
   - voltage drop on one of the conducting diodes;
   - maximum voltage drop on this diode in reverse bias.
4. Draw observed plots on the given grids. Write the parameters: time base, gains of oscilloscope inputs, mark zero offset.

4. Diode bridge full-wave rectifier with smoothing capacitor

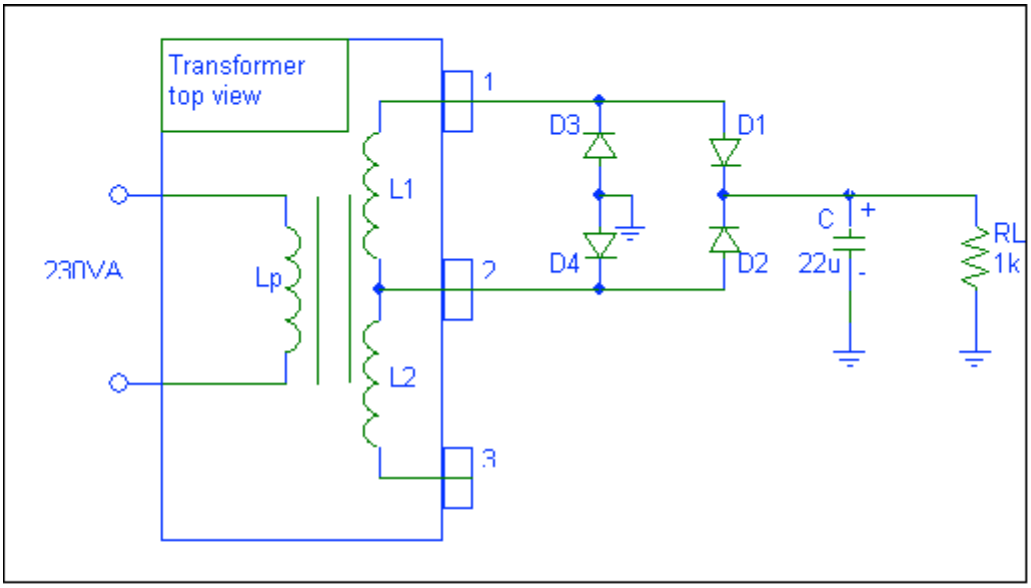

Fig. 4 Diode bridge full-wave rectifier with smoothing capacitor

1. Solder the circuit illustrated in fig. 4.

Warning! 22µF capacitor is an electrolyte capacitor. It can work only in one positive polarization. It means that the voltage on the plus lead must be greater than on the minus one. <u>Minus lead is shorter than the plus one and it is marked on enclosure.</u> Wrong connection of the capacitor causes its explosion.

2. Observe DC voltage of load resistance.
3. Measure maximum and minimum voltage magnitude on the load.
4. Draw observed plots on the given grids. Write the parameters: time base, gains of oscilloscope inputs, mark zero offset.
5. Increase load by adding second load resistor as in fig. 5 and repeat points 2-4.

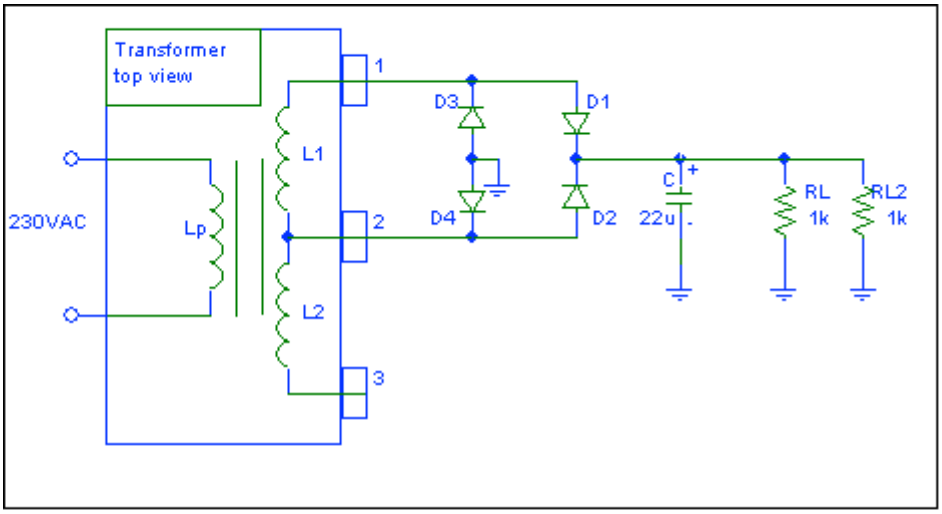

Fig. 5 Diode-bridge full-wave rectifier with smoothing capacitor with increased load.

5. Diode-bridge full-wave rectifier with Zener diode voltage regulator

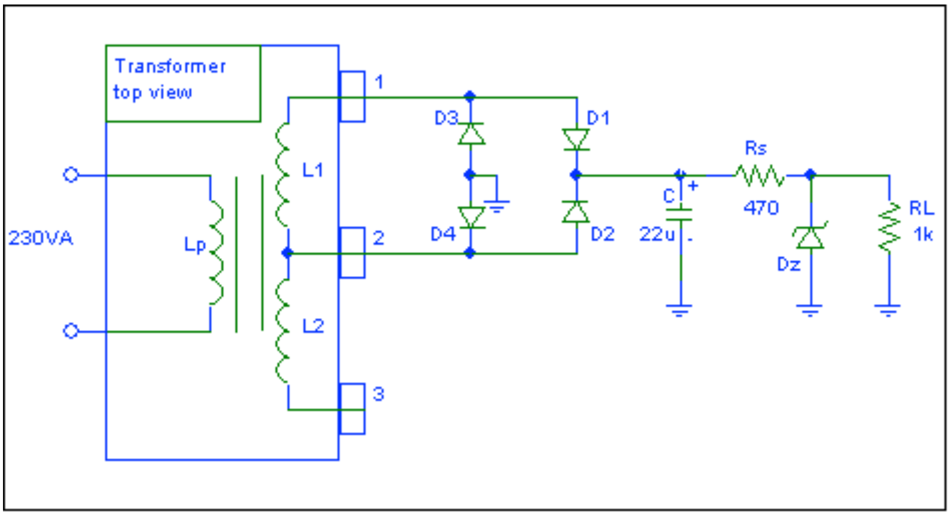

Fig. 6 Diode-bridge full-wave rectifier with Zener diode voltage regulator.

1. Solder the circuit illustrated in fig. 6.
2. Observe DC voltage of load resistance.
3. Measure maximum and minimum voltage magnitude on the load.
4. Draw observed plots on the given grids. Write the parameters: time base, gains of oscilloscope inputs, mark zero offset.
5. Increase load by adding second 1kΩ load resistor and repeat points 2-4.

6. Diode-bridge full-wave rectifier with LM78L05 voltage regulator

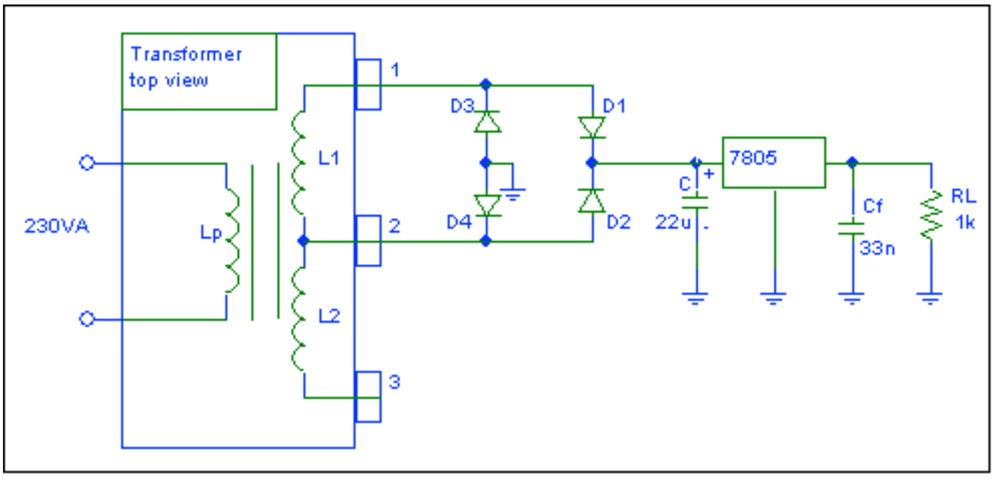

Fig. 7 Diode-bridge full-wave rectifier with LM78L05 voltage regulator.

1. Solder the circuit illustrated in fig. 7.
2. Observe DC voltage of load resistance.
3. Measure maximum and minimum voltage magnitude on the load.
4. Draw observed plots on the given grids. Write the parameters: time base, gains of oscilloscope inputs, mark zero offset.
5. Increase load by adding second 1kΩ load resistor and repeat points 2-4.

! **Warning! You do not need to do SPICE simulation of this circuit. There is no model of LM78L05 in student version of SPICE software.**

Report preparation

The report must be delivered in electronic form to your teacher. Each page in header should have named and id numbers of persons carried out the exercise. Oscilloscope plots should be drawn by hand on earlier prepared grid. Each report should include:

- schematics of the examined circuits (e.g. prepared in SPICE);
- measurements results;
- oscilloscope plots and marks of reference to appropriate plot in the report text;
- simulation results;
- comparison of the obtained measurement results and oscilloscope plots with SPICE simulation results;
- comments and conclusions;