BİLKENT UNIVERSITY
DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

EE 311 ELECTRONICS II

Experiment 4

Lab Report

JFET Source-follower amplifier

Student Name:

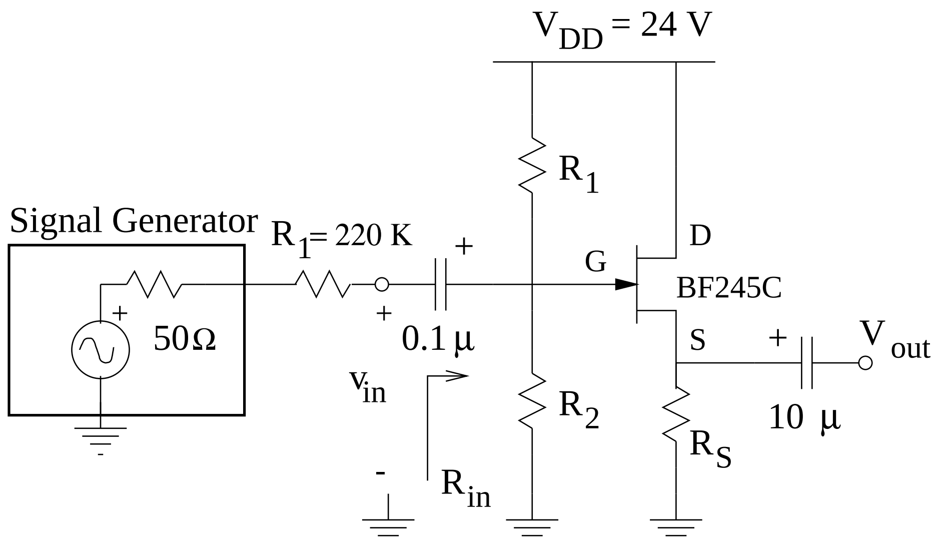
ID Number:

Date:

INTRODUCTION

In this experiment, you will design, construct, and evaluate a single-stage JFET source-follower amplifier that employs self-biasing. Such an amplifier may be used as the output stage of a multistage amplifier to achieve a low output resistance.

You will also generate the i_D vs v_{DS} curve of a JFET for various values of v_{GS}, and measure the transistor parameters I_{DSS} and V_p.



PRELIMINARY WORK

1. Design a single-stage bias-stable JFET amplifier based on the circuit topology given in the figure. In your calculations, assume that the output is not loaded ($R_L = \infty$). The nominal transistor parameters for BF245C are $V_p = -6.5$ V and $I_{DSS} = 17$ mA. The following specifications must be met by the circuit:

- Voltage gain $A_v = v_{out}/v_{in} \geq 0.8$
- Input resistance $R_{in} \geq 200$ kΩ
- Output resistance $R_{out} \leq 300$ Ω
- $V_{GSQ} = -3 \pm 1$ V and $V_{DSQ} = 8 \pm 1$ V

Determine the values of R_1, R_2, and R_S. Note that you should have $V_{SQ} > V_{GQ}$ so that the n-channel JFET can be properly biased. Use nominal 10% resistor values only. Try to leave some margin of safety in meeting the above specifications.

The resistor R_1 is included in the circuit to help measure the input resistance R_{in}. Measuring the AC voltage over R_1 will allow you to determine the AC current i_{in} at the input of the amplifier. Dividing v_{in} by i_{in} will allow you to determine R_{in}.

2. Generate plots of i_D vs v_{DS} and i_D vs v_{GS} for the transistor parameters used in part 1. Draw the load line and indicate the Q-points on these plots. Attach these plots to this report.

3. Analyze the circuit you designed in part 1 for the following transistor parameters and tabulate the results. This will show you how variations in the transistor parameters affect your circuit.

V_p	I_{DSS}	V_{GSQ}	I_{DQ}	V_{DSQ}	g_m	R_{out}	A_v
−6.5 V	17 mA						
−5.0 V	17 mA						
−6.5 V	15 mA						
−5.0 V	15 mA						

4. Perform the following SPICE simulations. Append the pages containing the input decks and the results of SPICE simulations to the end of this report.

(a) Calculate the voltage gain at 2 kHz.

(b) Calculate the frequency dependence of the voltage gain from 2 Hz to 1 MHz. Determine the lower 3-dB corner frequency.

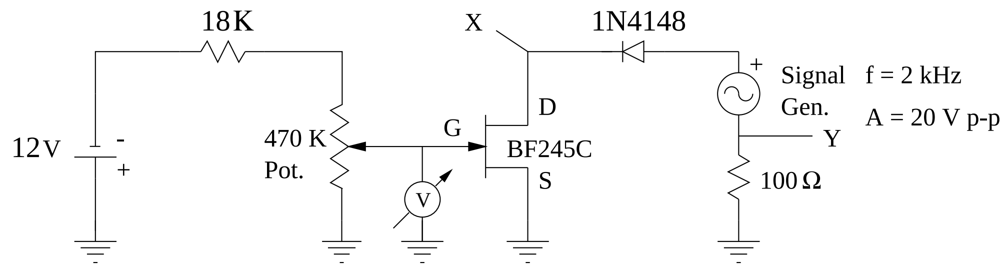
(c) Calculate the input resistance at 2 kHz.

(d) Calculate the output resistance at 2 kHz.

A SPICE model that can be used for transistor BF245C can be found at:
`http://www.ee.bilkent.edu.tr/~aytur/courses/ee311/labs/bf245c.txt`

EXPERIMENT:

1. Construct the following experimental setup to measure the i_D *vs* v_{DS} curve of transistor BF245C for various values of constant v_{GS}. The 470 kΩ potentiometer together with the −12 V dc supply are used to set v_{GS} to any desired value. The signal generator in series with the diode sweeps v_{DS} approximately in the 0–10 V range. The drain current is measured by reading the voltage across a 100 Ω resistor. The oscilloscope is used in X-Y mode so that the i_D *vs* v_{DS} curve can be directly seen on the screen.



Generate and plot the i_D *vs* v_{DS} curve for $V_{GS} = 0, -1, -2, -3, -4, -5, -6, -7$ V. Measure I_{DSS} by noting the saturation current when $V_{GS} = 0$ V. To measure V_p, set V_{GS} close to where $I_D \simeq 0$ and change the 100 Ω resistor with a 10 KΩ resistor. Then slowly adjust V_{GS} to determine when I_D becomes exactly zero to find V_p.

2. Construct the amplifier that you designed in part 1 of the preliminary work section, and verify that your design meets the specs.

To measure the output resistance R_{out}, connect a 470 Ω potentiometer as a load resistor to the amplifier output. Adjust the resistance of the potentiometer while you watch the gain. When the loaded gain is equal to half of the unloaded gain, there is an equal division of output voltage across R_{out} and R_L, in which case $R_{out} = R_L$. Remove the potentiometer and measure its resistance to find R_{out}.

Tabulate the measured values of V_{GSQ}, I_{DQ}, V_{DSQ}, R_{in}, R_{out}, A_v, and peak-to-peak undistorted output swing.

Call the TA and demonstrate the performance of your circuit. Your circuit must meet the specs before you leave the lab room.