National Aviation University

Department of Electronics, Robotics, Monitoring and IoT Technologies

Course: "Fundamentals of Analog Electronics"

Experiment 7

"Class-B Power Amplifier"

Prepared by prof. V. Ulansky

Kyiv 2020

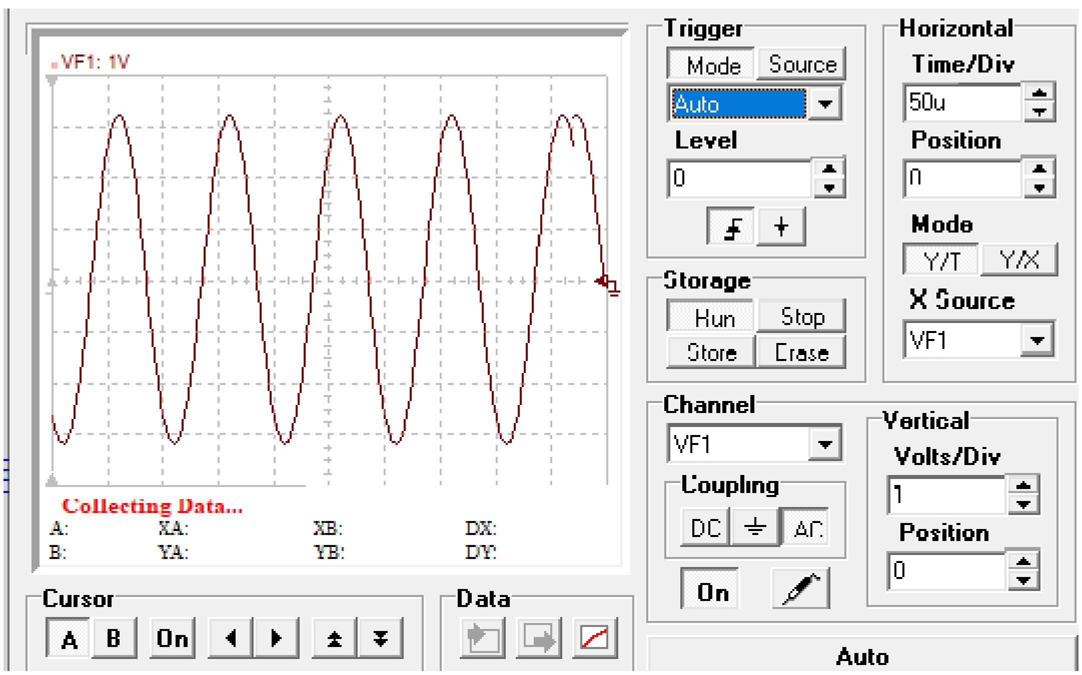
OBJECTIVES

1. To construct class-B power amplifier.
2. To simulate the operation of class-B power amplifier using TINA-TI SPICE-based analog simulation program.
3. To measure voltages and currents in all nodes and branches of the circuit.

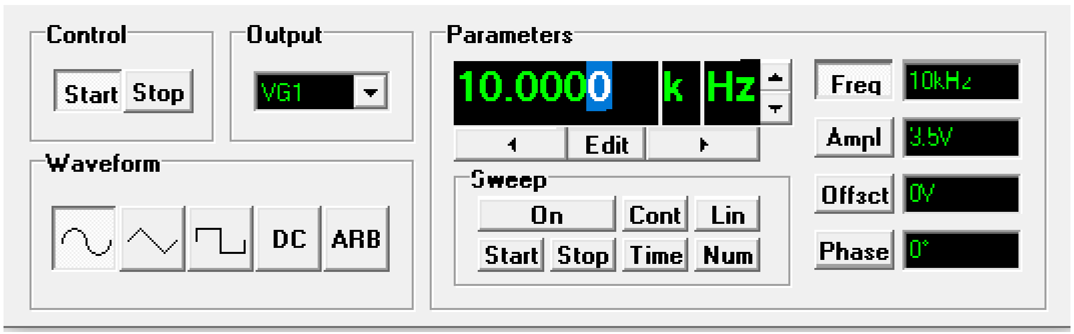
EQUIPMENT

1. Digital multimeter
2. Solderless breadboard: BB830T
3. Oscilloscope
4. Sinusoidal voltage generator
5. Power Supply: 12V
6. BJT: *npn* PZT2222AT1, *pnp* PZT907AT1
7. Resistors: 2 × 187 Ω, 1 ×8 Ω
9. Capacitor: 2 × 400µF

Oscilloscope



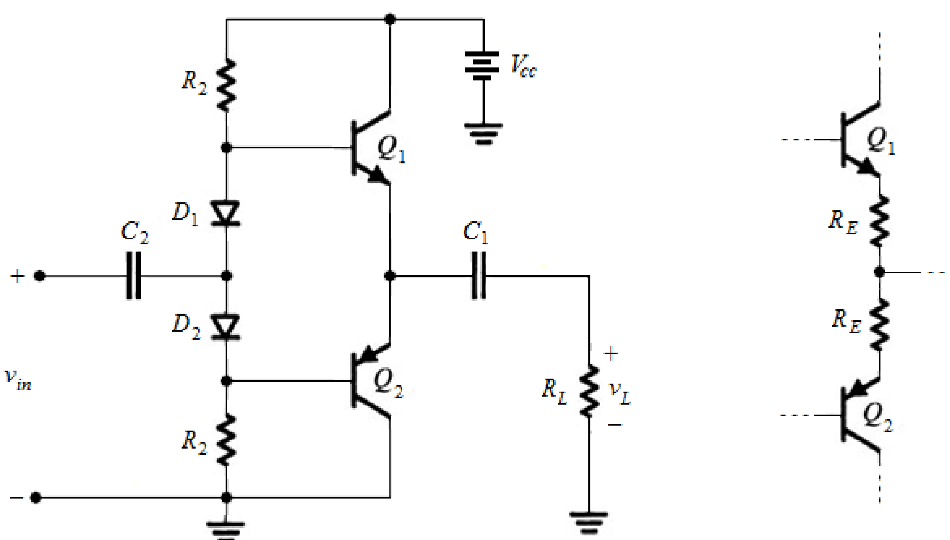
Function generator



Theory

A Class – B audio power amplifier uses one transistor to amplify the positive portion of the input signal and another transistor to amplify the negative portion of the input signal. The class – B audio amplifiers provide higher efficiency and lower output impedance to drive a typically low-impedance load. For example, a speaker load is typically 8Ω.

The circuit of the complementary symmetry amplifier with compensation diodes is shown in Fig. 1(a).



(a) (b)

Fig. 1. Complementary symmetry power amplifier with diode compensation (**a**) and additional emitter resistors for preventing the thermal runaway (**b**)

Diodes D_1 and D_2 are connected for reducing the fluctuations of V_{BE} with temperature. These diodes should have characteristics similar to those of the transistors and they should be mounted on the same heat sink.

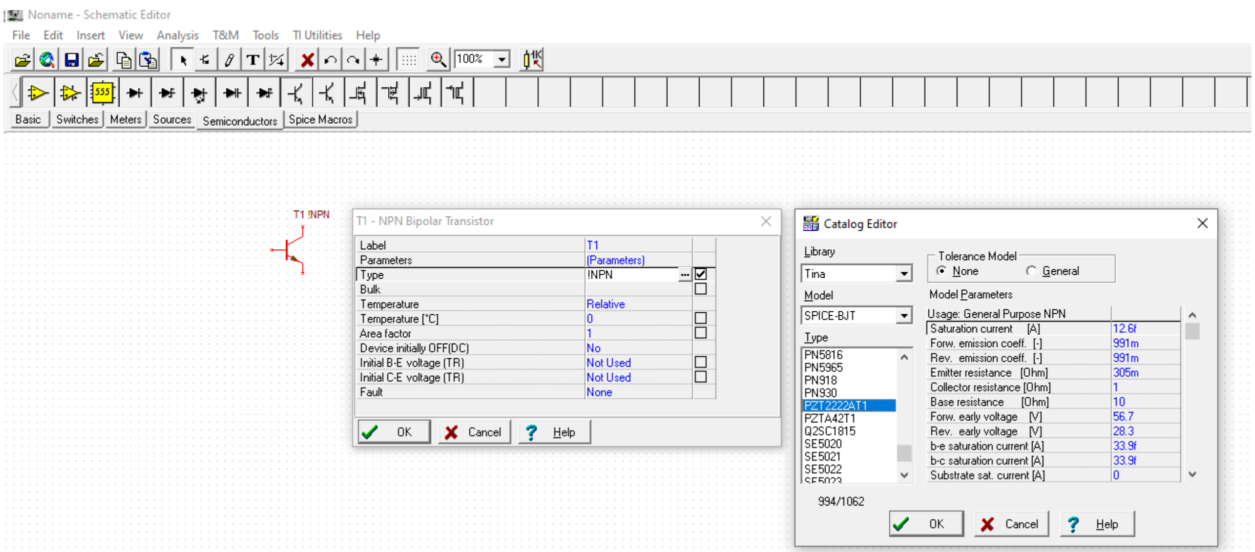
There are three problems in the design of a complementary symmetry amplifier. *The first* is the crossover distortion. This distortion can be reduced by placing a small resistor R_2 in series with each diode to cause I_{CQ} to be slightly above zero. This causes both amplifiers to amplify the *ac* input signal in the cutoff region.

The second problem is the possibility of thermal runaway, which can be caused by the two complementary transistors having different characteristics or by the value of V_{BE} decreasing at high temperatures. This can lead to a higher collector current, resulting in additional power dissipation and heating. This process continues until the transistor overheats and fails. Thermal runaway is prevented by placing a small resistor in series with each emitter to increase the bias level. With a load of 4 to 8Ω, each resistor should be approximately 0.5Ω. With small R_E a feedback appear, which stabilizes the operation of BJT. This circuit topology is shown in Fig. 1(b).

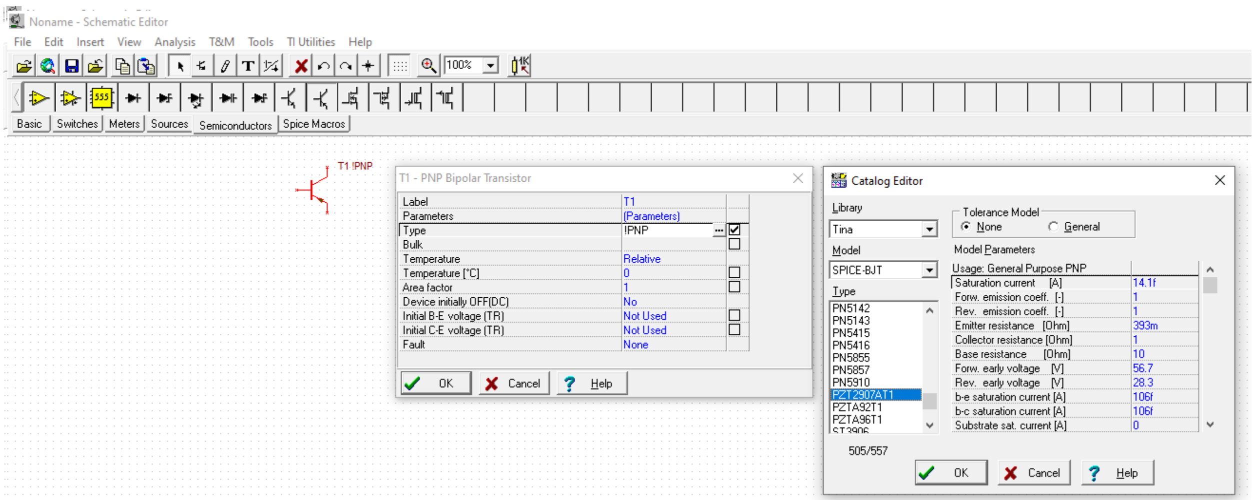
The third problem is the distortion that results if the bias diodes (D_1 and D_2) stop conducting. One of the design requirements is to keep the diodes always turned ON. It is important that the diode bias current be large enough to keep the diodes in their forward-biased region for all input voltages.

PROCEDURE

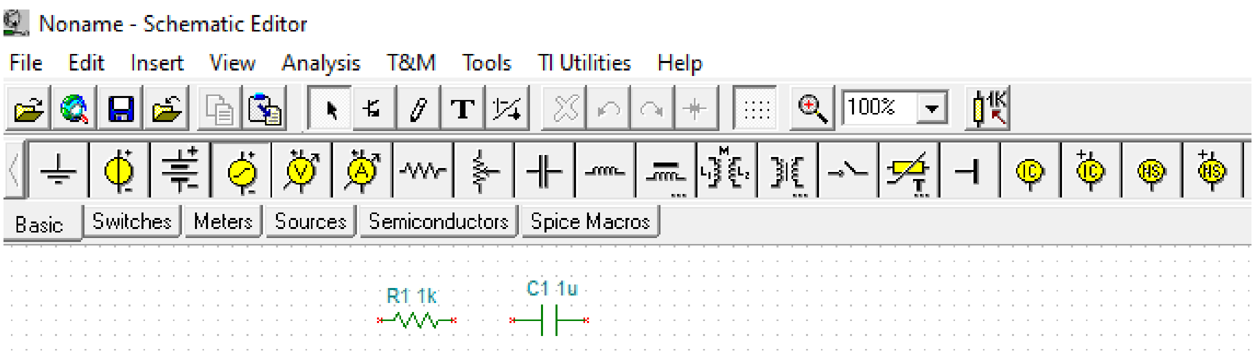
1. Select transistor PZT2222AT1 as shown below.



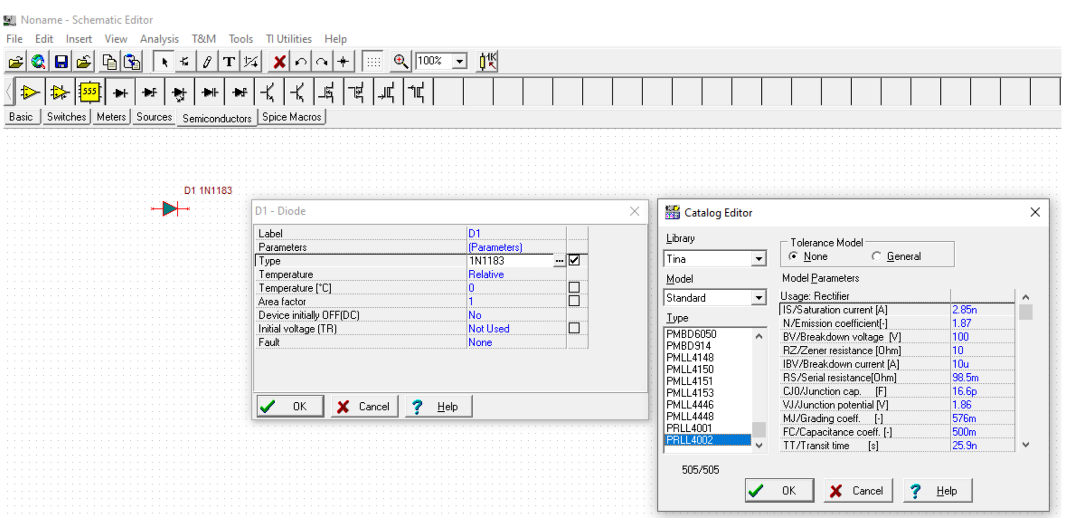
2. Select transistor PZT2907AT1 as shown below.



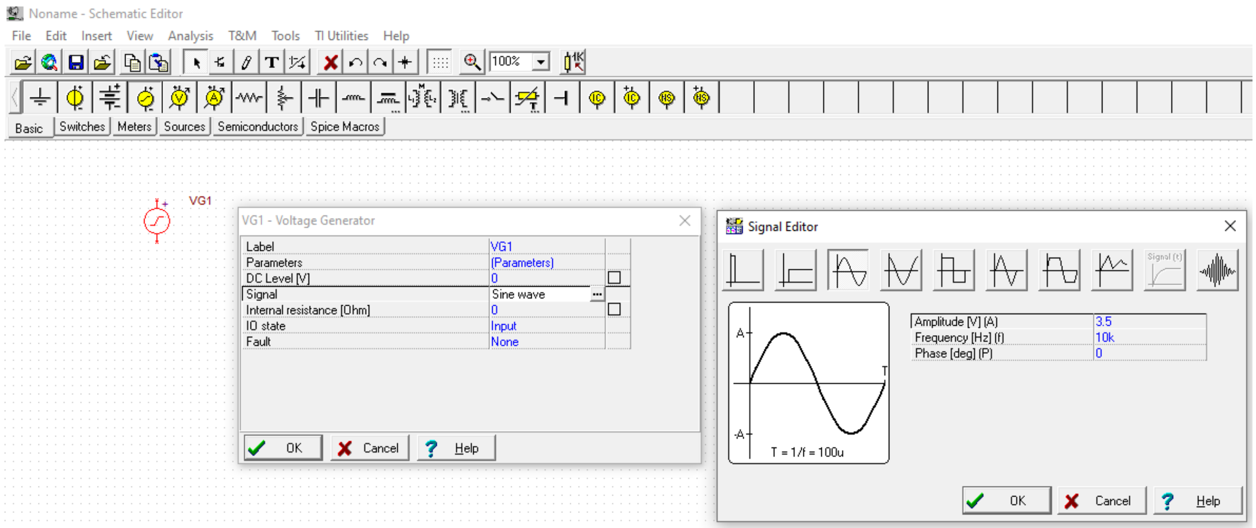
3. Select resistors and capacitors as shown below.



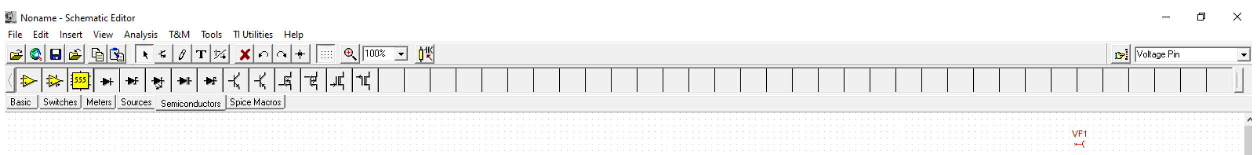
4. Select diodes PRLL4002 as shown below.



5. Select sinusoidal voltage generator (3.5 V, 10 kHz) as shown below.



6. Select voltage pin  as shown below.



7. Construct the circuit of the class-B power amplifier as shown in Fig. 2.

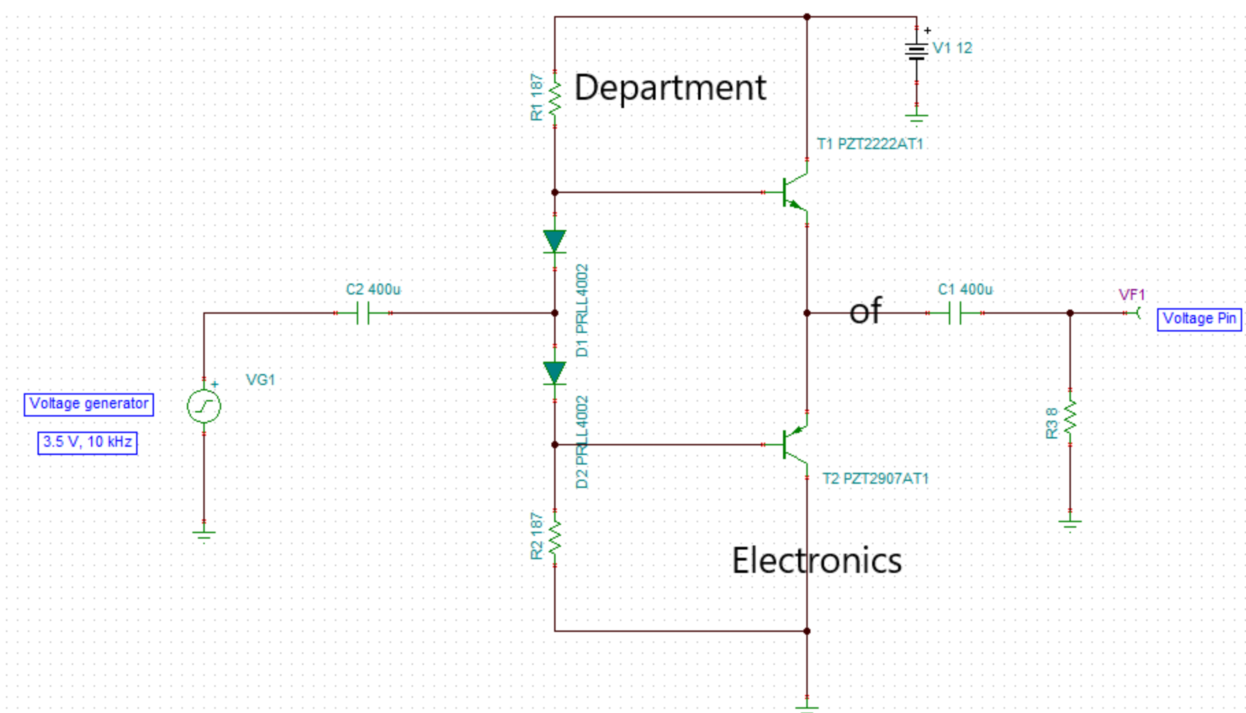
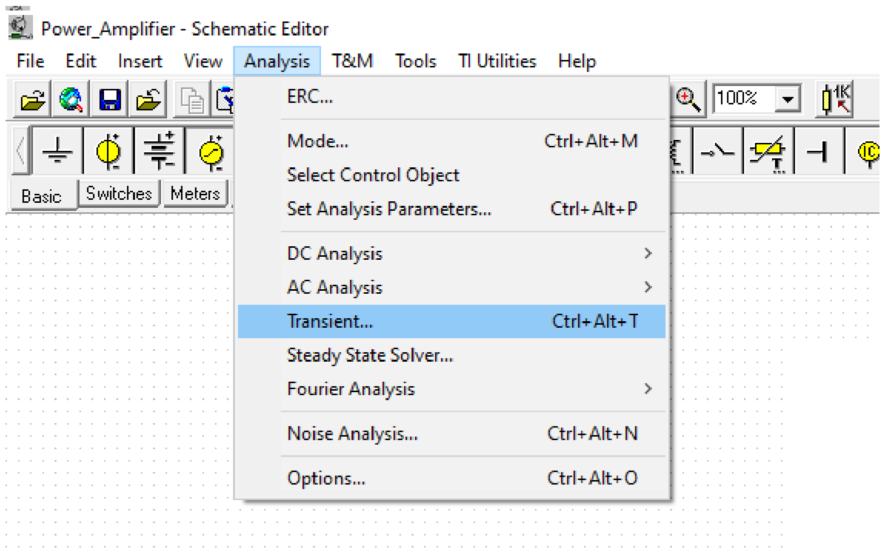
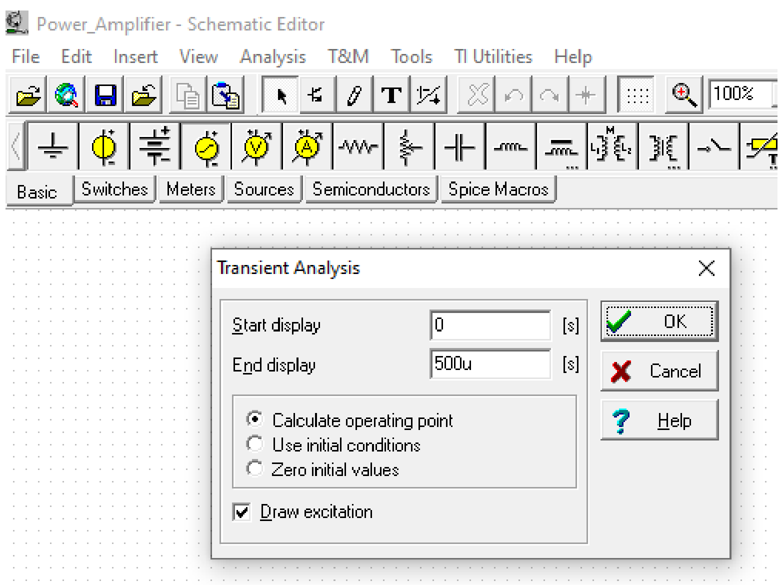


Fig. 2. Class-B power amplifier circuit diagram.

8. Select transient mode as shown below.



9. Choose Start display and Stop display time-points.



10. Press the buton OK and display the input and output waveforms of the amplifier as shown in Fig.

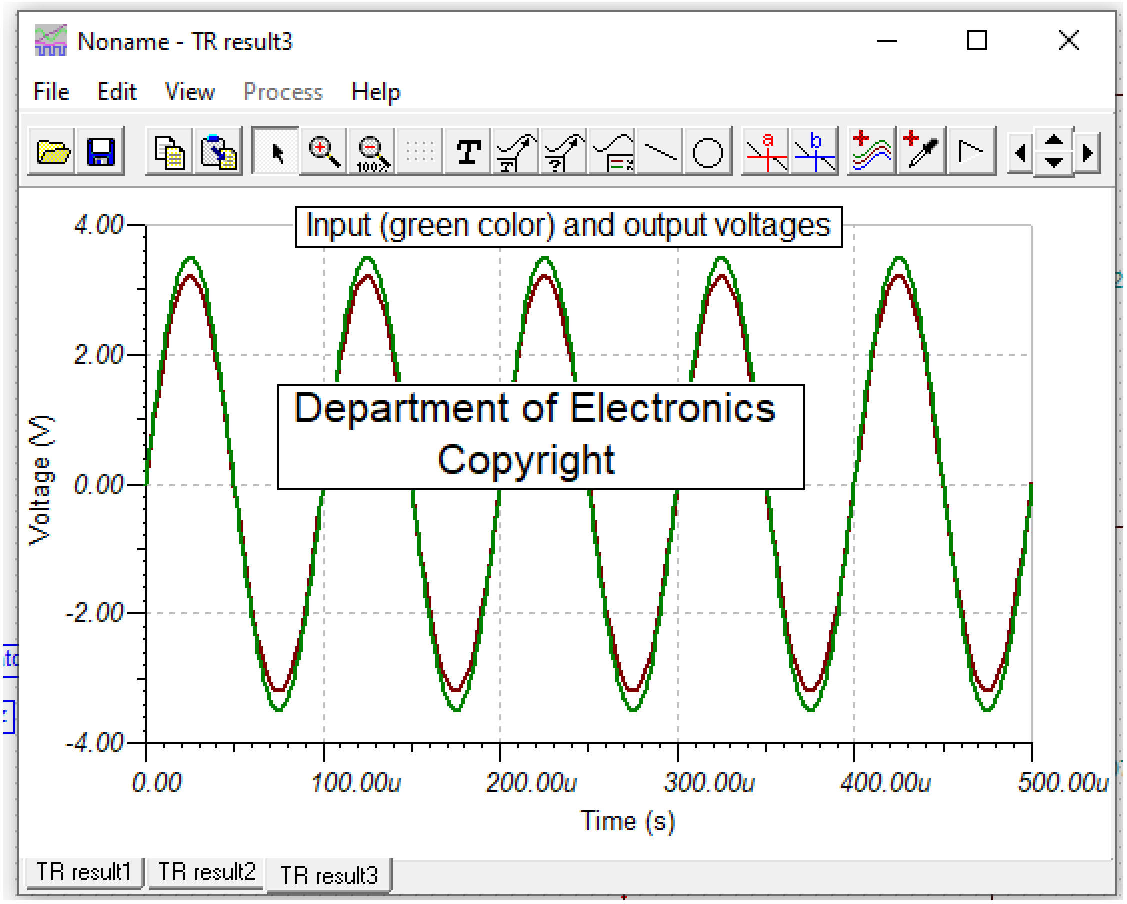
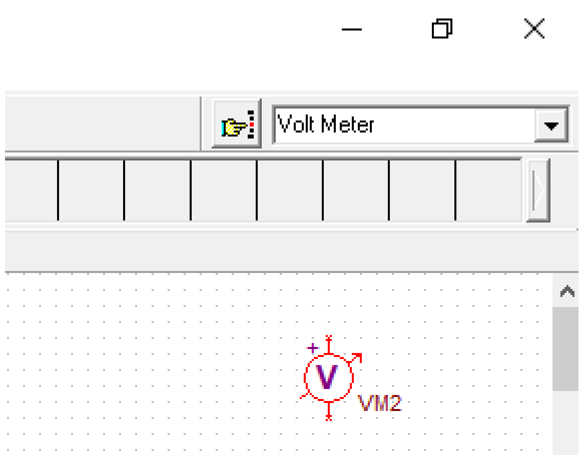


Fig. 3. Input and output waveforms of the class-B power amplifier.

11. Select voltmeter as shown below.



12. Connect voltmeter across the load resistor as shown in Fig. 4.

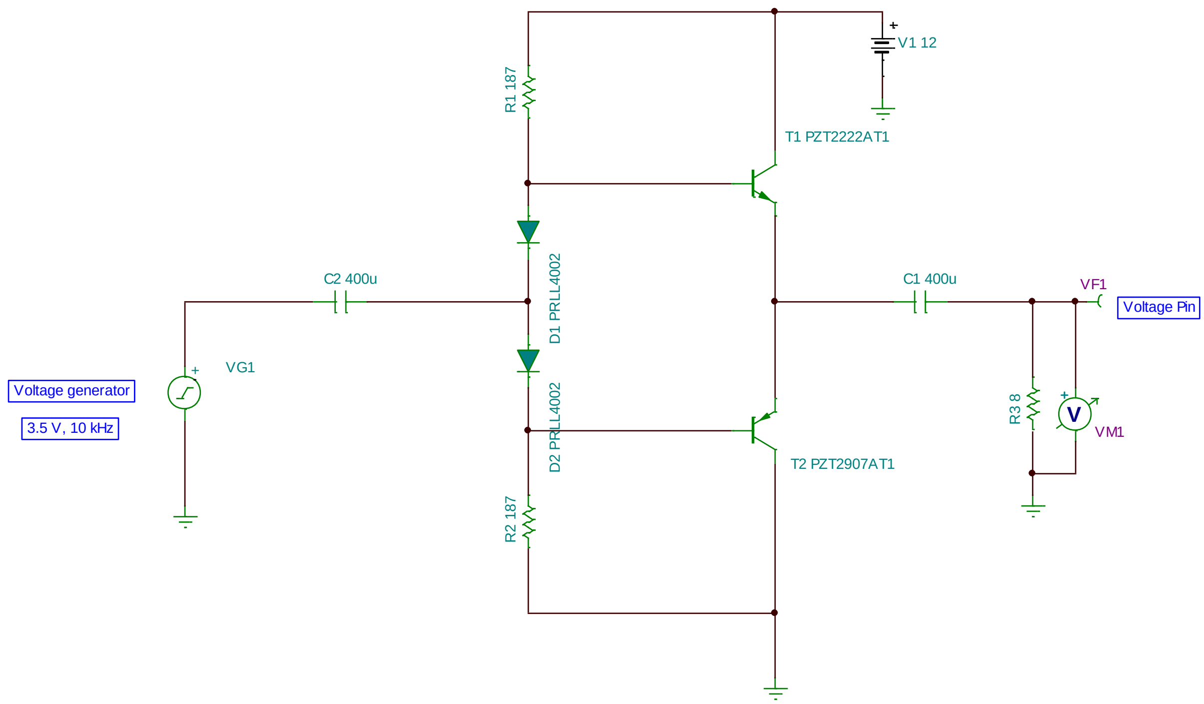
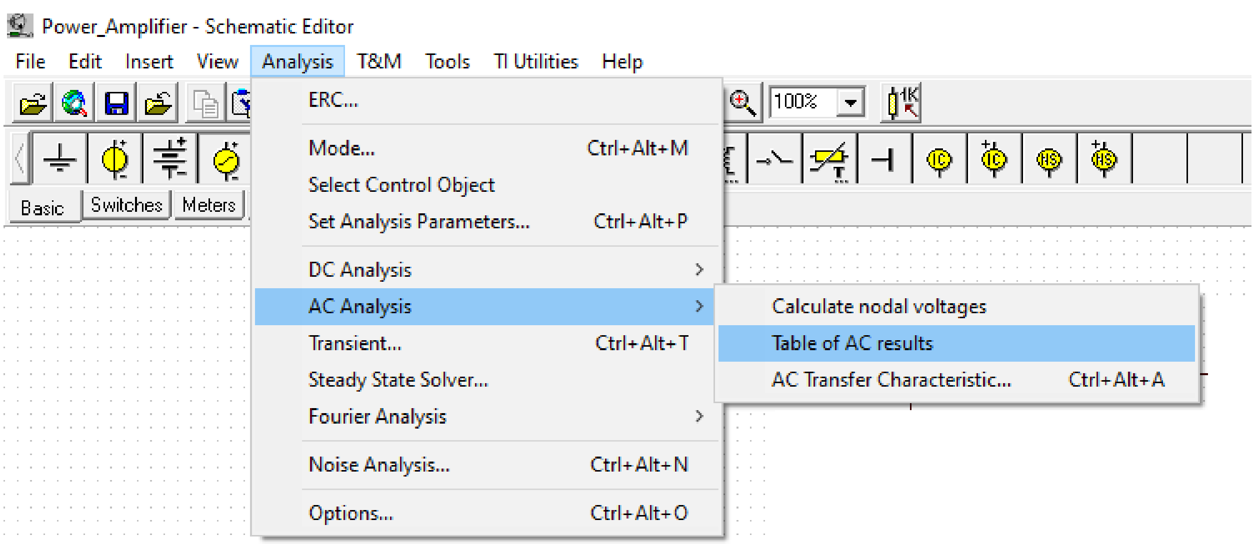


Fig. 4. Connection of the voltmeter VM1 across the load.

13. Select AC analysis as shown below.



12. Analyze nodal voltages and branch currents in the table of Fig. 4.

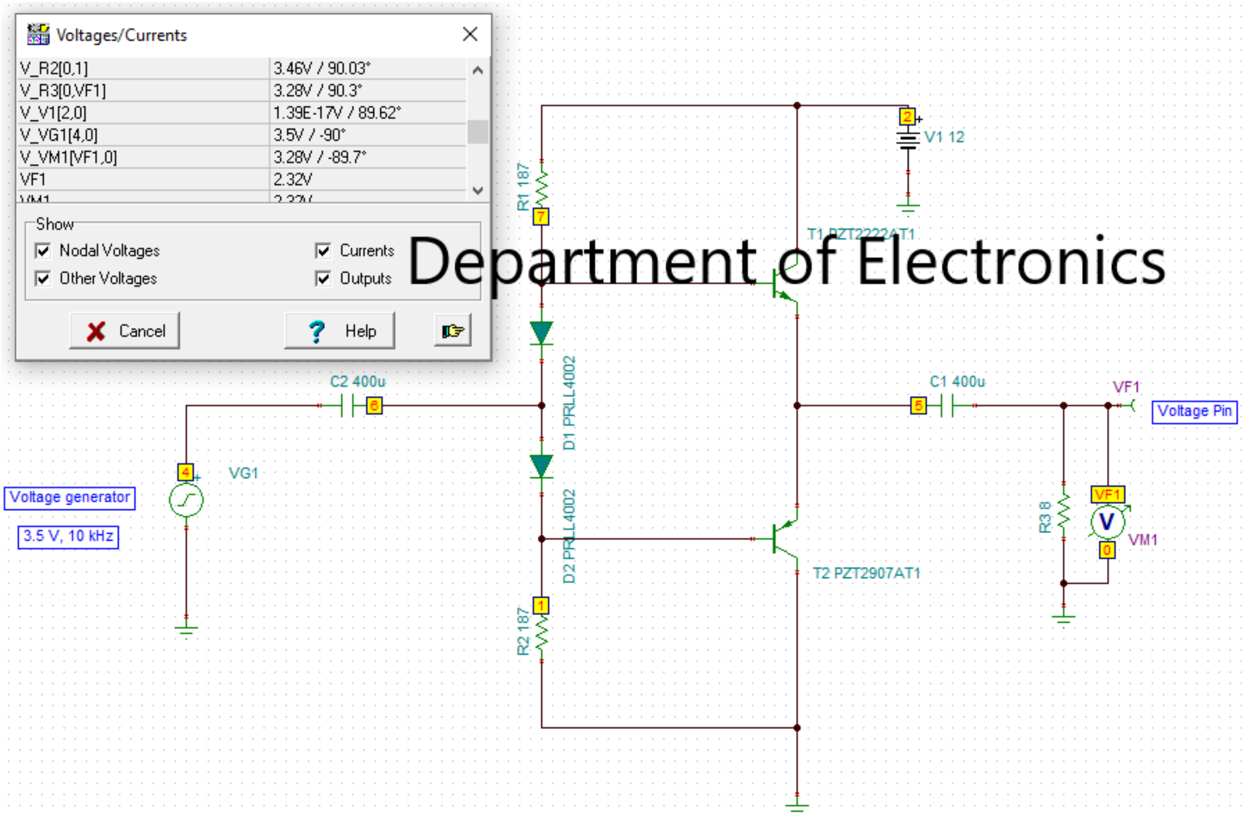


Fig. 5. Displayed nodal voltages.

13. Calculate the voltage and current gain of the amplifier.

Reference

1. A.S. Sedra and K.S. Smith, "Microelectronic circuits", 5th ed., New York: Oxford University Press, 2004, 1283 p.