DEPARTMENT OF ELECTRONICS AGH UST

LABORATORY
OF
**ELECTRONIC ELEMENTS**

# Junction Field-Effect Transistor

REV. 0.2a

# 1. THE GOAL OF THE EXERCISE

- Determination of JFET basic parameters i.e.:
  - pinch-off voltage,
  - transconductance,
  - output resistance,
  - determination of JFET regions of operation (linear and saturation)

# 2. THE UTILIZED MODELS AND ELEMENTS

During the exercise following components will be used:

- NI ELVIS Prototyping Board (ELVIS) connected with PC,
  - Virtual measurement devices:
  - `Virtual Instruments (VI):`
  - `Digital Multimeter (DMM),`
  - `Two-Wire Current-Voltage Analyzer (2-Wire)`
  - `Function Generator (FGEN),`
  - `Variable Power Supplies (VPS)`
  - `Oscilloscope (SCOPE)`
- Tektronix digital oscilloscope
- Agilent multimeter
- Set of electronic elements listed in Table 1.

Table 1. Values of electronic elements required to perform the exercise

| | |
|---|---|
| Resistors | 1x100 Ω, 1x5kΩ, 1x10kΩ, , |
| Capacitors | 1x100nF, 2x33µF |
| Transistors | 2xBF245 |

# 3. PREPARING THE DRAFT

3.1. Draw the output and transitional characteristics of Junction Field-Effect Transistor (j-FET). Present a method for practical verification of characteristics with the use of NI ELVIS Prototyping Board (ELVIS). Analyze the circuit presented in Fig. 3.1, 3.2, 3.3 and 3.4. What are the conditions for proper determination of JFET transconductance and output resistance values with the use of setups presented in Fig. 3.3 and 3.4?

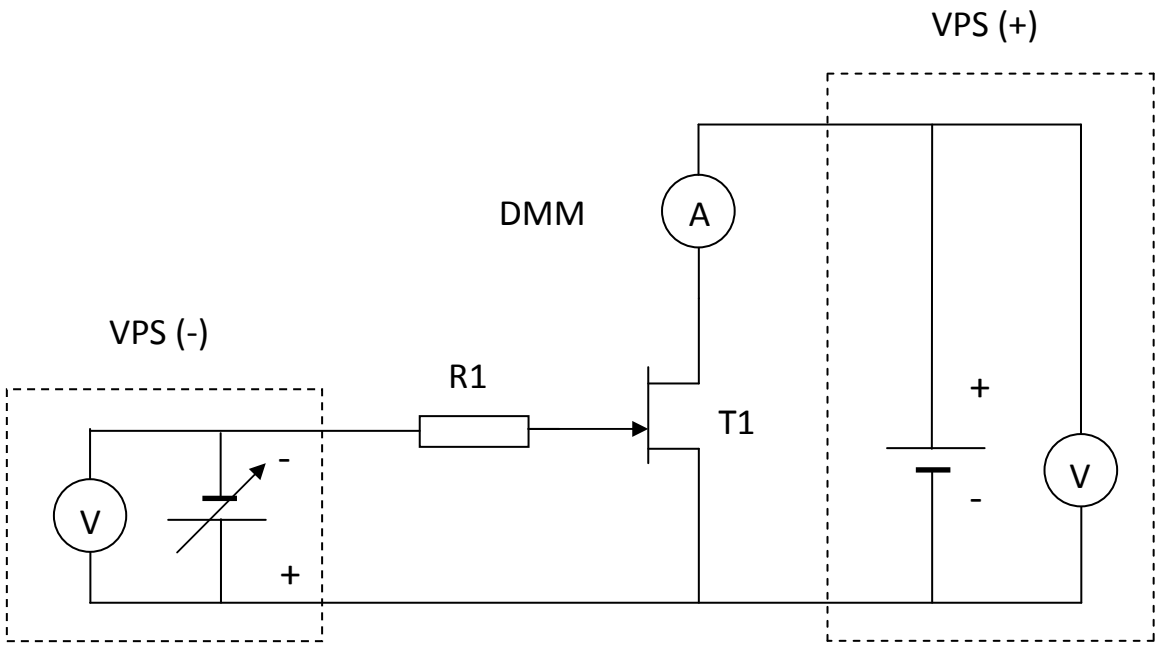



Fig. 3.1. Scheme of measurement setup used to determine transfer (transitional) characteristics.

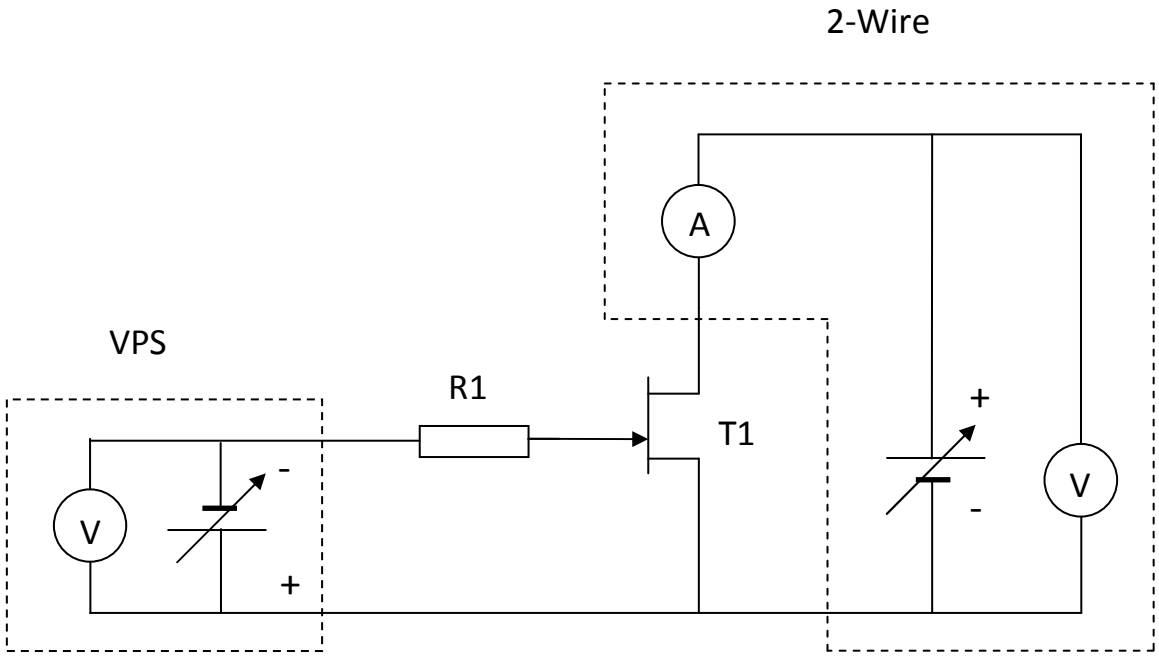



Fig. 3.2. Scheme of measurement setup used to determine output characteristics.

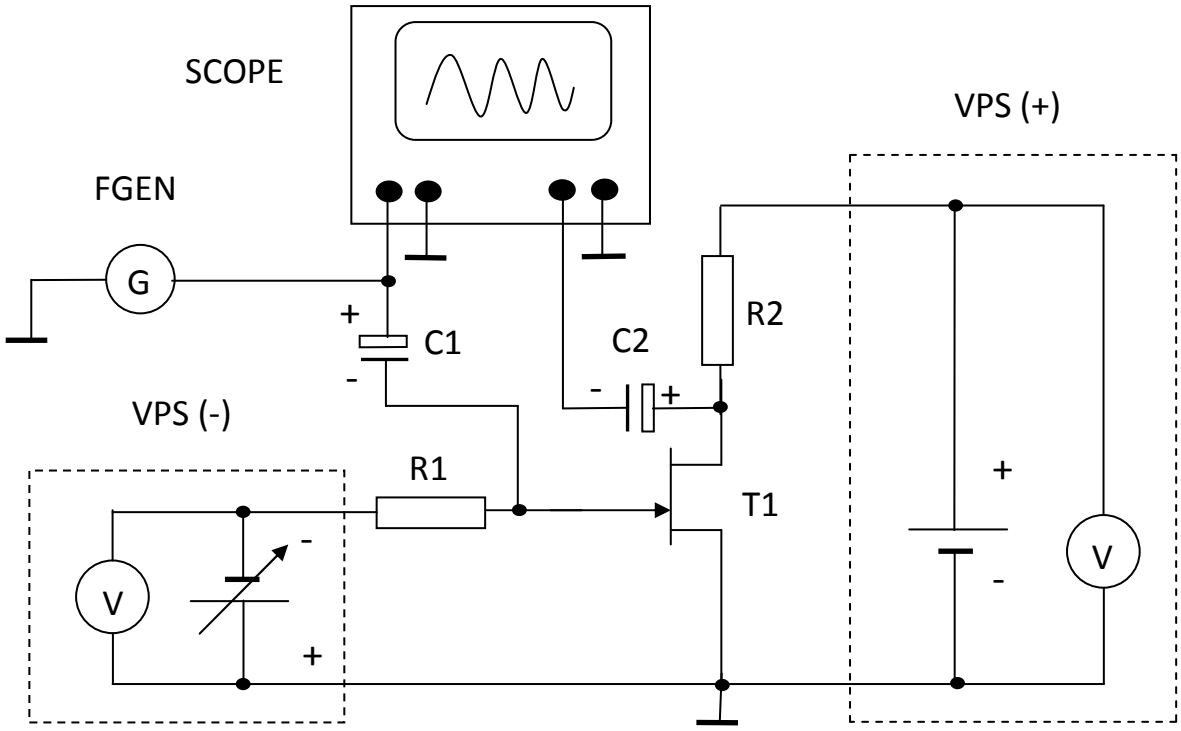



Fig. 3.3 Scheme of measurement setup used to determine transconductance by means of small-signal (dynamic) method.

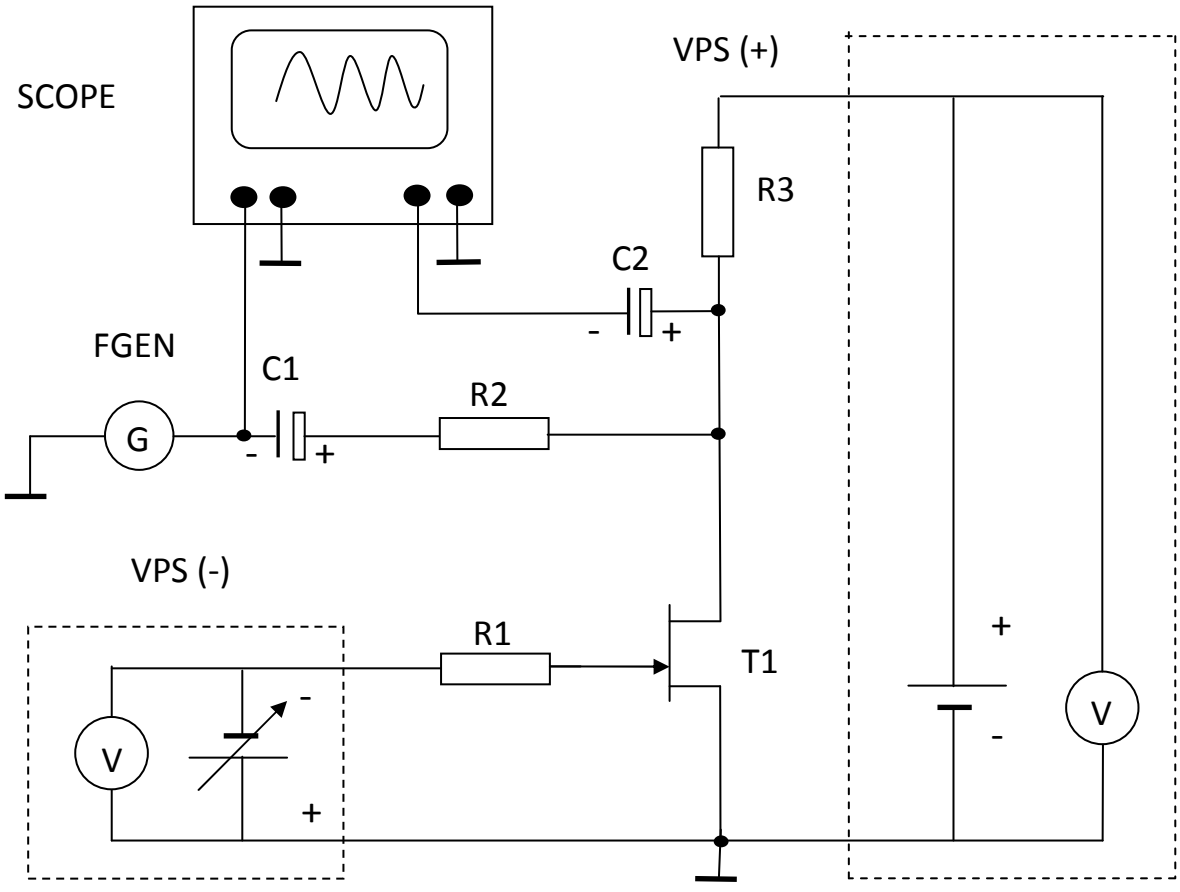



Fig. 3.4 Scheme of measurement setup used to determine output resistance by means of small-signal (dynamic) method.

# 4. THE COURSE OF THE EXERCISE

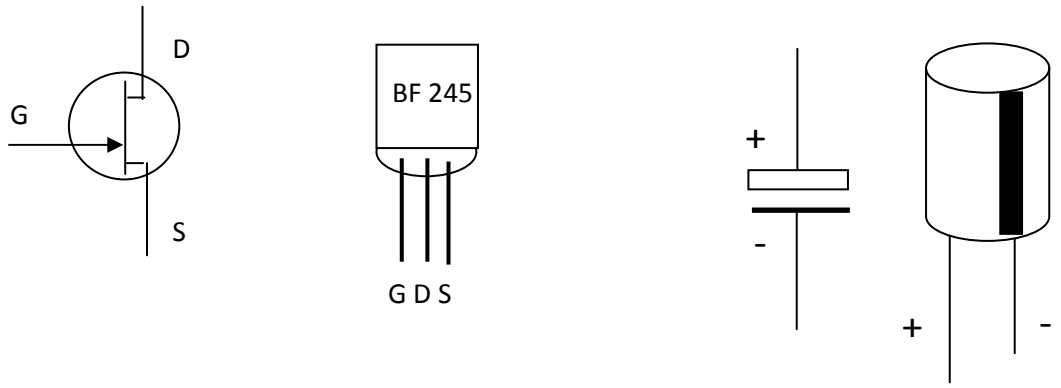
4.1. Arrange the measurement setup from Fig.3.1. Use virtual multimeter (DMM) to measure the current. Value of the R1=10 kΩ. For the fixed $U_{DS}$ voltage, from the range 6-8 V, (current limitation +20 mA )(+VPS), change $U_{GS}$, from 0 V with the step 0.2 V (-VPS) until the pinch-off voltage is obtained (despite the presence of $U_{DS}$ polarization, current stops flowing through the transistor). Repeat measurements for the $U_{DS}$ from the range 1-2 V. Note particular values of current $I_D$ of j-FET transistor obtained for different values of voltage $U_{GS}$. Draw the transfer (transitional) characteristics for two values of $U_{DS}$ voltage, for which measurements have been performed. Determine values of $I_{DSS}$ and $U_p$.

4.2. Arrange the measurement setup from Fig.3.2. Value of R1=10 kΩ. Change $U_{DS}$ within 0-10 V range with step of $\Delta U_{DS}$=0.05 V, current limitation +20 mA (2-Wire), $U_{GS}$ range 0-$U_p$ with step of 0.2 V (-VPS). With the use of „log" option, save appropriate output characteristics of j-FET transistor obtained at different $U_{GS}$ values.

4.3. Arrange the measurement setup from Fig.3.3. Values of R1=10 kΩ, R2=100 Ω, C1=33 μF, C2=33 μF. Value of $U_{DS}$ (+VPS) is the same as in the first part of 4.1, $U_{GS}$ should be changed within range of Up-0 V (-VPS). Use a triangle waveform voltage signal having frequency of 1kHz and peak-to-peak value equal 100 mV generated by (FGEN). Measure by means of oscilloscope (SCOPE) the peak-to-peak value of alternating voltage $U_{ds}$ (amplitude of alternating voltage), for a few values of $U_{GS}$ in the range: Up<$U_{GS}$<0 V. Determine the values of j-FET dynamic transconductance, which correspond to the values of $U_{GS}$. Compare the obtained results with the values determined with the use of transfer characteristic for the corresponding $U_{DS}$ values. ATTENTION: „-„ of electrolytic capacitor (shorter terminal) needs to be connected to a lower potential (-). In order to connect the generator, the direct output on the prototyping board (FGEN) should be used. To connect oscilloscope, AI 0-AI 7 inputs need to be used.

4.4. Arrange the measurement setup from Fig.3.4. Values of R1=10 kΩ, R2=5 kΩ, R3=100 kΩ, C1=33 μF, C2=33 μF. Voltage $U_{DS}$ should have value around 0V (0-0.3V), $U_{GS}$ should be changed within the range of Up-0 V. Use a triangle waveform voltage signal having frequency of 1kHz and peak-to-peak value equal 100 mV generated by (FGEN). Measure by means of the oscilloscope (SCOPE) the peak-to-peak value of alternating voltage $U_{ds}$ (amplitude of alternating voltage), for a few values of $U_{GS}$ in the range: Up<$U_{GS}$<0 V. Determine the values of j-FET resistance, which corresponds to the values of $U_{GS}$. Compare the obtained results with the values estimated basing on the output characteristics. ATTENTION: „-„ of electrolytic capacitor (shorter terminal) needs to be connected to a lower potential (-). In order to connect the generator, the direct output on the prototyping board (FGEN) should be used. To connect oscilloscope AI 0-AI 7 inputs need to be used.

Elements' terminals:




## 5. LITERATURE

[1] Lecture (P. Dziurdzia)

[2] Behzad Razavi „Fundamentals of Microelectronics"

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