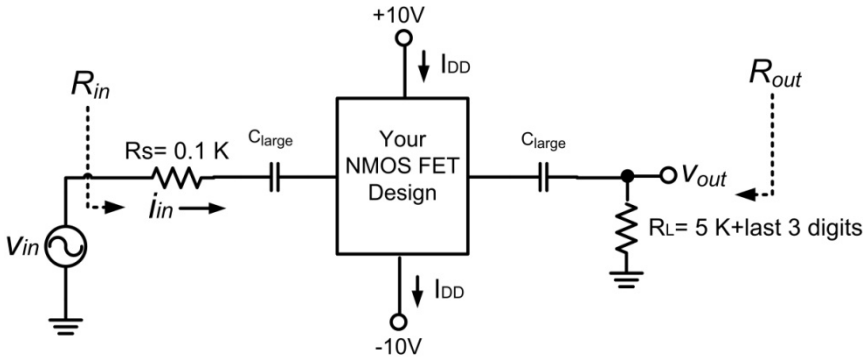
Design a "common-gate" FET amplifier to the following specifications. This will be a single stage design. *This is an individual effort; similar designs will not be graded.*

SPECIFICATIONS:

- Transistor: NMOS FET type V2N2222, Kn = 0.06 A/V^2, V_{TN} = +2.6V, r_0 = large.
- Maximum DC Power Dissipation for transistor: $P_{D,max}$ = 500mWatt
- Resistor-only DC biasing (no current sources allowed)
- Dual DC voltage supply, VDD = +10VDC, -10VDC
- All resistors <= 500kΩ
- All coupling and bypass capacitors = 1 (large)
- Load Resistor, R_L = (5 kΩ + last 3 digits of your student ID)



1. **Hand calculations:** Design a **<u>common gate</u>** single-stage NMOS FET amplifier to achieve a small signal voltage gain (magnitude), $|A_v| = \left| v_{out} / v_{in} \right|$, greater than 5 and less than 10, in other words, $5 \le |A_v| \le 10$. *(Hint: the design could be similar to the circuit shown in figure P4.48 in the textbook problems section at the end of the chapter).*
    a. This is a design project; show all steps for selection of resistors and bias points. Submit all hand calculations. Verify any assumptions. Extra points for neatness.
    b. Submit your schematic and show all resistor values.
    c. What is your calculated voltage gain, $\boldsymbol{A_v}$?
    d. What is your calculated value for $\boldsymbol{R_{in}}$?
    e. What is your calculated value for $\boldsymbol{R_{out}}$?
    f. Estimate the amplitude of the input source, v_{in}, to have the transistor just operating at the condition for small signal. What is this value of v_{in}?

2. **PSPICE:** Simulate your design using an input sinusoid, v_{in}, operating at 1kHz with a peak amplitude equal to 1mV. If using Orcad, use the PSpice model for the VN2222 found in the "EVALAA" library.

    a. Simulate the DC performance of your design. Submit your PSpice **schematic** showing values for DC voltage and DC current on the schematic.

b. What are the simulated DC bias parameters? **Submit a table showing the simulated values for I_{DQ}, V_{GSQ}, V_{DSQ}, and $P_D=(V_{DSQ})(I_{DQ})$**? Is your circuit operating the "**saturated**" region? Did you exceed the **power rating** for this transistor?

c. **Simulated Gain:** Simulate a Transient analysis, **submit** a plot showing v_{in} and v_{out} versus time under small signal conditions. The time scale is 0 to 3 msec, adjust the "max. time step" for a smooth sinusoidal curve. Ideally, plot both curves on the same graph but separate graphs are also acceptable. Are your waveforms *in-phase* or *out-of-phase*? Is there any distortion in the output sinusoidal waveform, v_{out}? What is the simulated voltage gain, $A_v = v_{out}/v_{in}$? (Use cursors to measure the peak amplitudes of each voltage waveform). Compare the simulated value to your calculated value.

d. **Simulated Input Resistance**: Simulate a Transient analysis, **submit** a plot of v_{in} and i_{in} versus time under small signal conditions. What is the simulated input resistance, $R_{in} = v_{in}/i_{in}$? (Use cursors to measure the peak amplitudes of each waveform and calculate the ratio). Compare the simulated value to your calculated value.

e. **Simulated Output Resistance**: Move the voltage source to the output of the circuit. Place a short across the input. Simulate a Transient analysis. **Submit** a plot of v_{out} and i_{out} versus time under small signal conditions. What is the simulated input resistance, $R_{out} = v_{out}/i_{out}$? (Use cursors to measure the peak amplitudes of each waveform and calculate the ratio). Compare the simulated value to your calculated value.

f. **Simulated Gain Over Temperature:** Simulate the transient output voltage over temperature. Using Orcad, in the *simulation analysis profile*, there is a temperature sweep setting. Add this checkbox to the transient simulation. Enter the following three temperatures: -40C, +25C and 85C. Run the transient simulation. The three temperature plots will be superimposed onto the same graph. **Submit** the plot showing the gain with changing temperature. Is your gain stable over temperature?