Accommodating (Activist)

EXPERIMENT 5: FIELD EFFECT TRANSISTOR BIASING

BEGINNER

I. **Main Objective:** To explore and learn by immediately engaging in the assembly and testing of simple FET bias circuits, gaining experience through trial and error.

II. **Procedure:**

1. Enter the virtual lab and watch the presentation. Focus on how the FET bias circuit works in real-life scenarios, paying attention to VDD suggestions and the roles of resistors and capacitors.
2. Choose the resistor and capacitor values yourself based on what you understood from the presentation.
3. Assemble the FET bias circuit in the VR lab using the provided virtual components. Focus on how each part connects and what happens as you build.
4. Use a voltmeter and ammeter immediately to observe what values are present.
5. Write down your measurements in a worksheet or notebook outside the VR. Include notes on what you expected and what actually happened.
6. Use the formulas shared in the VR presentation to calculate voltage and current. Compare your results with your measurements to see if they match your expectations.
7. Create a simple block diagram showing how the meters were connected during your simulation. Include a few handwritten or typed reflections on what you learned from this setup.

EXPERIMENT 5: FIELD EFFECT TRANSISTOR BIASING

1. OBJECTIVES	
A. Content Standards	• Learners demonstrate understanding of the basic operation of a FET bias circuit by assembling a given circuit correctly in a VR laboratory. • Learners apply safe handling practices of virtual instruments (breadboard, voltmeter, ammeter) for basic measurement tasks.
B. Performance Standards	• Learners accurately follow a guided procedure to assemble a simple FET bias circuit in VR. • Learners take basic voltage and current readings at specified points with minimal error. • Learners record and compute basic voltage and current values using straightforward formulas.
C. Learning Competencies/Objectives	• Assemble the given FET bias circuit in VR following basic guided instructions. • Perform simple voltage and current measurements using VR instruments. • Record measurements in a basic table and apply simple formulas to compute voltage and current values. • Create a basic block diagram showing instrument connections.
2. CONTENT	Experiment 5: Field Effect Transistor Biasing
3. LEARNING RESOURCES	
A. References	• ECEN 30034 Experiments Material Module 9 • ECEN 30034 Instructional Material • Electronics Devices and Circuit Theory by Robert L. Boylestad and Louis Nashelsky 10 ed.
4. PROCEDURES	
A. Pre-Activity Preparation	**NAVIGATION OF VIRTUAL LABORATORY** • Students enter the VR laboratory environment and are given 5 minutes to practice basic navigation • Teachers will facilitate the activity by giving instructions, answering questions, and ensuring students are familiar with the VR setup while they explore. **LEARNING STYLE IDENTIFICATION** • Students are given 5 minutes to complete a quick Learning Style Questionnaire to determine if they are Pragmatist, Theorist, Reflector, or Activist.

EXPERIMENT 5: FIELD EFFECT TRANSISTOR BIASING

	KNOWLEDGE LEVEL ASSESSMENT • Students are given 10 minutes to take a pre-test assessing their understanding of FET bias circuits. This will classify them into Beginner, Intermediate, or Advanced levels. **ASSIGNMENT OF TRACKS** • Based on learning style and knowledge level results, students are assigned the appropriate version of the VR presentation and activity procedure.
B. Discussion of Concepts	**INTRODUCTION** A pleasant morning everyone! I'm excited to see you here in our virtual classroom today! Welcome to the Electrosphere! Today, we will explore how to assemble and measure a basic FET bias circuit. We'll work step-by-step, applying only what's practical and needed to complete the task. Don't worry about complex theories right now. We'll focus on doing the circuit using tools properly, reading voltages, and understanding how a circuit works through real actions. Are you ready to get started? Let's jump into our virtual world and bring these circuits to life! **PART 1: WHY FET BIAS CIRCUIT?** FET bias circuits are important because they make sure the transistor works properly. If the bias isn't set right, the transistor may not turn on, or it might behave unpredictably. This can lead to problems in real-world applications like amplifiers or radios. Instead of just reading about it, you'll experience how biasing works by actually building the circuit yourself. Through this activity, you'll see where components go, connect the power supply (VDD), and observe how your FET responds. What to Watch for in the VR Presentation:

- Look at the basic FET circuit diagram and get a feel for how everything connects.
- Notice where resistors and capacitors are placed—try to remember their purpose as you build.
- See where the power supply (VDD) is connected and how it powers the circuit.

As you go through the lab, don’t worry about getting everything perfect right away. Focus on learning through doing. Build the circuit, test it, and check if your readings make sense. This hands-on approach will help you understand how and why the biasing affects the FET’s behavior.

PART 2: WHAT IS VDD AND WHY DOES IT MATTER?

VDD is the voltage you connect to the drain of the FET—it's what powers the whole circuit. Getting this value right is important because it controls how your FET behaves. If VDD is too low or too high, your circuit might not work right. You could see distortion, overheating, or the FET not turning on at all.

But instead of memorizing values, you’ll see what happens when you try different VDD levels in the virtual lab.

What You’ll Notice in the Lab:

- With 5V–9V, the circuit is ideal for low-power uses like sensors or battery-powered systems. Try it and observe how the current stays small and controlled.
- With 12V–15V, there’s more “space” for signal movement. This is great for amplifier circuits you’d typically build in the lab.
- With 18V–24V, you’re entering higher-power territory—used for things like RF applications. But be careful: these higher voltages might need heat protection or extra components.

Try This:

Start with 12V. It’s a solid middle ground. As you build and test your circuit, watch how VDS and ID respond. If something looks off—like no current or weird voltage drops—adjust VDD and see what changes. This hands-on trial and error helps you feel how VDD impacts the circuit, not just understand it in theory.

PART 3: COMPONENTS' PREVIEW

As you build your FET bias circuit, you'll be using real components in a virtual space. These tools let you see and feel how each part affects the circuit's performance.

Main Components You'll Work With:

- Resistors – already chosen for you, just place and observe how they shape the voltage and current.
- Capacitors – also pre-selected. Pay attention to where they're placed and how they affect signal flow.
- Breadboard – your workspace. Move parts around and rebuild if needed—don't worry about mistakes, that's how you learn.
- Multimeter – use this tool to check voltages and currents. Try probing different points in the circuit to see what changes.

Hands-On Tip:
Check your connections before measuring. If the reading seems off, pause and look at the layout again. Even a small misconnection can change everything—and discovering those mistakes helps you understand the circuit better.

PART 4: DIFFERENT WAYS TO BIAS A FET

Let's experience how biasing affects a Field Effect Transistor (FET). Just like BJTs, FETs need to be set at the right operating point to work properly—but instead of memorizing theory, you'll try different biasing methods yourself in the virtual lab and see how each one behaves.

Try These Biasing Methods in Action:

1. Fixed Bias

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This one's the simplest—just a resistor from the gate to the power supply. Build it and notice how quick it is to set up. But keep an eye on your readings; it may not stay stable, especially if conditions (like temperature) change.

2. Self-Bias
Add a resistor to the source (RS). When you try this setup, you'll see how the circuit "adjusts itself" through negative feedback. This version is great to play with and learn how bias can balance out on its own.

3. Voltage Divider Bias
Use two resistors to split the voltage going into the gate. This setup feels more balanced—you'll likely see stable results across different conditions. Try analyzing it visually or by testing voltages to see how the divider works.

4. Feedback Bias
Connect a resistor from the output (drain) back to the gate. This method is neat because it "feeds" some output back to help the circuit stay stable. Try this with an enhancement-mode MOSFET and watch how it reacts.

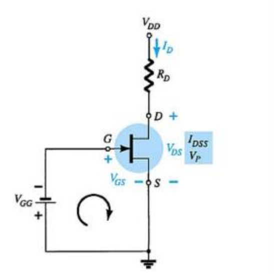
PART 5: BASIC FORMULAS

We'll use only simple formulas today to help pick resistor values.

Key Formulas Presented:

- *Ohm's Law: V = IR (to find correct resistor values for gate, drain, and source)*
- *Fixed-Bias Calculations*

$$V_{DS} = V_{DD} - I_D R_D$$
$$V_S = 0V$$
$$V_C = V_{DS}$$
$$V = V_{GS}$$
$$V_{GS} = -V_{GG}$$



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- *Self-Bias Calculations*

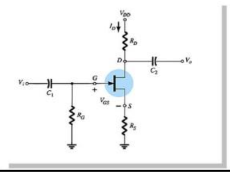
For the indicated loop, $V_{GS} = -I_D R_S$

To solve this equation:

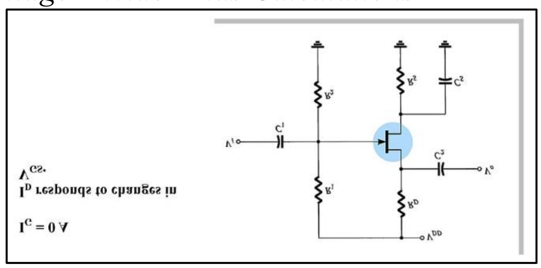
- Select an $I_D < I_{DSS}$ and use the component value of R_S to calculate V_{GS}
- Plot the point identified by I_D and V_{GS}. Draw a line from the origin of the axis to this point.
- Plot the transfer curve using I_{DSS} and V_P ($V_P = V_{GSoff}$ in specification sheets) and a few points such as $I_D = I_{DSS} / 4$ and $I_D = I_{DSS} / 2$ etc.

The Q-point is located where the first line intersects the transfer curve. Use the value of I_D at the Q-point (I_{DQ}) to solve for the other voltages:

$$V_{DS} = V_{DD} - I_D(R_S + R_D)$$
$$V_S = I_D R_S$$
$$V_D = V_{DS} + V_S = V_{DD} - V_{RD}$$



- *Voltage-Divider Bias Calculations*



V_G is equal to the voltage across divider resistor R_2:

$$V_G = \frac{R_2 V_{DD}}{R_1 + R_2}$$

Using Kirchhoff's Law:

$$V_{GS} = V_G - I_D R_S$$

The Q point is established by plotting a line that intersects the transfer curve.

Voltage-Divider Q-point

Step 1

Plot the line by plotting two points:

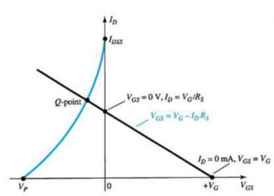
- $V_{GS} = V_G$, $I_D = 0$ A
- $V_{GS} = 0$ V, $I_D = V_G / R_S$

Step 2

Plot the transfer curve by plotting I_{DSS}, V_P and the calculated values of I_D

Step 3

The Q-point is located where the line intersects the transfer curve



Using the value of I_D at the Q-point, solve for the other variables in the voltage-divider bias circuit:

$$V_{DS} = V_{DD} - I_D(R_D + R_S)$$
$$V_D = V_{DD} - I_D R_D$$
$$V_S = I_D R_S$$
$$I_{R1} = I_{R2} = \frac{V_{DD}}{R_1 + R_2}$$

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	• *Reminder that capacitors help smooth out voltages* **PART 6: BASIC SETUP** In the virtual lab, your teacher will walk you through building the FET bias circuit step-by-step using a voice guide. Watch closely, listen, and follow along. Don't worry about remembering all the theory right now—just do what you see. *Place the multimeter probes – Watch where the teacher touches the circuit to take readings.* • *Drag and drop the FET into the breadboard* • *Insert resistors and capacitors into proper places* • *Connect the power supply (VDD) carefully* • *Show where the multimeter probes should touch* You are encouraged to copy exactly at first. Focus on completing the setup without worrying about memorizing theories yet. **PART 7: WHAT TO MEASURE** Once your circuit is ready, you'll use the multimeter to measure: • *VGS — Gate-to-Source Voltage* • *VDS — Drain-to-Source Voltage* • *ID — Drain Current* We'll record these values in our worksheet. After measuring, you'll apply very basic formulas to double-check if your circuit behaves properly. **PART 8: CONCLUSION** You now have everything you need to start building your first FET bias circuit. Today, you learned the essentials: what a bias circuit does, how VDD powers the circuit, how to use simple formulas and how to choose the right resistors and capacitors. Now, it's your turn to make your FET bias circuit!

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<tr><td>C. Presentation of the Experiment and Establishing a Purpose</td><td>EXPERIMENT 5: FIELD EFFECT TRANSISTOR BIASING

Materials: VR headset and controller, worksheet

Main Objective: To explore and learn by immediately engaging in the assembly and testing of simple FET bias circuits, gaining experience through trial and error.
Procedure:
1. Enter the virtual lab and watch the presentation. Focus on how the FET bias circuit works in real-life scenarios, paying attention to VDD suggestions and the roles of resistors and capacitors.
2. Choose the resistor and capacitor values yourself based on what you understood from the presentation.
3. Assemble the FET bias circuit in the VR lab using the provided virtual components. Focus on how each part connects and what happens as you build.
4. Use a voltmeter and ammeter immediately to observe what values are present.
5. Write down your measurements in a worksheet or notebook outside the VR. Include notes on what you expected and what actually happened.
6. Use the formulas shared in the VR presentation to calculate voltage and current. Compare your results with your measurements to see if they match your expectations.
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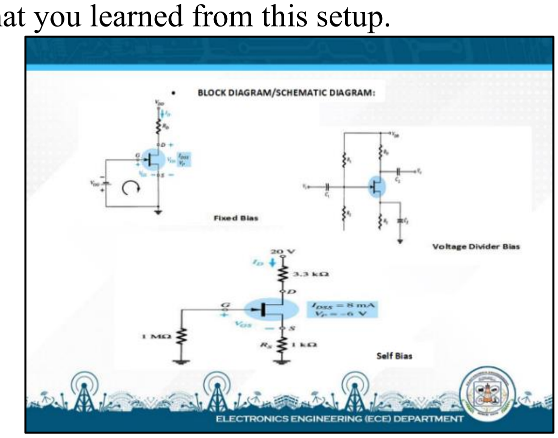
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EXPERIMENT 5: FIELD EFFECT TRANSISTOR BIASING

D. Post-Assessment (Knowledge Check)	Students are given 10 minutes to take a post-test inside VR to measure knowledge improvement by comparing pre-test and post-test results.
E. Experiment Conclusion	The teacher summarizes key learnings, discusses results, and addresses common challenges observed during the VR activities.

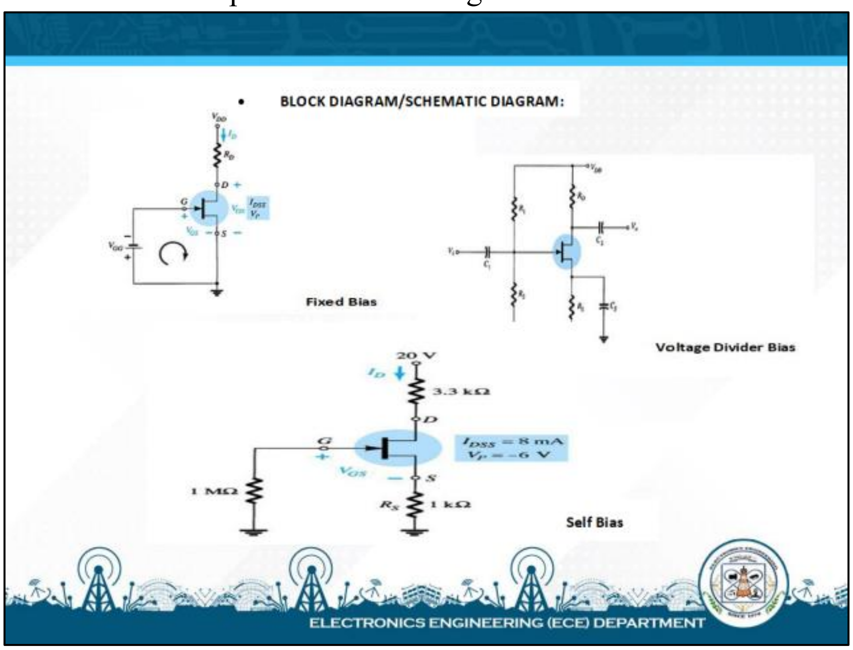
EXPERIMENT 5: FIELD EFFECT TRANSISTOR BIASING

INTERMEDIATE

I. **Main Objective:** To actively experiment with circuit variations, measure results, and adjust configurations to see how changes affect outcomes.

II. **Procedure:**

1. Enter the virtual lab and watch the guided presentation. This will help you understand the FET bias principles and review the basic formulas.
2. Compute the resistor and capacitor values using the formulas shared in the video. Focus on how the values relate to VDD and the FET bias type.
3. Assemble the FET bias circuit inside the VR environment. Use the drag-and-drop tools shown in the demonstration. Copy the arrangement of the FET, resistors, capacitors, and VDD as shown.
4. Use the virtual voltmeter and ammeter to measure voltages and currents at key points (VGS, VDS, and ID). Watch the demo to see where to place the probes. Try to repeat the same steps so your readings are accurate.
5. Record your measurements manually in a worksheet outside the VR environment.
6. Compute and compare measured values with expected results using formulas discussed during the VR presentation and record it in the worksheet.
7. Draw a simple block diagram that looks like the setup you just built. You can base it on the example shown during the demo to make sure it's accurate.



EXPERIMENT 5: FIELD EFFECT TRANSISTOR BIASING

I. OBJECTIVES	
A. Content Standards	• Learners demonstrate understanding of FET bias circuit behavior through independent assembly and theoretical validation using measurement results. • Learners apply analytical thinking to recognize and explain minor discrepancies between theoretical and practical measurements.
B. Performance Standards	• Learners independently assemble the given FET bias circuit in VR, selecting appropriate resistor and capacitor values based on calculations. • Learners perform accurate multi-point measurements and organize data for analysis. • Learners compare theoretical and measured results and explain possible causes of deviations.
C. Learning Competencies/Objectives	• Assemble the given FET bias circuit in VR independently with minimal guidance. • Select suitable resistor and capacitor values based on theoretical calculations. • Accurately measure voltages and currents across multiple circuit points. • Organize data systematically, compare theoretical and measured values, and reflect on minor discrepancies. • Create a functional block diagram of the actual VR measurement setup.
II. CONTENT	Experiment 5: Field Effect Transistor Biasing
III. LEARNING RESOURCES	
A. References	• ECEN 30034 Experiments Material Module 9 • ECEN 30034 Instructional Material • Electronics Devices and Circuit Theory by Robert L. Boylestad and Louis Nashelsky 10 ed.
IV. PROCEDURES	
A. Pre-Activity Preparation	**NAVIGATION OF VIRTUAL LABORATORY** • Students enter the VR laboratory environment and are given 5 minutes to practice basic navigation • Teachers will facilitate the activity by giving instructions, answering questions, and ensuring students are familiar with the VR setup while they explore. **LEARNING STYLE IDENTIFICATION** • Students are given 5 minutes to complete a quick Learning Style Questionnaire to determine if they are Pragmatist, Theorist, Reflector, or Activist.

EXPERIMENT 5: FIELD EFFECT TRANSISTOR BIASING

	KNOWLEDGE LEVEL ASSESSMENT • Students are given 10 minutes to take a pre-test assessing their understanding of FET bias circuits. This will classify them into Beginner, Intermediate, or Advanced levels. **ASSIGNMENT OF TRACKS** Based on learning style and knowledge level results, students are assigned the appropriate version of the VR presentation and activity procedure.
B. Discussion of Concepts	**INTRODUCTION** Good day. Welcome to the Electrosphere! Today, we're diving deeper into the practical side of FET biasing, not just wiring up components but understanding why we choose certain values and how each part affects the transistor's operation. In this session, we'll revisit and apply key concepts like typical VDD, resistor, and capacitor values, biasing methods, and formulas. This goes beyond basic connection because we'll talk about setting the correct operating point, avoiding distortion, and ensuring your FET performs reliably. Let's start! **PART 1. REVIEW OF FET BIASING METHODS** In this part, you won't need to memorize complex theories right away. Instead, while you're in the virtual lab, simply watch how each biasing method is built and how changes in component placement affect the behavior of the FET. You'll learn best by observing patterns and copying setups. We'll walk through four practical biasing methods. As you follow along, focus on how the placement of resistors, capacitors, and the VDD supply changes in each type: 1. Fixed Bias • Gate is connected through a resistor to VDD. • Simple to implement but lacks thermal stability. • Useful for controlled lab conditions and basic switching applications.

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	In the demo, notice how the gate connects to VDD using just one resistor. It's easy to build, but you'll also see it's sensitive to temperature changes. 2. Self-Bias • Source resistor (RS) introduces negative feedback. • Improves stability over fixed bias. • VGS is derived from voltage drop across RS. • Watch how source voltage influences gate biasing in the simulation. Look closely at the source resistor (RS). It's added to create automatic feedback, which improves stability. You'll see the voltage at the source changes and affects the gate's bias. 3. Voltage Divider Bias • Uses two resistors (R1 and R2) to set a stable gate voltage. • Offers better control over VGS and consistent Q-point. • In VR, observe how Thevenin's equivalent helps simplify analysis. 4. Feedback Bias • A resistor connects from the drain back to the gate. • Enhances stability, especially for enhancement-mode MOSFETs. • Circuit responds dynamically to drain current changes. During the VR walkthrough, pay close attention to how VDD levels (typically 9V–15V) and RC time constants (determined by resistor-capacitor values) influence signal behavior and bias point stability. You'll be adjusting or reviewing these to match the biasing method used. **PART 2. REVIEW OF BASIC FORMULAS** We'll use only simple formulas today to help pick resistor values. **Key Formulas Presented:**

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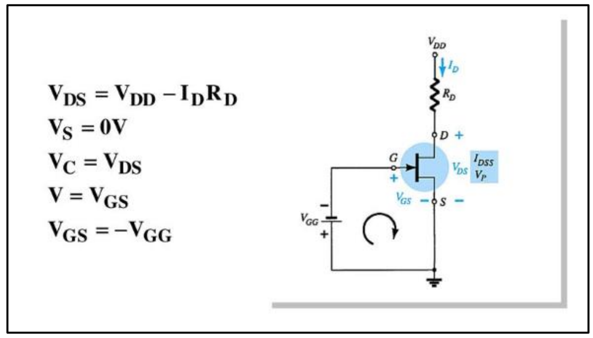
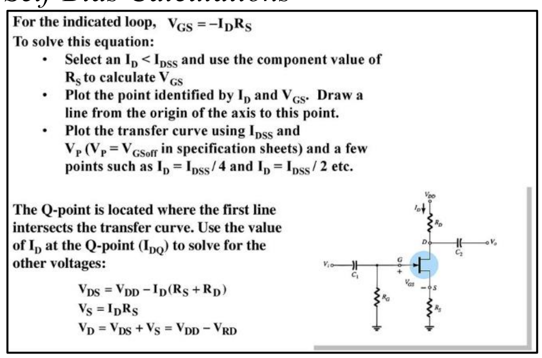
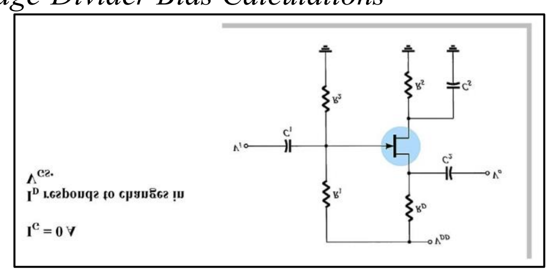
- *Ohm's Law: V = IR (to find correct resistor values for gate, drain, and source)*
- *Fixed-Bias Calculations*



- *Self-Bias Calculations*



- *Voltage-Divider Bias Calculations*



V_G is equal to the voltage across divider resistor R_2:

$$V_G = \frac{R_2 V_{DD}}{R_1 + R_2}$$

Using Kirchhoff's Law:

$$V_{GS} = V_G - I_D R_S$$

The Q point is established by plotting a line that intersects the transfer curve.

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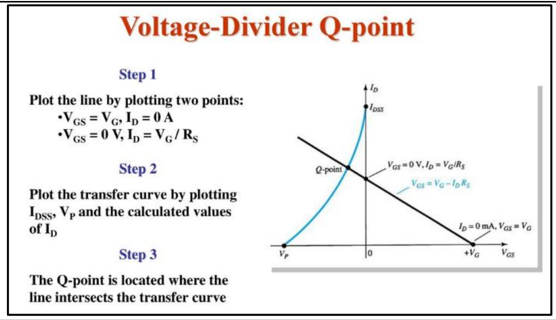


Using the value of I_D at the Q-point, solve for the other variables in the voltage-divider bias circuit:

$$V_{DS} = V_{DD} - I_D(R_D + R_S)$$
$$V_D = V_{DD} - I_D R_D$$
$$V_S = I_D R_S$$
$$I_{R1} = I_{R2} = \frac{V_{DD}}{R_1 + R_2}$$

- *Reminder that capacitors help smooth out voltages*

PART 3: CONCLUSION

Great job following through the discussion! You’ve now reviewed the key principles behind FET biasing, including how to set VDD correctly, and how resistor-capacitor combinations shape the transistor’s performance.

It’s now your turn to put these concepts into action. Begin your virtual lab activity by assembling the bias circuit, measuring VGS, VDS, and ID, and analyzing whether your design aligns with expected values.

C. Presentation of the Experiment and Establishing a Purpose

EXPERIMENT 5: FIELD EFFECT TRANSISTOR BIASING

Materials: VR headset and controller, worksheet

Main Objective: To build, measure, and validate FET bias circuits in a virtual lab, applying formulas and comparing real behavior directly to expected outcomes.

Procedure:

1. Enter the virtual lab and watch the guided presentation. This will help you understand the FET bias principles and review the basic formulas.
2. Compute the resistor and capacitor values using the formulas shared in the video. Focus on how the values relate to VDD and the FET bias type.
3. Assemble the FET bias circuit inside the VR environment. Use the drag-and-drop tools shown in

EXPERIMENT 5: FIELD EFFECT TRANSISTOR BIASING

	the demonstration. Copy the arrangement of the FET, resistors, capacitors, and VDD as shown. **4.** Use the virtual voltmeter and ammeter to measure voltages and currents at key points (VGS, VDS, and ID). Watch the demo to see where to place the probes. Try to repeat the same steps so your readings are accurate. **5.** Record your measurements manually in a worksheet outside the VR environment. **6.** Compute and compare measured values with expected results using formulas discussed during the VR presentation and record it in the worksheet. **7.** Draw a simple block diagram that looks like the setup you just built. You can base it on the example shown during the demo to make sure it's accurate.
D. Post-Assessment (Knowledge Check)	Students are given 10 minutes to take a post-test inside VR to measure knowledge improvement by comparing pre-test and post-test results.
E. Experiment Conclusion	The teacher summarizes key learnings, discusses results, and addresses common challenges observed during the VR activities.

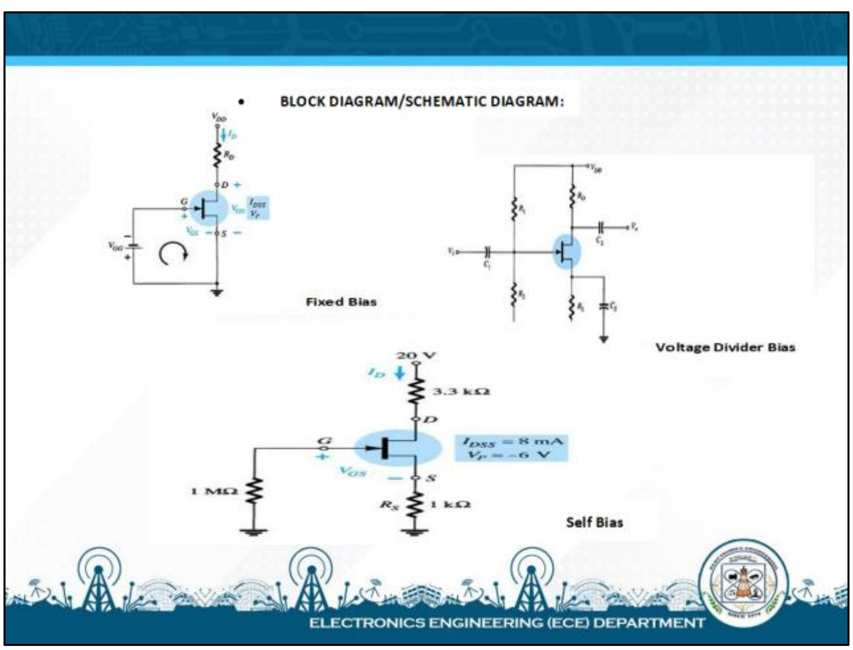
EXPERIMENT 5: FIELD EFFECT TRANSISTOR BIASING

DIFFICULT

I. **Main Objective:** To lead hands-on projects involving the design, testing, and troubleshooting of advanced FET circuits, learning through dynamic problem-solving and real-time feedback.

II. **Procedure:**

1. Enter the virtual lab and watch the guided presentation about bias circuit optimization.
2. Choose optimized resistor and capacitor values using the design tips provided in the video. If you're unsure, follow the sample values shown in the walkthrough. Focus on how these choices affect circuit behavior like voltage drops and signal shape.
3. Build the FET bias circuit using the virtual breadboard and components inside the VR lab. Use the drag-and-drop feature and match your setup with the visual guide.
4. Use the virtual voltmeter and ammeter to take measurements. Watch the demo on where to place probes for accurate voltage and current readings.
5. Write down your measurements (VGS, VDS, ID, etc.) in your worksheet outside VR. This will help you later when reviewing how well your circuit performs.
6. Compute expected values manually using the formulas provided earlier. Compare them with your actual measurements to check if your circuit is working as expected.
7. Organize your results neatly. Highlight any mismatches or unusual readings, and think about what might have caused them (e.g., incorrect values, probe placement, etc.).
8. Draw a block diagram that clearly shows how your circuit is connected, including where your measuring instruments were placed. Use arrows to show signal flow and label each component to make your setup easy to understand.



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I. OBJECTIVES	
A. Content Standards	• Learners demonstrate advanced understanding of FET bias circuit performance, identifying causes of real-world measurement deviations and proposing optimizations. • Learners apply troubleshooting strategies and critical analysis to enhance circuit reliability and performance.
B. Performance Standards	• Learners optimize resistor and capacitor values based on theoretical understanding and practical VR results. • Learners troubleshoot and refine the assembled FET bias circuit to achieve closer alignment between measured and expected values. • Learners develop a detailed block diagram showing refined signal and measurement flows based on their analysis.
C. Learning Competencies/Objectives	• Independently select optimized resistor and capacitor values for improved FET bias performance. • Assemble, measure, and troubleshoot the given FET bias circuit in VR with minimal supervision. • Analyze significant deviations between expected and measured results, diagnose causes, and propose refined solutions. • Develop a detailed block diagram illustrating instrument signal flow and finalized circuit setup.
II. CONTENT	Experiment 5: Field Effect Transistor Biasing
III. LEARNING RESOURCES	
A. References	• ECEN 30034 Experiments Material Module 9 • ECEN 30034 Instructional Material • Electronics Devices and Circuit Theory by Robert L. Boylestad and Louis Nashelsky 10 ed.
IV. PROCEDURES	
A. Pre-Activity Preparation	**NAVIGATION OF VIRTUAL LABORATORY** • Students enter the VR laboratory environment and are given 5 minutes to practice basic navigation • Teachers will facilitate the activity by giving instructions, answering questions, and ensuring students are familiar with the VR setup while they explore.

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	LEARNING STYLE IDENTIFICATION • Students are given 5 minutes to complete a quick Learning Style Questionnaire to determine if they are Pragmatist, Theorist, Reflector, or Activist. **KNOWLEDGE LEVEL ASSESSMENT** • Students are given 10 minutes to take a pre-test assessing their understanding of FET bias circuits. This will classify them into Beginner, Intermediate, or Advanced levels. **ASSIGNMENT OF TRACKS** Based on learning style and knowledge level results, students are assigned the appropriate version of the VR presentation and activity procedure.
B. Discussion of Concepts	**INTRODUCTION** A pleasant morning everyone! It's great to welcome you here to the Electrosphere! Today, we're leveling up! This session is crafted for those who already have a strong grasp of basic biasing. We'll focus not just on building circuits, but on optimizing bias circuits for the best performance. You'll learn practical strategies to fine-tune circuit behavior, balancing parameters like gain, linearity, power efficiency, and stability. Ready to elevate your circuit design skills? Let's dive into advanced biasing optimization in our virtual world! **PART 1: WHY OPTIMIZE BIAS CIRCUITS?** Even if your transistor turns on and the circuit works, it might not be working at its best. Without proper tuning (called bias optimization), several problems can happen: • Distorted output – The signal shape gets messy, especially in amplifier circuits • Overheating – Current can keep increasing (thermal runaway), which may damage the transistor

- Low performance – The transistor might not amplify well or may be in the wrong operating zone
- More noise – This is a big issue in circuits that need clean, quiet signals (like radio or audio systems)

That's why it's not enough to just build a working circuit. You also need to optimize it so it works reliably and efficiently.

Optimization ensures:

- Stable Q-point (Operating point)
- Maximum symmetrical signal swing (avoid clipping)
- Minimum distortion
- Controlled power dissipation

Key Points Shown in VR Presentation:

- *Importance of setting the Q-point in the middle of the load line*
- *How device parameters (like β for BJTs, or Vth for FETs) shift with temperature*
- *Real-world factors: load variations, temperature drift, and manufacturing tolerances*

PART 2: STRATEGIES FOR BIAS OPTIMIZATION

Let's go over the practical methods shown in the presentation for fine-tuning bias circuits:

1. Use of Emitter (or Source) Degeneration

- Add a resistor to the emitter (BJT) or source (FET).
- It introduces negative feedback which improves thermal stability and linearity.

2. Fine Adjustment of Base/Gate Voltage

- Instead of fixed resistors only, use a voltage divider with trimmer potentiometer.
- Let's you "dial in" the exact Vb (BJT) or Vg (FET) needed to set the desired operating point.

EXPERIMENT 5: FIELD EFFECT TRANSISTOR BIASING

	3. Implement Temperature Compensation • Use temperature-sensitive components like thermistors or diode junctions. • As temperature rises, these components adjust biasing automatically to prevent thermal runaway. ***Example:*** *Adding a silicon diode in the bias path whose Vbe drops with temperature to counteract transistor Vbe drop.* 4. Load Line Shifting • After setting the initial bias, recalculate the load line based on real component behavior (not just ideal). • Adjust collector/drain resistor (RC or RD) for symmetrical voltage swing, ensuring maximum undistorted output. *Aim for the Q-point roughly halfway between VCC and ground for amplifier circuits.* 5. Bypass Capacitor Optimization • Bypass capacitors across emitter/source resistors restore AC gain while preserving DC stability. • Fine-tune capacitor value to control lower cutoff frequency (fL) in amplifier designs. **Formula:** $$f_L = \frac{1}{2\pi R_E C}$$ *Larger C → Lower cutoff frequency* *Smaller C → Higher cutoff frequency* **PART 3: WHAT TO MEASURE AND FINE-TUNE** Once you've applied optimization techniques, verify performance by measuring:

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VCE / VDS (Collector-to-Emitter / Drain-to-Source voltage) - Check if the Q-point is centered.
IC / ID (Collector / Drain current) - Confirm bias stability under temperature changes.
Gain (Av) - Confirm amplifier gain matches design specs.
Distortion - Check output waveform symmetry.
Power Dissipation - Ensure within safe device limits.

Slight changes (±10%) in resistors or VDD should not cause major drift in biasing. If it does, your circuit needs better stabilization.
PART 4: CONCLUSION
Today, you explored how bias circuit optimization is not just about making circuits “work,” but making them perform reliably and efficiently.
You learned practical fine-tuning strategies. Now, it’s your turn! Do the experiment and apply these techniques. Let’s start!
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<td>C. Presentation of the Experiment and Establishing a Purpose</td>
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EXPERIMENT 5: FIELD EFFECT TRANSISTOR BIASING
Materials: VR headset and controller, worksheet
Main Objective: To design, optimize, and troubleshoot FET bias circuits for specific goals, using practical VR measurements, manual calculations, and direct evaluation of circuit performance.
Procedure:

Enter the virtual lab and watch the guided presentation about bias circuit optimization.
Choose optimized resistor and capacitor values using the design tips provided in the video. If you're unsure, follow the sample values shown in the walkthrough. Focus on how these choices affect circuit behavior like voltage drops and signal shape.
Build the FET bias circuit using the virtual breadboard and components inside the VR lab.

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EXPERIMENT 5: FIELD EFFECT TRANSISTOR BIASING

	Use the drag-and-drop feature and match your setup with the visual guide. **4.** Use the virtual voltmeter and ammeter to take measurements. Watch the demo on where to place probes for accurate voltage and current readings. **5.** Write down your measurements (VGS, VDS, ID, etc.) in your worksheet outside VR. This will help you later when reviewing how well your circuit performs. **6.** Compute expected values manually using the formulas provided earlier. Compare them with your actual measurements to check if your circuit is working as expected. **7.** Organize your results neatly. Highlight any mismatches or unusual readings, and think about what might have caused them (e.g., incorrect values, probe placement, etc.). **8.** Draw a block diagram that clearly shows how your circuit is connected, including where your measuring instruments were placed. Use arrows to show signal flow and label each component to make your setup easy to understand.
D. Post-Assessment (Knowledge Check)	Students are given 10 minutes to take a post-test inside VR to measure knowledge improvement by comparing pre-test and post-test results.
E. Experiment Conclusion	The teacher summarizes key learnings, discusses results, and addresses common challenges observed during the VR activities.